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REGIONAL REMOTE SENSING, WEST AFRICA
PROJECT 698-0420

FINAL EVALUATION REPORT

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Glossary of Terms

- AFR/RA - Office of Regional Affairs, Bureau for Africa (A.I.D.)
- A.I.D. and AID/W - Agency for International Development (Washington)
- CFA - Francophone West African Unit of Currency
- CRTO - West Africa Regional Remote Sensing Center (Centre Regional de Teledetection de Ouagadougou)
- ECA - Economic Commission for Africa (U.N. regional economic body in Addis Ababa)
- EOSAT - Earth Observation Satellite Company (The Organization presently managing the LANDSAT program)
- FAO - Food and Agricultural Organization (UN Specialized Agency)
- GTZ - Deutsche Gesellschaft for Technische Zusammenarbeit (German technical assistance agency)
- IDRC - International Development Research Council (Canada)
- ISTI - International Science and Technology Institute, Inc.
- LANDSAT - Land Satellite - The U.S. Civilian earth resources satellite program
- REDSO/WCA - Regional Economic Development Services Office/West and Central Africa (AID regional office in Abidjan)
- R.S. - Remote Sensing
- SPOT - Satellite Pour l'Observation de la Terre (New French land resource satellite series)
- UNDP - United Nations Development Program
- UNSO - United Nations Sahelian Office (Part of UNDP)
- USAID - AID field mission

1.0 Executive Summary

U.S. assistance to the West African Remote Sensing Center (CRTO) has been made available within the framework of a collaborative effort involving a number of donors on the one hand and a group of West African countries on the other. The AID project was conceived and designed in the mid-1970s following the launch of LANDSATs I and II as part of a larger AID interest in encouraging the use of these new sources of data in the developing world. Ouagadougou was selected as the project site because of its Sahelian location, availability of local facilities and support by other donors, particularly France.

The U.S. project (698-0420) was initiated in 1978 and has totaled \$3.4 million, devoted mainly to technical assistance, support for training, the enlargement of the Center's physical facilities, and equipment and supplies for its photo laboratory. The project is scheduled to end in December. A mid-term evaluation was carried out in March-April 1983; its impact was vitiated by other circumstances (Section 3.2).

A technical appraisal of the project indicates that its major contribution has been in training Africans in remote sensing technology and its applications. 221 Africans have received training of whom 75% have been francophone (trained mainly by French resident experts) and the remainder anglophone. Nearly half of those who complete the introductory three month course go on to the more applications-oriented advanced course, also three months.

The anglophone program was judged to be more informal and applications oriented while the francophone tended to be more structured and theoretical. Both only provide an introduction and grounding in the technology. Most of the trainees have returned to the government agencies that sent them and about 20-25% are believed to be actively utilizing their training on remote sensing subjects. A common criticism of the program by interviewees was its short duration and the need for increased specialization in a wider variety of disciplines -- changes that would involve a major redirection of CRTO and increased costs.

The user assistance program, although a major original objective of the project, has had a limited character and impact, so far as the evaluators could tell. Reasons have been the limited staff and financial resources of the Center, the limited availability of imagery, lack of participation by the U.S. staff since mid-1982 (due to contractual problems), and the intrinsic difficulty which a regional institution confronts when requested to work on project specific and country-specific subjects. Most of the user assistance activities carried out by the CRTO has been on smaller projects and located in Burkina Faso.

The photo laboratory is a major and vital component of the project because CRTOs training, user assistance and data dissemination functions depend on it for photo products. Although well housed and equipped, management and maintenance have been plagued by problems since mid-1982. These are the results in discontinuities of U.S. technical assistance and, more basically, by delays in the identification and recruitment of an African manager. The latter problem has recently been resolved but, unless the project is extended, there is inadequate time remaining for training the new arrival. In addition, the lab requires additional personnel, equipment and supplies, and a facility for treating its effluent.

The library and archives of the Center are presently inadequate to its needs and recommendations are made for reorganizing and refurbishing these facilities. A major problem affecting CRTO's technical capacity to respond to requests for services is lack of adequate imagery.

The performance of the U.S. technical assistance contractor staff has been excellent from various standpoints including technical quality, teaching ability, rapport with African and French colleagues and ability to function in a Sahelian milieu. Technical services have, however, been adversely affected by problems of contract continuity which, in turn, was a result of conflict and indecision within AID, 1982-84, as to the future of the project.

The project has made a contribution to the understanding and use of remote sensing technology in West Africa, especially through the results and "spread effect" of its training program. This contribu-

tion has been reinforced by West African exposure to various donor funded resource planning projects involving remote sensing and by more recent efforts in Senegal, Cameroon, Ghana, Mauritania and the Ivory Coast to establish national remote sensing centers. However, the increasing and import-intensive nature of the costs of the technology imply a continuing need by West African countries for external assistance for some time to come. Outside of the training program, the CRTO has done little to disseminate remote sensing technology through such means as conferences, workshops, publications, etc.

Good progress has been made in Africanizing the CRTO's staff. A relatively capable, multi-national, multi-disciplinary group of junior and mid-level African professionals has been recruited and is assisting with the training and user assistance programs and with the Center's administrative functions. While well versed in their occupational disciplines, many of these people should have further training in remote sensing theory and applications before being asked to replace the expatriate teachers.

Progress in "Africanizing" CRTO's financial condition has been difficult to evaluate because of problems in obtaining information. Although revenues from the sales of services continue to be disappointingly low, it appears that in 1985 CRTO's internal cash flow actually ran a surplus due to an unusual inflow of contributions from six member countries. However, future financial prospects are uncertain since future contributions are unlikely to continue at the 1985 level and the CRTO's operating costs will rise as donor financing for imported supplies, spare parts and materials declines.

CRTO's financial situation is related to its management which has both strengths and weaknesses. Management has been very successful in soliciting contributions and assembling an African staff. Internal management of CRTO's operations follows a formal, hierarchical and compartmentalized style which has had negative effects on staff morale and sense of organizational identity.

AID management of the project has been affected by ambiguity as to "who is in charge" -- USAID or AFR/RA -- for field implementation, by the "regional" nature of the project and by its fairly low priority status within USAID's portfolio. Day to day USAID backstopping has been good. However, the project went through a period of turmoil between 1982 and 1984 -- due to conflict and indecision within AID as to its future -- which has adversely affected its substantive effectiveness.

CRTO recently sponsored a "Round Table" meeting of donors to discuss "Phase II" of the project, namely the construction of a station to directly receive, record, process and disseminate data from LANDSAT and/or SPOT satellites. A review of the papers presented at the meeting has led the evaluators to conclude that U.S. participation in such a project would not be advisable.

In comparing the project's performance with its original objectives, it appears that the project was reasonably successful in achieving its program or sector goal of contributing to the general advancement and utilization of remote sensing in West Africa, mainly through CRTO's training activities. Less success has been realized with respect to the project purpose of building a strong and dynamic regional center, especially in respect to user assistance and outreach capabilities. Progress has been made, however, in turning the Center over to African hands.

With respect to "lessons learned" from the project experience, the evaluation identifies and discusses the following:

- (a) The effectiveness of technical assistance is as much a function of its continuity and management as it is of its technical quality.
- (b) Regional programs may be a good way to introduce a new technology but may not be the best way to apply it.
- (c) Technology-driven projects run the risk of confusing ends and means.

- (d) Project management suffers if there is ambiguity as to who is responsible for field implementation.
- (e) Remote sensing data does not require high technology equipment and training to be an effective tool in resource evaluation and development.

The evaluation discusses the following issues and recommendations with respect to future AID relationships with CRTO and remote sensing in West Africa:

- (a) AID should not participate in Phase II.
- (b) AID should complete its assistance to CRTO with the present project. The benefits of a follow on project would not justify the additional costs. However, turning the project over to CRTO in a responsible and tidy manner will involve a number of specific actions (as discussed in Section 10.2). They would and should involve additional funding and an extension of the term of the project and the Spectral Data contract to mid-1987.
- (c) AID should continue to support the technology of remote sensing, not as a stand alone concept but as one of a number tools -- and an important one -- to help Africa address many of its major natural resource and environmental issues. On the basis of its visits to 12 West African countries and AID missions, the team believes that a project which offered USAIDs and African agencies access to environmental problem-solving services and resources -- including but not limited to remote sensing -- would soon be in heavy demand. The team believes the proposed NREMA project, including a remote sensing component, would serve such a purpose and recommends its vigorous support by the Africa Bureau.

2.0 Introduction

A final evaluation of project 698-0420 (West Africa Regional Remote Sensing) was commissioned by AID/AFR/RA in June, 1986. AID contracted for this task with the International Science and Technology Institute, Inc. (ISTI) which in turn employed John D. Blumgart (Program and Institutional Analyst) and Andrew S. Stancioff (Resource and Remote Sensing Expert) to carry out the study. Its scope of work is included in Annex II.

The evaluation methodology consisted of (a) visits to twelve of the fifteen CRTO member countries and (b) a review in Ouagadougou of the work of the CRTO itself. Stancioff visited ten of CRTO's Franco-phone members and Blumgart two of the Anglophone. Team members were in Africa July 3 - August 14 with the following month devoted to write up and debriefings in Washington.

The team wishes to express its thanks to USAID/Burkina Faso for the support it rendered while the team was in Ouagadougou and to each of the West African USAIDs and REDSO/WCA for their assistance during the country visits. Thanks are also extended to the Director General Leon Okio and to members of his staff for their assistance and for spending many hours discussing CRTO matters with the team. The members of the Spectral Data field staff were also most helpful. The team wishes to indicate its special thanks to Jeanne Marie Zongo and Marie Noelle Tuyna of USAID/Burkina Faso and to Christine Chereese Powell and Aisha A. Samatar of ISTI for their skilled, patient and steadfast efforts on the preparation of this report.

Throughout this exercise the West African Remote Sensing Center was referred to by its local acronym, CRTO, (Centre Regional de Teledetection de Ouagadougou) and the team has used that term in referring to the Center in this report.

3.0 BACKGROUND

3.1 Brief History and Description of Project

3.1.1 Program Framework

U.S. assistance to the West African Remote Sensing Center (CRTO) has been made available within the framework of a collaborative effort involving a number of donors on the one hand and a group of African countries on the other. The AID project was conceived and designed in the mid-1970's, following the launch of LANDSATs I and II, as part of a larger AID interest in encouraging the use of these new sources of data in the developing world. AID's objectives were to identify and demonstrate specific ways in which such data could help developing countries to plan and deal with their own environmental and natural resource issues and to train African planners and technicians in such applications.

AID's interest in bringing the results of the new technology to the developing countries was matched by an equally strong desire by the latter to participate in the benefits which it promised. In Africa, in particular, a ministerial meeting of the U.N. Economic Commission for Africa (ECA) called as early as 1975 for actions to promote the transfer and use of the technology throughout the continent. Subsequently, the African countries, again working through ECA, reached agreement on a plan for establishing regional centers (for receiving, processing, storage and disseminating satellite data and for training and technical assistance in the technology) at five locations -- Cairo, Nigeria (Ile Ife), Kinshasa, Nairobi and Ouagadougou, Upper Volta (now Burkina Faso).

The choice of Ouagadougou commended itself to AID for a number of reasons. Its Sahelian location underlined AID's interest in addressing environmental problems in that region, then in the midst of a severe drought. In addition, land and basic facilities for such a Center were available at the site of a former French satellite tracking station and France was prepared to provide major collaboration and support for a project at that location. During

approximately the same period, AID also agreed to provide important support for a similar regional center at Nairobi to serve East and Southern Africa.

Since the launching of CRTO in 1978-79 the U.S. and France have remained the project's principal external donors. Canada was an early participant as a major donor but has since withdrawn due to problems in relationships with the local government and disagreements with France in regard to the proposed receiving station. UNDP, UNSO, FAO, West Germany (GTZ), IDRC and The Pope John Paul II Foundation have also been furnishing items of assistance from time to time. On the African side, a regional framework for the CRTO has been established. It includes a Governing Statute for the rules and procedures of the Center, a headquarters agreement between the Center and host government, and a Regional Management Committee composed of representatives of each of the fifteen countries that have joined the Center*. The Committee is represented by a five member Executive Board to which the head of the Center, the Director General, reports.

3.1.2 The Project (698-0420)

The AID project for assistance to the CRTO was approved in 1978. It was contemplated as a five year project that would be structured in two phases. Phase I, of some two years duration, would involve the Center only in training, user assistance and dissemination functions based on LANDSAT imagery and other data products such as aerial photography. If Phase I activities were implemented successfully, evidence of significant African support was forthcoming, and a number of other caveats were satisfied, a second phase was contemplated in which a satellite receiving, recording and data processing facility would be added to the Center. Canada was envisaged as the major funding source for the receiving station.

* Current membership consists of Algeria, Benin, Burkina Faso, Cameroon, Congo, Ivory Coast, Ghana, Guinea, Liberia, Mali, Mauritania, Niger, Senegal, Sierra Leone and Togo

The U.S. and France, which had agreed to provide the major support for training and other technical assistance activities during Phase I would continue such assistance during the second.

In the event, for a number of reasons discussed elsewhere, the Center has yet to enter Phase II. Thus U.S. and French support has largely been devoted to technical assistance activities. U.S. funding to date (a total of \$3.375 million) has financed, under a contract with the Spectral Data Corporation, remote sensing specialists in various skills who have conducted most of the anglophone training courses, undertaken "sensitization" missions to member countries and provided assistance to Africans wishing to use the technology to solve specific problems. During the period 1979-82, the contract provided three long term specialists, a geographer, a forestry applications specialist, and a photo laboratory engineer. Of particular importance for the project has been support to the Center's photo lab since the CRTO's training and technical assistance functions depend on a local capability to process and reproduce imagery, aerial photos, maps and other visual data products. The AID grant financed a building and equipment for the lab as well as an expansion of The Center's facilities. AID has also financed items for CRTO's operating costs, particularly imported requirements such as supplies for the photo lab, satellite imagery and tapes, publications, travel and training funds. Since June 1982 U.S. technical assistance has been sporadic and intermittent due to contracting and implementation problems and delays.

3.2 The 1983 Evaluation and Results

A one month evaluation of the project was conducted in March/April 1983 by two remote sensing specialists who visited seven of CRTO's member countries as well as reviewing the work of the Center. The team found that the project was meeting many of its Phase I objectives but falling far short on others. CRTO had made good progress in training West African technical and professional cadres, publicizing the Center's capabilities to national authorities, undertaking studies and reports on development activities utilizing

remote sensing, setting up a well functioning photo lab, assisting in the establishment of two national centers and starting the process of Africanizing CRTO's staff.

However, the evaluation team also pointed to a number of unresolved problems that threatened the future of the project. Of particular importance was the lack of trained African staff to carry out the Center's technical functions, a lack of expatriate staff to conduct advanced training or provide user services, a poorly functioning capability to perform routine administrative functions or deal with staff problems and a lack of progress in obtaining local financing through revenues for CRTO services or member country contributions. It also noted that the photo lab, and with it the Center, was in jeopardy through inadequate maintenance and lack of staff. The evaluation team also questioned the emphasis placed on a Phase II receiving station, pointing out that there was more than adequate existing satellite data to meet the Center's needs.

The evaluation team recommended a 2 1/2 year time extension and additional financing for the project (\$2.3 million) to permit (a) recruitment of a 5-6 person technical assistance staff of whom the chief would serve as CRTO's Deputy Director, (b) additional equipment and space for the lab, (c) short term experts, supplies and travel. The foregoing would be subject to CRTO agreement to fill specific counterpart positions. In addition, the team recommended a major reorientation in the style and function of the U.S. staff. Rather than having a training/technical role and be largely based at the Center, the team would be a more mobile, operational unit to scout out and promote remote sensing activities, carry out projects and generate income for the Center. The team leader (Deputy Director) would lead this effort. The training program would be revised to emphasize advanced training and management.

Although supported by the Mission, the evaluation's major funding and personnel recommendations were not followed in the AID/W project review process during consideration (1983-84) of the project's extension and further funding. However, some of the thrust of the

evaluation found expression (when the project was eventually reactivated) in the increased stress placed on the marketing and sensitization functions of the U.S. team leader and in the new conditions precedent that were added to the grant agreement to leverage CRTO's recruitment and placement of an African photo lab technician, fill other African staff vacancies and produce a financial plan.

3.3 Current Status of the Project

3.3.1 Status of the CRTO

At the present time the CRTO is performing its technical functions under African management, augmented African technical staff and continued expatriate assistance. Courses in introductory and more applied remote sensing subjects are underway for classes of five anglophone and eleven francophone students concurrently. A new Director from Benin, chosen by member countries in accordance with the Center's Statute, replaced the previous Director in August 1984. A number of Africans, some graduates of the training program, have been appointed to technical and mid level positions. A team of four French specialists and (at the moment) four U.S. experts are providing assistance in training, photo lab maintenance and operations, user assistance activities and in publicizing the Center's capabilities among current and potential member countries. Financially, although some progress has been made in member country contributions and in generating revenues from services, CRTO remains largely dependent on assistance from donors, especially the U.S. and France. The AID project (698-0420) ends in December 1986. France is reportedly planning to carry out an evaluation of its own of the CRTO as a basis for defining a future relationship. Thus CRTO is entering a critical phase in its evolution.

3.3.2 Donors Round Table and the Issue of a Receiving Station

From its very beginning the CRTO project contemplated the possibility of adding a satellite receiving, recording and data processing facility to complement and reinforce its training,

technical assistance and data dissemination functions. "Phase I" of the project was thus seen as the possible prelude to "Phase II". The technical, financial and managerial pros and cons of such a step are discussed in Section 7.0.

Phase II has been the subject of numerous technical and programatic discussions going back to the early years of the project. It received a major set back in the early 1980's when Canada and France reached an impasse on the design, capability and cost of the equipment to be installed.

More recently, the cause of a receiving station has been pressed by the African members of CRTO, especially by the Executive Board of its Regional Management Committee. After several postponements, a "Round Table" to solicit support for Phase II was held July 28-29, 1986 in Ouagadougou with the Chairman of the Executive Board as its presiding officer.*

The meeting was attended by representatives of France, the U.S., the European Development Fund, UNDP, UNSO, FAO and IDRC. Notably absent were Canada and West Germany.** Since the meeting was held on fairly short notice, few of the donors (including the U.S. which declined to sign the minutes of the meeting) were able to provide financial commitments for Phase II although some hope was held out by the European Development Fund and the smaller donors expressed interest in continuing technical assistance. The exception was France which had assisted CRTO to prepare the meeting's documentation and was represented by a special delegation from Paris. The delegation announced that France had budgeted 30 million French francs (about \$4.3 million) for a satellite receiving facility, particularly one capable of receiving imagery from the

* See Annex III for a summary of the proceedings of the Round Table
** West Germany, like Canada, had previously considered contributing to a receiving station, especially the antenna. At the Round Table a letter from Bonn was read announcing West Germany's willingness to provide limited training equipment to CRTO and to provide similar help for remote sensing related activities in Senegal, Cameroon, Niger and Sierra Leone.

SPOT series. However, the delegation noted that French support would be dependent on major complementary assistance from other donors as well as evidence of African ability to support the increased operating costs that a receiving station would involve.

The participants also discussed and established a time table of preparatory steps for undertaking Phase II (studies, fund raising, tenders, bid evaluation, contracting, etc.). However, given the uncertainty of donor attitudes, the Round Table was at best inconclusive regarding the prospects of organizing and financing Phase II. At worst, it tended to distract attention and emphasis from the CRTO's very real problems associated with continuing and optimizing Phase I.

4.0 Assessment of Project's Technical Activities

This section summarizes the technical activities of the project. It is based on interviews with 53 member-nation users and government officials, 55 USAID mission personnel, 4 CRTO staff, 14 U.S. contractor personnel, 31 present or ex-CRTO trainees and 16 other individuals from donor organizations or remote sensing related projects.

4.1 The Training Program

The principal emphasis of CRTO's activities since its inception has been on training. Since July of 1978, 221 individuals have received remote sensing training at the Center in French for francophone countries and in English for anglophone states. Most of the trainees have had three months of training, others 6 and a few 9 months. Since the beginning, training has been conducted by French, American and Canadian experts. Beginning in 1980 some training activities have been conducted by Africans. In 1985 African training staff was increased and now includes from 4-9 staffers depending on the type and level of the course offered.

4.1.1 Historical and Quantitative Summary

Of the 221 trainees, 169 have been francophone and 52 anglophone. Nearly one fourth of the francophone trainees have come from Burkina Faso and over one quarter of the anglophone have come from Ghana. Until recently, course work has been taught in separate three month segments of introductory and advanced training. A total of 112 students (87 francophone and 25 anglophone) have continued with the 3 months of advanced training. Average class size has been 11 for basic courses and 5 for advanced in the francophone, while an average of 7 anglophones have attended introductory classes and 4 the advanced courses. Most trainees come from the public sector and return to the ministries from which they come. It is estimated that about 25% of the graduates have opportunities to apply their training. A large percentage (43%) of the trainees are geologists and foresters by training. Of the francophone introductory trainees, 74% are college graduates and 26% technicians (high school) as compared to 58% and 42% for the anglophones. The anglophones in the advanced course are all college graduates. Four photo technicians have been trained in the photolab. All are francophone.

4.1.1.1 The Anglophone Course

The anglophone course has been taught by up to three scientists and technicians provided under contract by Spectral Data Corporation. This company has supplied masters or PhD level geographers, foresters, geologists and a photo technician since the first anglophone course was taught in 1979. Interviews indicate that the entire staff stresses the basics of remote sensing and particularly promotes practical hands-on interpretative work and field work. More recently African staff members have been added and have taught one 3 months course as well as assisting in the teaching of a specialized courses in French along with the contractor staff. The curriculum for the anglophone course follows the typical U.S. college curriculum in remote sensing.

4.1.1.2 The Francophone Course

This course has been offered by French expatriates and visiting lecturers, since 1978. Most of the higher level teachers and lecturers come from the French space program offices at Toulouse or from the Institut Geographique National (I.G.N.) with some coming from universities in France. Junior lecturers and remote sensing technicians have worked at CRTO in lieu of military service and these generally spend only a few months at the Center. The francophone course is structured in a more rigid academic manner with emphasis on theory. Recently African staff have augmented the expatriate staff and now 6 Africans assist in teaching as well as working in the lab, conducting field exercises and working in user assistance. These new staff members have good skills in their subject matter disciplines but are short on remote sensing training, most of which has been obtained by working at the Center.

4.1.1.3 Trainee Selection Procedures

The trainees are proposed by their host country institutions and nominees are screened and selected by the Center. Nevertheless, a recurrent problem is their very disparate backgrounds, abilities and motivation. Candidates vary in educational background from technical school graduates to PhD's. Moreover, the calibre and background of a PhD in rural development or geography is often not at the same level as one in agronomy, pedology or geology and calibre varies also from one country to another. To eliminate this problem it was proposed in the 1983 USAID CRTO evaluation, that prospective candidates be tested in their countries by the CRTO staff visiting the countries on sensitization missions (as was done with good results in the early anglophone courses). It was also suggested that technicians be taught a separate less advanced course with an emphasis on data collection, reduction (drafting) and archiving.

4.1.1.4 Financial Costs and Benefits of Training

As usual this is a difficult subject to address since we do not know exactly how each country is benefiting from the training of its people. However, we can relate training per se to expenditures by the donors and member states. Considering that 221 people have received an estimated 1000 man months of training at CRTO which has cost approximately 8.5 million dollars,* training has cost $\pm 40,000$ per man or \$8,500 per man/month. On the other hand if we look strictly at the anglophone training and consider only the 52 anglophone trainees and the 3.4 million USAID investment, we arrive at a \$65,000/trainee figure. If we subtract the 1 million dollar estimated cost for the photolab (building + materials etc.) we arrive at a figure of approximately \$44,000 per man. In view of the limited usage by trainees of remote sensing techniques (see Section 4.2.1.3), this seems a high price to pay for training. To the extent one allocates project costs to user assistance activities and other CRTO services, the cost per trainee declines. However, the training program has not been as cost effective as had been hoped.

4.1.2 Assessment of Training Program

The program's assessment is summarized in Annex I, Section A and Table A-1 and in the following sections.

4.1.2.1 Course Assessment

In reviewing course work offered at CRTO, actual curriculum (French plus English) was discussed with instructors. In addition, results of the program were discussed with students at CRTO, ex-students in their home countries, with management personnel in participating countries, and with AID missions and other representatives of

* This is a very rough calculation representing contributions of \$3.4 million U.S., about the same for France, \$800,000 for Canada and the balance from African sources.

international organizations. Also reports and theses of students (advanced courses) were reviewed as were other activities, seminars and special courses.

The anglophone instructors felt some improvements could be made to the courses offered by having more instructors from more varied backgrounds, such as hydrology and agronomy. The francophone instructors were satisfied that the courses as offered met the needs of West African development.

Ex-students tended to praise the anglophone courses but found the francophone to be too theoretical. All agreed that advanced courses are not long enough, do not provide the students with experts in their field, do not focus enough on applications, and do not permit them to spend enough time in the field in their own countries reviewing the results of their efforts before returning to CRTO to complete the work under the instructor's guidance. The advanced courses are limited in scope due to the lack of instructors, the lack of imagery, the particular training of the instructors, and the short duration of the advanced course and the lack of training of the African staff.

West African management personnel on the whole believed that the francophone courses were not at a high enough level and not sufficiently applications oriented. Comment on the anglophone course was that the instruction was very good as far as it went but was too short, did not offer enough specialized segments, and that the instructors were too few. Most managers felt that higher level courses, field experience, and specialized course under experts in those fields were lacking at CRTO, and that such courses were important to West African development.

Review of about 15 reports of advanced CRTO students reflect the problems mentioned above by the ex-students and management people. The reports, however, in every case do address West African development problems if in a parochial way and indicate a good grasp of the subjects by the students. In summary, the students with very few exceptions have not had a chance to test their abilities because of the limitations of the Center's resources.

The evaluation team concludes that training courses, advanced instruction and seminars in remote sensing at the CRTO as prepared and presented by the CRTO staff, have, as required, focused on applications to West African development needs. These courses have been beneficial and relevant. A recent course in agro-statistics has been the exception to this relatively positive response. The shortcomings of the current program and the improvements suggested (longer, higher level, more specialized courses and a larger student throughput) are reasonable but would require a larger more higher trained staff and expanded physical facilities. Whether the expense of such measures would increase the cost effectiveness of the program is a question the team is not able to answer.

4.1.2.2 Deployment and Utilization of Trainees

Thirty one of 221 CRTO trainees and graduates were interviewed 18 of these were at CRTO of which 15 were students and 3 were instructors. The remaining 13 ex-trainees were all working on some aspect of remote sensing. In Senegal, Cameroon, Mali, Niger, Ghana and Liberia the trainees were working on R.S. projects whereas in Mali, Niger, Guinea and the Cameroons ex-trainees also function as (or functions chiefly as) advisors in remote sensing to their ministry. On the whole, trainees appear to return to positions which are relevant to the skills they acquired at the Center and a significant minority are applying those skills in their job situations. Unfortunately, lack of an "alumni networking" activity on the part of CRTO makes timely information on trainee utilization difficult to obtain.

4.2 Assistance to Regional Resource Projects and Resource Planners - The CRTO User Assistance Department

User assistance is one of the two main objectives of the CRTO. In principle, the CRTO staff should be sensitizing member states, international donors and other potential users of the CRTO potential to assist them in resolving natural resource and environmental monitoring problems. The staff at CRTO should not only know how to conduct these surveys but also how to plan the projects, prepare the terms of reference, submit the proposals and negotiate the contracts.

In this context the previous USAID evaluation had recommended that a training course be taught at the CRTO which would have been specifically aimed at achieving such objectives.

4.2.1 Summary of User Assistance Projects

Since its inception CRTO has conducted 28 user assistance projects for various agencies and organizations. They are listed in Annex IV. Not all of these have been user-financed; in fact many were conducted free of charge. Of the 28 projects, 20 have been conducted in Burkina, one in Ghana, one in the Cameroons, three in the Ivory Coast and in Benin, and one for the region.

4.2.2 Extent of User Demand and Capacity to Meet Demand

User demand is difficult to judge because all requests are filtered through the Director's office or through individuals at the Center. However, judging by the visits to member states it appears that in most cases when user assistance at CRTO has been requested to supply information on imagery, costs, or the imagery itself the CRTO has been unable to supply the need or uninterested in doing so. No CRTO brochure was seen which indicates the services available to users and the CRTO newsletter has been defunct for 3 years.

Although most staff members at CRTO appear underutilized it seems improbable that a heavier demand for users services could be met. A major constraint is lack of available imagery. Furthermore, projects outside of Burkina would require lengthy periods of field work by African and expatriate staff. The capacity of the photo lab to support a large number of projects has yet to be tested but would probably be constrained by a lack of staff. In addition, the African user assistance staff is not yet trained adequately to provide such services. On the basis of reviewing many of the internal CRTO reports, they are judged to be adequate or good if evaluated on trainee criteria but do not meet international standards. Problems of space and equipment are also constraints. Because of these various constraints, the impact of the user assistance program on West African resources management has been quite limited.

4.3 The Photographic Laboratory

The main functions of the photographic laboratory are the acquisition, storage, processing, production and distribution of remote sensing imagery. Its chief objectives are to (a) support student training projects at the Center, (b) support remote sensing projects carried out by or in cooperation with CRTO, (c) produce and sell imagery to approved requestors, (d) train photographic laboratory technicians for West African remote sensing organizations, and (e) assist remote sensing photographic laboratories in West Africa.

4.3.1 Historical Review and Description

From its inception the photographic laboratory was under the supervision of Mr. James Sorenson, with the assistance of Mr. Bougna Benoit Gomina, a Burkinabe trainee who attended the Center's first training course and remained to assist with day-to-day production of the lab. Having completed supervision of construction of the photographic laboratory and the installation of equipment, Sorenson has generally managed the operations of the lab including the acquisition, production and distribution of photographic products.

A major and protracted problem of the photolab has been the length of time it has taken for CRTO to identify and recruit an African counterpart to Sorenson. This was apparently a result of a scarcity of candidates with suitable skills and experience as well as the time consuming employment procedures that govern CRTO. Several candidates were identified but fell by the wayside. The absence of a counterpart and the expiration of the Spectral Data Contract created a technical and management vacuum at the photolab (despite the good efforts of Mr. Gomina) resulting in the breakdown of equipment, pilfering of supplies and general disorganization. During the period from August 1983, Sorenson has been brought back five times for short periods to restore chaos, repair equipment and reorder supplies. Meanwhile, USAID kept pressing the CRTO to provide a counterpart and when the project was reactivated in late 1984 such action was made a condition precedent of the amended grant

agreement. Nevertheless, it was not until July 1986 that CRTO assigned an African professional to the lab. The training of this person is of critical importance to the future of the lab.

Because little LANDSAT data have been gathered over West Africa during 1982-86 acquisition of additional imagery for the photographic laboratory's library has been limited to only a few scenes recorded in previous years.

Production of photographic products for the Center's training and user application activities continues. However, requests for imagery from outside agencies decreased somewhat from a peak of approximately 350 work orders from mid-1981 to mid-1982 to about 100 orders for the following 21 month period.

4.3.2 Facilities and Capabilities

During project design USAID recognized that the then existing CRTO facilities could not house the necessary photolab and provided the funds for a new 30 by 30 foot building. Although this facility is well built and very well equipped, any increase in demand by member countries and students or by the construction of a receiving station would require an increase in space and equipment up to as much as double the present capacity. This problem was addressed in the 1983 USAID evaluation. Nevertheless, the photolab is considered by experts in these matters to be extremely well equipped to meet its present responsibilities. The items of equipment which it contains are listed in Annex V.

The photolab is said to be able to produce about 90 each 16 x 20 black & white prints per day, and about 30-40 color composites per day (8 hours). The lab can also produce about 240, 8 inch black & white 1:1,000,000 LANDSAT products or aerial photos per 8 hour day as well as developing conventional film and processing the latter for color prints. Any major (doubling) of the load would require a 2 shift per day operation.

A partial list of typical customers for whom the photolab has provided products is shown in Annex VI (29 of the 52 customers served were from 'Burkina Faso) .

4.3.3 Summary Description of Photolab Costs and Activities 1983-1986

The problems referred to above (4.3.1) have had a most deleterious effect on photolab production and training at the Center. The results have been a decrease in production and revenue. In 1982-83 the photolab earned \$9,894.00 which is more than double the 1985 revenues. This decrease indicates that the constraints noted earlier, lack of imagery, lack of user assistance requests and general outreach as well as the non-availability of the expatriate lab technician and the absence of an African counterpart are obstacles to a profitable CRTO photolab operation. It should be noted that these problems were addressed in the 1983 evaluation and that the conclusions and recommendations made in that report are still relevant.

4.3.4 Photolab Output and Demand

The output of the photolab has not decreased much since 1982-83 but prices have risen and an effective pricing policy has yet to be implemented although it was proposed in 1982. Were an effective pricing and marketing policy set up, the photolab could probably generate an income of \$50,000 annually. This estimate represents the income from the production of 300 LANDSAT products with an average charge of \$250 per product yielding a revenue of \$75,000.00/year at an estimated cost to the CRTO of \$25,000.00. Such income would not amortize existing equipment or pay for replacements but would be sufficient to buy spare parts, chemicals and provide support materials to the training courses.

A potential output of 300-400 products a year could be doubled by efficient operation under the continuous supervision of a photo engineer and could easily be quadrupled by working a second shift. The demand for such services depends on two factors which have been previously discussed, lack of imagery and lack of CRTO outreach (marketing).

4.3.5 Prospects for the Lab

The future of the .photolab will be limited to serving training requirements if it continues to operate under the present system. To make the lab more valuable and profitable the following priorities should be put into effect: (a) purchase imagery (see Section 4.4.5), (b) promote sales in member countries (not just Burkina), (c) train at least two additional photo-technicians, (d) create a competitive pricing guide, and (e) acquire some new equipment and material (see below).

4.3.5.1 Additional Photolab Personnel

Mr. Sangara, the new counterpart, should be trained in the USA and France before returning to take hands-on, on-the-job training at CRTO. Under Mr. Sorenson's guidance such training should last 7-8 months for Mr. Sangara of which 2-3 months should be with Mr. Sorenson. Mr. Gomina, the technician, who has done an excellent job at CRTO since 1978, should be paid a salary which is commensurate to his responsibilities and provides him with an incentive to continue at CRTO. He should continue his on-the-job training and provide continuity between Sorenson and Sangara. A third technician should be hired within a year of the time new imagery is ordered (and a better imagery acquisition system is employed and marketing program is effected).

4.3.5.2 Photo Equipment and Material Requirements

The 1983 evaluation proposed that certain materials and equipment be purchased in order to make the Center and in particular the photolab more effective in reaching the CRTOs goals. These recommendations still stand but should be amended in view of subsequent developments. We suggest a somewhat dir nished list of materials and equipment to support the photolab as follows:

Item	Estimated Cost
30" x 40" manual processor plus spare parts	10,000.00
100 sheets, 30" x 40" color paper	800.00
250 sheets, 16" x 20" color paper	500.00
Chemicals to process above	11,073.00
100 sheets, Ektachrome 8 x 10	394.00
10 gallons, E-6 chemicals	376.70
200 sheets, 4421 film 10 x 10	209.60
20 gallons, D-19 Developer	54.90
300 sheets, Kodacrome 16 x 20 paper	379.08
2 rolls, 40" x 100' Kodacrome	320.32
1 roll Kodalith 40" x 100'	411.73
1 roll P-4 film 42" x 100'	334.00
1 roll PP-4 film 42" x 100'	383.00
20 gallons Kodalith developer	63.30
Spare parts	±1000.00
Shipping, insurance, fee	±6000.00
Model 720403 Ribey/Kelsey 220v 50 cycle reflecting projector w/accessories	13,805.00*
One PC AT station to be tied into IBM computer being procured with existing funding	<u>10,000.00**</u>
Total	56,105.00

Furthermore, and regardless of the volume of business conducted by the photolab, it is desirable to build a chemical effluent treatment plant for the photolab*** to avoid polluting the water in the vicinity of the CRT0. The cost of this facility is estimated at \$15,000.

The photolab should also be equipped with a small computer which would permit archiving of imagery and photography and permit effective materials inventory. Such a computer could in fact be a station tied into the computer (IBM PC AT) which is to be purchased

* For photolab, user assistance, and training

** See below

*** See October 1981 report of Consultants L.N.B.T.P.

to assist the Center's accounting office. This station could also act as the repository for the CRTO regular archives (see Section 4.4).

4.4 CRTO's Archives, Library and Imagery Acquisition Situation

The status of the Library and Archives are discussed in the Burkina Faso Section of Annex I. Both are in an unsatisfactory state and need much improvement.

4.4.1 The Archives

The role of the archival section of the CRTO is to: (a) provide a browse facility for West African remote sensing experts, (b) collect, store, retrieve and organize a data reference system for the browse facility, (c) contact other data collection groups to arrange for the acquisition of additional remote sensing data, and (d) disseminate data to potential users on the availability of data at the CRTO.

Based on the visits to member states and inspection of the archives, it is quite clear that the CRTO archives are not meeting the usual goals of such a facility. Its use is nearly totally internal and member states have no access by telecommunications or efficient access by mail. Problems of utilization may be summarized as follows: (a) inadequate facilities, (b) lack of methodology, (c) mixing of archival and library materials (LANDSAT data and topographic maps and other maps), and (d) no easy means of establishing availability of imagery.

The following steps are suggested regarding the archives: (a) archive materials should be arranged in a retrievable manner and separated from often used maps and other materials, (b) archives should be referenced on a micro-computer (see photolab requirements, Section 4.3.5.2), (c) more materials should be ordered for the browse file from other data collection sources, (d) a browsing area should be set aside, (e) a telephone/telex/mail response browse system should be organized, (f) a newsletter should advise users of

available data, means of acquisition and price, and (g) a printout system should be attached to the computer for accessing available data and mailing to users.

4.4.2 Imagery Acquisition

A major problem affecting CRTO and its ability to function effectively in disseminating remote sensing technology and in evaluating the resources of West Africa is the lack of imagery at the Center. The CRTO image library consists of 300 hard copy enlargements, ± 1500 Landsat negative and positive transparencies and 75 computer compatible tapes (CCT). To cover the area of the 15 member nations would require ± 1800 images. It is estimated by the photolab engineer that since its opening ± 1400 imagery products have been ordered from CRTO. On the other hand, during the same period over 23,000 image products have been ordered for the same area from the EROS Data Center and approximately 950 CCTs have been ordered from the same source. The greatest numbers from the latter have been ordered for Algeria, Burkina and Niger whereas the smallest number have been ordered for Togo, Sierra Leone, Liberia, Benin and the Congo.

Lack of imagery at CRTO is due to several factors. The first is the absence of a receiving station thus precluding the ability of the center to receive, use and disseminate data directly. To acquire imagery from existing stations which directly cover parts of West Africa is currently very time consuming. To acquire imagery from U.S. receiving stations is a complex process requiring that NASA/EOSAT turn on the satellite over the countries in need of the data. Another factor is the increase in cost of the imagery. A fuller discussion of increased imagery costs and its impact on CRTO is included in Annex VI.

The combination of above constraints due to lack of availability of remote sensing data (especially satellite) has had an extremely negative effect on the development of remote sensing in West Africa and all areas of the third world, but has had a particularly negative effect on the user assistance program and the revenues of the CRTO.

4.4.3 The Library

An indispensable support system to any training program is its library. Unfortunately the CRTO has neglected this requirement to supply effective support to its training program. The library has only about 500 useful texts, magazines and reports and not many new acquisitions. The lack of francophone texts is a serious deficiency in view of the percentage of students from French speaking member states. In fact French textbooks are not usually provided to the students nor has a set of French language notes been made available to them. Furthermore few texts are available in the center which deal with basic reference material on resources, resource planning, management, environmental or African development issues.

Considering the relatively low cost of books and magazines and the enthusiasm and interest elicited by francophone Africans in reading, it seems that more could be done by CRTO. Clearly any organization with ambitions regarding the improvement of natural resource information and management of the environment should give greater attention to improving its library. The 1983 USAID evaluation noted this gap and recommended that CRTO take measures to remedy this situation.

The evaluators believe that to be successful as a training center the CRTO should: (a) acquire at least \$2000/year in textbooks, (b) spend at least \$500/year on remote sensing and resource related monthly publications, (c) put aside at least \$1000/year to acquire basic reference texts, including: atlases, and scientific texts, and material on African resources and environmental problems, (d) request free of charge from member countries complete sets of maps of each of those countries in all sectors, and (e) finally, the library should be improved physically and its accession system reviewed.

4.5 CRTO Technical Outreach

CRTO promotion of its technical expertise and capabilities was evaluated during team visits to member countries. The countries where effective technical outreach was indicated are Burkina where

outreach has been excellent, Ghana and Cameroon where it has been good, Mauritania, Niger and Mali where it has been mediocre. In the remaining countries visited, technical outreach has been limited. Those interviewed complained of inadequate training, lack of communication, few or no visits by CRTO African staff and the lack of availability of imagery. These opinions were voiced by government officials as well as USAID missions and regional agencies. These results are disappointing as funds had been allocated for such an effort in the Spectral Data contract and it was expected that the Director and his staff would be more involved in such outreach efforts and be more positive in supporting the contractor's efforts.

4.6 Assessment of Contractor Technical Performance

The contractor, Spectral Data Corporation, has been providing technical services, expert training and equipment to the CRTO since 1979. Services have not been continuous due to contracting difficulties (see Section 6.2). The evaluators believe that the services provided by the contractor have been excellent on the whole. These efforts have in some cases involved some personal sacrifice. The contractor has provided five technical experts of high calibre including 3-PhD's. They have, according to all sources interviewed, provided professional, highly competent services.

Major emphasis has been on training and the contractor has been responsible for the anglophone program since the Center's inception. Training has been technically sound with a special effort to make it relevant to African needs and problems and to emphasize applications and practical results. Another important responsibility was the photolab. The contractor defined the requirements for the photolab, supervised its construction and the procurement and installation of its equipment. The photolab technician has proved highly effective in managing the lab in support of the training and user assistance projects of the CRTO.

The contractor has also been very effective in promoting the value of remote sensing and the role of the CRTO. Dr. Ebtehadj, chief of party, conducted visits to 4 member states where he was extremely

well received and where, through his efforts, managers and scientists alike are much more aware of the technical potential of remote sensing. Contractor staff had also conducted earlier visits to Ghana, Liberia, Sierra Leone, Cameroon and Benin to publicize the CRTO and participate in the selection of trainees. Countries not visited by the contractor or CRTO staff have significantly less understanding of CRTO technical capabilities and the technical value of remote sensing.

4.7 Technical Summary

The CRTO has played a significant role in training West Africans to understand the potential for remote sensing technology in resource mapping. The CRTO has not been as effective in providing support for resource projects in West Africa nor in providing an outreach mechanism to facilitate the transfer of the technology. It should be noted that this deficiency may be attributable to two major causes: CRTO has lacked imagery (due to lack of receiving station and lack of funds) and because the full impact of remote sensing in resource mapping and monitoring was not understood by the donor community and the member nations). Viewed in this context, CRTO has done a commendable technical job in providing training and Africanizing the staff.

The future of remote sensing depends on greater acceptance of this tool as a simple, but significant component of resource analysis and monitoring and that remote sensing is merely one of many ways of collecting and analyzing data. It should be added that the data collected by means of remote sensing, and the system itself, should become an integral part of a much more comprehensive data collection methodology. Such a methodology would permit the integration, manipulation and analysis of numerous sets of data all of which are needed in order to proceed to the judgments and decisions required to solve food security and monitor environmental problems in Africa. In conclusion it may be said that CRTO's main limitation is its inability to relate its services to the resource management needs of most of its member countries nor to integrate its capabilities into a broader West African framework in coordination with other regional organizations.

5.0 Assessment of the Institutional Development Aspects of the Project

5.1 Institutionalization of the Technology in West Africa

5.1.1 Overview

It seems clear that remote sensing technologies are better understood and more widely applied by West Africans in their countries than was the case ten years ago. Specifically, earth resources and meteorological data gained from satellites is increasingly accepted as a valid and valuable technology, and has found its place beside aerial photography as a tool for resource planning and monitoring in West Africa.

There are a number of reasons for this change. Of particular importance has been the "demonstration effect" of projects, usually funded by external donors, especially AID, which have utilized the technology. Nearly every West African country, including all of those visited by the evaluation team, are utilizing or have available satellite and/or aerial derived data. Notable examples of their use are the country wide resource inventories that have been made of Mali, Senegal and other West African countries, use in river basin assessments for the Senegal, Gambia and Volta rivers, and its current and contemplated role in the Sahel with respect to the Agrhymet project. Although carried out for the most part by expatriate specialists, such projects have introduced and familiarized many West Africans with remote sensing and stimulated interest in the subject.

A second factor is the "spread effect" of the training program of the CRTO. Some 220 trainees with three to six months exposure to the theory and uses of remote sensing have passed through the Center and returned, mostly to resource development agencies, with an understanding and interest in using their skills at home. Their ability to do so, however, is often constrained by lack of local resources and foreign exchange for equipment, imagery and materials. They also report constraints caused by unsympathetic

superiors or budget officers. Their participation in development activities involving remote sensing is often dependent on the initiation and funding of local projects, usually involving donor financing. Yet the trainees continue to constitute a trained human resource potential in West Africa upon which the countries can draw.

A third factor is the interest in and, in some cases, the emergence of national centers for coordinating and applying remote sensing for local purposes. This phenomenon appears to be a "spin off" from the earlier introduction of the technology and has been facilitated by the availability of local talent who have been trained at the CRTO or in conjunction with the projects referred to earlier. A national center has been established in Senegal and efforts are underway to establish centers in the Cameroon, Ghana, Mauritania, and the Ivory Coast. In some cases, as in Senegal and Ghana, the preference is to locate the center at the local university where it can avoid competing ministerial jurisdictions. In other cases, location in a government agency is contemplated. In most cases, external financing for equipment, data products and technical assistance is being sought.

As a result of these developments, the institutionalization of remote sensing may be regarded as having sunk real but fragile roots in West Africa. The training of Africans and the trend toward national centers are positive developments and the CRTO has contributed to the technology's human resource base.

However, the increasing costs of acquisition of satellite and aerial imagery and the somewhat sophisticated and import-intensive nature of the technology imply a continued need for external assistance at least over the balance of the current decade. The best prospects for further institutionalization appear to lie in encouraging the growth of national efforts where remote sensing can best be integrated into local development plans and priorities and where prospects for local financing and support over the longer term appear to be more solid.

5.1.2 Role of the CRTO

As indicated above, the CRTO has through its training activities, made a major contribution to the transfer of remote sensing skills to African personnel. According to its report to the Round Table, about 25% of the CRTO's some 220 graduates specialized in geology, 17% in forestry, 10% in agronomy and 9% in cartography. Additional contributions to technology transfer have resulted from CRTO's user assistance projects and through the Africanization of the Center's own staff.

However, CRTO has done little if anything to use the training program as a vehicle for disseminating the technology in West Africa or for advancing it in other ways. No regular contact is maintained with the CRTO's alumni. The Center no longer circulates a newsletter nor does it circulate information bulletins or announcements on remote sensing developments in West Africa, conferences, etc. The CRTO has not, to the best of the evaluation team's knowledge, organized any conferences, seminars, workshops or other professional gatherings to discuss specialized topics or technical developments. The major "outreach" activities conducted by the Center, appear to have been the "sensitization" visits by the head of the Spectral Data team and by occasional similar visits by the French experts. While the lack of such activities may in part be due to lack of financing and staff, a more immediate reason appears to be lack of concern and motivation. Aside from formal training, CRTO's role in encouraging the technology has been a passive one.

5.2. Institutionalization of the CRTO

5.2.1. Africanization of CRTO Staff

The CRTO has been headed by Africans since its inception. In 1984 the present Director General, a citizen of Benin, was elected to succeed the first Director (who is from Burkina Faso) in accordance with the statutes of the CRTO, and took Office in August. A criticism of the first Director was the slow pace at which Africans were being selected for staff positions and the preponderance of

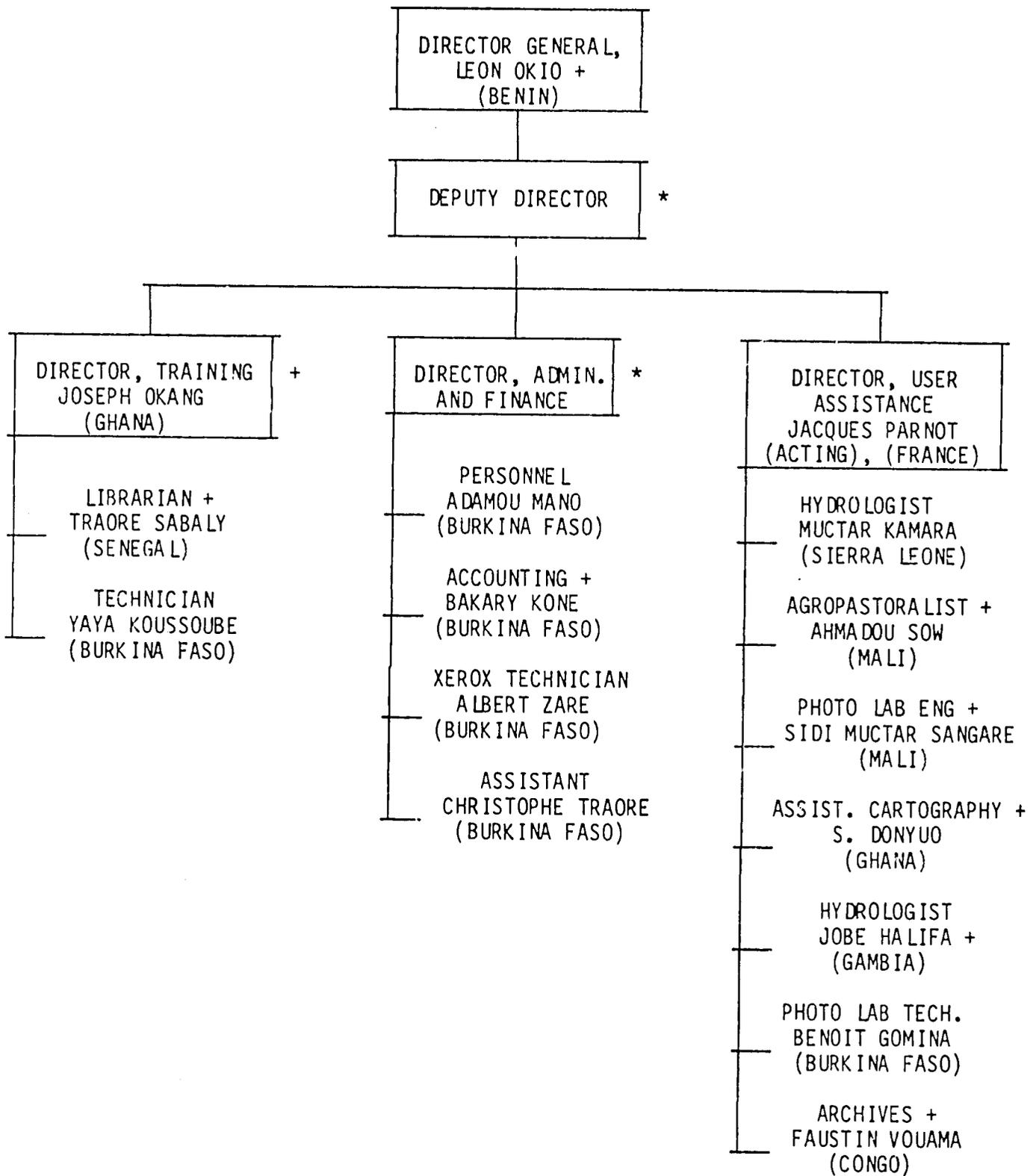
Burkina Faso nationals. The pace of staff Africanization has picked up as has its multinational character. As indicated in Figure 1 below (which also notes positions filled since the previous evaluation), the Training Department is now headed by an African and includes an African technician and librarian. Four mid level positions in the User Assistance Department (including for the first time a counterpart to the expatriate photo lab engineer) are now occupied by Africans. So are all the positions in the Administration and Finance Division (other than the Division Director which is presently vacant) and the archives.

Africanization has been affected by the regional nature of CRTO. Personnel procedures and salary scales are governed by the CRTO's statutes which are modeled after those of the Organization of African Unity. Appointments are normally for four years and are subject to renewal. Managerial and professional positions, which must be filled by citizens of member countries, are subject to competitive selection by the Center's Regional Management Committee on the basis of announcements circulated in advance and nominations by each country. However, the Committee usually meets only once a year. Apparently its Executive Bureau or Chairman can act on occasion on the Committee's behalf. These procedures have been beneficial in terms of broadening the search for qualified talent and raising the caliber of the Center's professional staff. The cost has been that of lengthy delays in filling positions.

The building of African capacity is probably most developed in the User Assistance Department which includes persons with good technical backgrounds in agropastoralism, hydrogeology and cartography. However, while all of them are considered well trained in their technical fields, it is also felt they are somewhat lacking in knowledge of the application of remote sensing technology to their fields. In this respect, all would benefit from additional training.

Some solid progress in Africanization has been made, especially since the arrival of the new Director. But the major technical functions of the CRTO, namely the training program and the photo

FIGURE 1



+ Joined since previous evaluation

* Vacancy

lab, are still dependent on the expertise and technical skills of the expatriate staff. Maintenance and repair of the photo lab has been a chronic and critical problem because of the lack of continuity in U.S. assistance and delays in the provision of African counterparts. A promising Malian counterpart, with graduate degrees in surveying and photogrammetry, has recently arrived but will require considerable training and hands-on experience in photo lab operations and repairs before he can take over responsibility. Unfortunately, only two person months of photo lab services remain in the Spectral Data contract and it is questionable whether that is adequate.

The forthcoming departure of the Spectral Data training staff means that the anglophone training program's next course, scheduled for April 1987, is likely to fall on African shoulders. This was attempted before, in the April 1985 course, with disappointing results*. The increase in depth of the African staff with natural resource backgrounds leads one to expect better results on the next occasion but the standard of training is bound to reflect the insufficiency in remote sensing skills noted above. Under these circumstances, it seems unrealistic to expect the anglophone program to be upgraded to a nine months "degree level" program as is the CRTO's present intentions

5.2.2 Financial Aspects of CRTO

Prior to the arrival of the evaluation team, and pursuant to instructions from AID/W, USAID formally requested the CRTO's cooperation in providing the team with information on the Center's revenues and expenditures, 1983-86, i.e. subsequent to the previous evaluation. The subject was discussed several times during the team's visit but obtaining specific and complete figures has been very difficult.

Financial management has apparently been a chronic problem with CRTO. Financial reports are difficult to obtain and rarely complete. Lack of access to financial records was reportedly one of

* See Annex on visits to Ghana and Liberia

the reasons for the cessation of Canadian assistance several years ago. USAID has not to date performed an audit of the project. Financial matters are held closely by the Director and by the former head of the Center's Administration and Finance Division. His recent departure and the rift that has developed between the Director and the Center's Accountant has further increased the difficulty of obtaining financial information. Thus the evaluation team cannot vouch for the accuracy or completeness of the data on the Center's finances. An improvement in its financial management is obviously required if the Center hopes to encourage donor support in the future.

In reviewing the Center's finances, one must distinguish between its ordinary recurrent costs and "development" costs financed by donors as part of their programs of assistance to the Center. The latter include expatriate personnel, equipment and construction of facilities. They are non-recurring costs that the Center will not have to assume after donor assistance has ended. In addition, the donors have also financed certain operating costs related to training, acquisition of imagery and spare parts and supplies for the photo lab. At some point, responsibility for these costs will pass over to the Center. It is estimated that the U.S. financing of such costs (since the renewal of its assistance to CRTO in mid-1985) is running at the rate of about \$90,000 per year. Similar costs financed by France are estimated to be running at about the same rate. Thus, at present, the two leading donors are financing operating costs of about 63 million CFA which is equivalent to about 45% of CRTO's reported expenditures in 1985.

According to data obtained by the team, the Center's operating costs in 1985 were less than half of those proposed for 1986 and ran as follows:

	(CFA 000)
Salaries	76,858
Electricity	13,329
Training	13,820
Water	627

Photolab	13,805
Field trips	7,422
Other running costs	6,810
Equipment and capital	3,153
Bank charges	618
Transportation	<u>4,096</u>
Total	140,538
	(\$401,537)*

On the other hand, CRTO income in 1985 was more than double expenditures and ran as follows:

	(CFA 000)
Member country contributions	274,029
Income from fellowships	20,006
User assistance projects	4,337
Photolab product sales	<u>1,468</u>
Total	299,840
	(\$856,686)*

It will be noted that revenues from services represented only 09% of total income and most of that was from fellowships provided by France, the U.S. and other donors. Earnings from projects and the photolab are minor items and they total about the same as they did in 1982 (see 1983 evaluation report, p. 26). On the other hand, 1985 saw an unprecedented inflow of contributions from six member countries, four of which made partial payments on accumulated arrears:

	(CFA 000)
Congo	40,781
Benin	6,938
Mali	10,000

* CFA350 = \$1.00

Senegal	17,965
Cameroon	56,345 ⁺
Ivory Coast	<u>141,000</u>
Total	261,682
	(\$782,940)*

The atypical nature of 1985 contributions is illustrated by the fact that contributions for the four years 1981-84 only totaled CFA 155 million or an average of \$110,000 per year. Even allowing for the current Director's more active fund raising role, contributions in 1986 will probably total much less than last year. Seven of CRTO's fifteen members -- Algeria, Ghana, Guinea, Liberia, Mauritania, Sierra Leone and Togo -- have made no contributions to date and their ability or willingness to do so this year is problematic. Total contributions from the eight others are likely to be less this year since last year's included some payments on arrears. More importantly, as noted in the Country annexes of this report, visits

to many of these countries indicate negative attitudes toward CRTO's image and program. Expenditures for 1986 are presently running at an annual rate of CFA 136 million with no member country contributions received to date. Thus the CFA 158 million surplus estimated to have been generated in 1985 is not likely to last very long in the absence of additional donor support and/or a renaissance of CRTO's perceived value to its members.

5.2.3. CRTO Management

Management at CRTO appears to be a combination of strengths and weaknesses reflecting the management style of the Director General. From the standpoint of internal management, that style is formal and hierarchical. In terms of solving external problems and achieving results it is positive and dynamic.

⁺ This sum apparently also includes a partial payment for 1986 made in 1985.

* CFA350 = \$1.00

The team's contact with the Director General gave evidence of a vigorous, dynamic executive who is energetically pursuing the interests of the CRTO. This is evident in his negotiations with donors and the success he has achieved in raising funds for the Center among member countries. Also, thanks in part to his efforts, the Center has made significant strides toward bringing qualified Africans into responsible technical positions on its staff.

Management within the CRTO follows for the most part a pyramid shaped structure. Professional contacts by the front office are mostly limited to a few subordinates, particularly the chiefs of the major Divisions. Communications in both directions follow a carefully defined chain of command. Subordinates are expected to follow instructions and the Director General considers and takes action on recommendations passed up to him from below.

The major units within the organization are quite compartmentalized and lateral communications between units are not formalized. In departmental staff meetings are infrequent. This style of management mitigates against a sense of institutional identity and team spirit. This is unfortunate given the multi-national nature of CRTO's professional personnel. Another factor that affects staff attitudes and performance are several personnel rifts or disputes between management and individual employees. Evidently the CRTO's personnel system lacks a mechanism for the prompt and equitable settlement of such problems.

Job performance among CRTO staff appears to vary widely. Some employees are lax in observing the Center's office hours and appear to perform their functions listlessly while others work evenings and even weekends to get their jobs done. The above modes of management may in part reflect the fact that two of the top management positions -- Deputy Director and Chief of the Administration and finance Division -- were vacant at the time of the evaluation. The placement of effective executives in these positions would permit some sharing of executive functions and strengthen CRTO's overall management.

6.0 AID Management Considerations

6.1. Project Backstopping

6.1.1. AID/Washington

The project paper authorizing AID assistance to the CRTO was originally approved as a "Sahel Regional " project and included as part of the larger program for Sahel Development that was getting underway at the time, As such it would have been backstopped by the Sahel geographic office, one of several geographic offices of the Africa Bureau. However, shortly after approval, it was decided to shift Washington backstopping to the Bureau's Office of Regional Affairs (AFR/RA). That office has traditionally played a somewhat different role than that of the geographic offices which backstop their country missions. Rather, AFR/RA functions as a "mission in Washington" performing both the backstop responsibilities of a geographic office and the implementation responsibilities of a field mission.

This change in office venue has given rise, in the case of the CRTO project, to a certain ambiguity as to who, Washington or USAID/Ouagadougou, has operational responsibility for field implementation and the extent to which USAID should play a normal field role or simply serve as a contact point. This ambiguity persists into the present.

Responsibility for day to day backstopping of the project in AFR/RA lay with a designated Project Officer who invariably has a number of other projects to handle. Correspondence in USAID files refer to an overloading of project responsibilities in AFR/RA by mid-1983. It is also USAID'S perception that AID/W backstopping was adversely affected by a marked negative attitude toward the project beginning about that time. Certainly there seems to have been major divergences between AID/W and field views on the project's future. Whatever the reason, Washington backstopping, particularly in regard to the provision of contract technical assistance, deteriorated after mid-1982 (the original expiration date of the Spectral Data contract). It deteriorated further in 1983-84 and practically disappeared in 1984-85.

As indicated in Section 3.2 above, the March/April 1983 evaluation noted the inadequacy of US technical assistance and argued for additional funding (\$2.3 million), expanded technical assistance and an extension of the project to the end of 1985. AID/W proved to be very slow in either coming to grips with these recommendations or in deciding on alternatives. Instead, from mid 1983 to mid 1984 a frail and intermittent U.S. technical assistance presence at CRTO was sporadically continued through a series of piecemeal actions. In early 1984, without (according to USAID files) consulting the Mission, AID/W proposed a truncated \$500,000 two year extension limited to assisting the photo lab. Eventually, after a further delay caused by questions raised in Congress on the project, a \$950,000 thirty-three month extension for broader services was approved (July 1984). However a contract for renewed technical assistance did not get signed until over a year later. Indecision and delays in AID/W thus resulted in the prolonged attenuation of U.S. technical assistance with unfortunate consequences for the training program and the photo lab (see Section 6.2 below).

In the opinion of USAID, Washington backstopping has improved considerably over the past six months. Both USAID and the contract team believe such backstopping has been much more effective and field oriented than was true previously.

6.1.2. USAID/Ouagadougou

USAID backstopping appears to have been satisfactory despite a fairly high turnover in staff responsible for day to day supervision and monitoring of the project as reconstructed below:

<u>Period</u>	<u>Office and Backstopper</u>
Up to 9/81	Office of Rural Development Personal Service Contractor
9/81-8/82	Office of Rural Development local hire engineer

8/82-8/84	Office of Human Resources AID Officer
8/84-2/85	Program Office Local hire engineer
2/85-12/85	Office of Regional Affairs Personal service contractor
12/85-present	Office of Regional Affairs AID Officer

One gets the impression, in reviewing the project files and in conversations that the project did not rank terribly high in importance within USAID's project portfolio. This may have been a perfectly valid assessment by the Mission as to its program priorities. However, one also gets the impression that the "regional" nature of the project and AFR/RA's more inclusive role in it has led USAID to pay less attention to it. This may be one of the reasons why no audit of the project has ever been conducted (one is scheduled for September/October).

A related matter is USAID's attitude that the U.S. contract staff reports to CRTO, not USAID. This is a valid perception given the objective of "Africanizing" CRTO under African leadership. However, it has led at times to deferring to CRTO on matters which may have been of disservice to the project. For example, the Spectral Data contract calls for the team leader to serve as adviser to the CRTO Director. Upon arrival he was informed by the Director General that he was to deal exclusively with the Acting Director of User Assistance (who is also head of the French technical assistance team), a situation that still exists. This diminution of the position of the U.S. team has not helped its morale nor the pursuit of its functions. It does reflect the current subordinate role of the U.S. presence at the project.

6.2 The Management of Technical Assistance

U.S. technical assistance to the CRTO has been provided through a contract between AID and the Spectral Data Corporation, a firm that has specialized in providing remote sensing services overseas. At the time of the evaluation, four Spectral Data personnel were working at the Center -- the team leader (a geologist), a geographer and remote sensing generalist, a forestry applications specialist and a photo lab engineer.

It is the team's judgment that AID and CRTO have been well served by the quality and character of the experts recruited by Spectral Data. Their technical skills as instructors have been good, including an ability to conceptualize the theory and to demonstrate its applications in field situations. The engineer has proved to be almost indispensable in organizing and maintaining the lab's operations. Equally important has been the team's ability to relate to their students and to establish a relaxed but professional rapport with their African and French colleagues. The head of the team has stimulated keen African and USAID interest in the Center as a result of his "sensitization" missions. Finally, Spectral Data has been skilled (and fortunate) in being able to bring back the same people for successive assignments, despite breaks in contract continuity.

The period from mid-1979 to mid-1982 can be considered as the most successful period of U.S. technical assistance to the project. During most of that time three remote sensing experts -- a geographer, forester and photo lab engineer -- were in residence at CRTO and provided a good portion of the project's external technical services. This was the period when the photo lab was under construction and its equipment being installed. During this period the anglophone training program got underway with four introductory and three advanced courses. The presence of resident experts made it possible for them to participate in student selection procedures (through visits to the anglophone countries) and maintain quality control. It also permitted them to participate in the user assistance program and to generally become involved in the activities of the Center.

Since mid-1982, as a result of contracting, funding and backstopping difficulties, U.S. technical assistance has been, for the most part, short term and sporadic. Through contract extensions or the use of personal services contracts, two members of the original team (geographer and photo lab engineer) have been brought back for visits of several months each to give the anglophone course and to shore up the laboratory. The teaching program has suffered through lack of advance preparations and adequate screening of applicants. During his periods of residence, the engineer has been able to catch up on the backlog of repairs and disorganization that have accumulated in his absence, but conditions deteriorate again when he leaves. The problem is mitigated by the efforts and know how of a very capable lab technician but the absence (until recently) of a full-fledged African counterpart to manage the lab and keep it organized has resulted in its periodic disruption and breakdown.

Thus, for over three years from mid-1982, the U.S. technical presence at the project assumed the role of transient visitors rather than co-workers. For a year in 1984-85 it disappeared altogether. In contrast, the French presence has been characterized by stability and continuity. During most of the period of the project France has maintained a team of four experts at the Center, two senior and two junior..

It is therefore not surprising that France now plays the dominant external role at the project and the U.S. the subordinate. The head of the French team is also the Acting Director of the User Assistance Division and the de facto Deputy Director of the Center. When the Spectral Data contract was reactivated in 1985 and its chief of party arrived, he was informed that he was to report to the above official rather than to the Center's Director. The Spectral Data instructors now giving the final anglophone course under the present contract are functioning more as guest lecturers than as faculty and have little role to play in the Center's other activities such as user assistance and program planning.

In other words, the character and effectiveness of U.S. technical assistance has been negatively affected by the awkward and clumsy

way in which it has been carried out. That, in turn, was a result of the prolonged indecision and conflict within AID over the future of the project.

7.0 Implications of a Receiving Station

7.1 Background

As noted in Section 3.3.2, ever since its inception the project has contemplated a second phase in which the Ouagadougou Center would acquire the equipment, buildings and technical personnel to permit it to receive data directly from earth resources and other civilian satellites. The leading donors (France, the U.S. and, for a time, Canada and West Germany) shared a view that a capability to receive and disseminate current and repetitive earth resources data would greatly increase the Center's value to its West African members as well as give the project a much greater visibility, prestige and attraction. In addition, African leaders believe that the acquisition of regional reception facilities was important so that African nations would no longer be dependent on foreign sources for resources data of their own region.

The acknowledged merits of a receiving station have been discussed at length on varying occasions and balanced against the significant capital cost of such facilities and the ongoing costs of their operation and maintenance. Both of these cost dimensions have increased significantly since the inception of the project. Part of the increase has been due to the upward general movement of prices over the years. Another part has been due to increases in the sophistication and complexity of the hardware, particularly if it is to be capable of receiving data from both the LANDSAT and SPOT series of satellites, which is the strong preference of CTRO's West African members.

7.2 Financial Implications

At the July 1986 Donors Round Table meeting, estimates for a receiving station having access to either the SPOT or LANDSAT satellites, or both, were presented as follows:

	SPOT	LANDSAT	LANDSAT & SPOT
	(CFA Millions)		
Receiving station equipment	3,596	6,318	7,908
Civil works	<u>825</u>	<u>825</u>	<u>825</u>
	4,421	7,143	8,733
Total in \$ millions*	12.6	20.4	25.0

The above estimates, which were prepared with the assistance of French experts for the meeting, do not include a proposed CFA 400 million (\$1.1 million) for equipment for an expanded training program (95 trainees per year) to be carried out by the Center. In addition, the above costs, which presumably would be funded by the donors, do not include technical assistance which is estimated at 125-150 million CFA per year (\$360-\$430,000).

If the above estimates for establishing a receiving station are daunting, the estimates for running it are even more so.

Estimated Annual Operating Costs of Station**

	SPOT	LANDSAT	LANDSAT/SPOT
	(CFA Millions)		
Access fee***	185	240	425
Maintenance	175	310	391
Supplies and materials	47	86	105
Power	150	150	167
Other	<u>33</u>	<u>33</u>	<u>33</u>
Total	590	819	1,121
Total in \$ millions*	1.7	2.3	3.2

As the Round Table papers point out, operating costs should also include the other functions of the Center in addition to the station. The latter are estimated as follows:

* CFA 350 = \$1.00

** Does not include technical assistance

*** The annual fee charged by the U.S. and France to turn on their satellites when they are in range of the station.

Estimated CRTO Operating Costs, 1986-90*

(CFA Millions)

	1986	1987	1988	1989	1990	Average 1986-90
Personnel	138	190.6	204.5	214.6	226	
Training	75	90	100	100	110	
Operations & Supplies	71.5	80	85	95	95	
Travel and Transp.	<u>48</u>	<u>60</u>	<u>60</u>	<u>60</u>	<u>60</u>	
	332.5	420.6	449.5	469.6	491	
\$ Millions **						1.2

Thus total annual operating costs for CRTO are estimated at between \$2.9 million for a SPOT station to \$4.4 million for a combined station.

The Round Table papers also made estimates, which appear to be exceptionally generous, as to revenues which might be anticipated from the Center's operations, assuming the receiving station begins operations in 1987. They are calculated as follows:

Estimated CRTO Revenues, 1987-1990

(CFA Millions)

	1987	1988	1989	1990
Training (expanded program)	344.5	344.5	344.5	344.5
User assistance projects	53	65	80	90
Photo lab products	<u>12</u>	<u>12</u>	<u>15</u>	<u>15</u>
	409.5	421.5	439.5	449.5

The optimism of these estimates may be judged by comparing them with actual revenues generated in 1985 of CFA 26 million (see Section 5.2.2. above).

* Does not include technical assistance

In addition, the papers also estimate revenues from the sale of tapes and images (following "an intensive sales campaign") as follows:

1987	1988	1989	1990
(CFA Millions)			
136	272	400	600

Estimated total revenues would thus be:

1987	1988	1989	1990
(CFA Millions)			
545.5	693.5	919.5	1,049.5

These figures compare with the cost estimates (station and other CRTO activities) noted above:

	1987	1988	1989	1990
	(CFA Millions)			
SPOT	1010.6	1039.5	1059.6	1081
LANDSAT	1239.6	1268.5	1288.6	1310
LANDSAT/SPOT	1541.6	1570.5	1590.6	1612

Thus, even with highly optimistic estimates of receipts, CRTO would still run a deficit over the four years of CFA 983 million (\$2.8 million) under the SPOT only option and as much as CFA 3107 million (\$8.9 million) under the SPOT plus LANDSAT option. In other words, member countries would have to contribute to the Center at the rate of \$700,000--\$2.2 million a year for the Center to cover its operating costs. As discussed in Section 5.2.2 above, an inflow of contributions at that level seems most unlikely.

Furthermore, it must be recalled that images acquired for the area covered by any receiving station built and operated in Ouagadougou would be in competition with the LANDSAT materials acquired by the existing stations at Fuccino in Italy and Mas Palomas in the Canaries. These two stations cover approximately 70% of the area that would be covered by the Ouagadougou station. These stations would be more accessible and possibly more reliable to international organizations, other offices and private investors seeking resource data for West and North Central Africa.

Such competition along with that already existing, in view of EOSAT's capability of recording West African data and selling it to U.S. users in West Africa, would significantly lower expected revenues of Ouagadougou.

7.3 Technical and Management Considerations

The construction of a receiving station would also have major management and operational consequences. It would involve the acquisition of delicate sophisticated equipment including the telemetry receiving and tracking apparatus, recording equipment and computers for handling and processing the data. The logistic and technical problems of maintaining such equipment and keeping it operational in a Sahelian environment would be considerable. Upkeep of the far less complex and less sophisticated photo laboratory equipment has proved to be a formidable task.

A receiving station would greatly affect the scale and operations of the CRTO. The photo laboratory would need to be expanded and additional equipment and staff would be required so that the vastly increased volume of data products could be accommodated. The capacity of the archives would need to be enlarged. The whole data dissemination and distribution function of the CRTO would require overhaul and modernization. Additional staffing and streamlined procedures would need to be installed so that CRTO could more rapidly respond to requests for images and tapes and to cope with a much greater volume of demand. A marketing and publicity function would need to be established. In addition, as noted earlier, the Round Table papers point to a major expansion of the training program to 95 trainees per year, or approximately a tripling of the present output.

The foregoing implies a need for additional staff, both expatriate and African. Operation and maintenance of the equipment for the receiving station and the training of an African crew would require a team of 3-4 expatriate technicians for several years. The expanded photo lab would require at least one expatriate expert and two or so expatriate instructors would be needed to handle the additional trainees until qualified Africans are recruited. The growth in the size and complexity of the Center would also imply a need for an effective administration and a dynamic management function. A major transformation in the character and complexity of the Center would be involved.

7.4 Evaluation

A receiving station would involve a major and prolonged financial and technical commitment by the donor community. Direct access by Ouagadougou to earth resources satellites would be an advantage for Burkina Faso. But for the other West African countries that advantage is vitiated (in terms of timely response to request for data) by the uncertainties and delays of sending the data out of Ouagadougou and its timely arrival at its West African destination. When one considers that the same or nearly comparable data can be obtained from Fucino and Mas Palomas for most of the area in real time, and further, that nearly comparable tape recorded data can be acquired from EOSAT in Maryland or from SPOT Image in Toulouse, France at a fraction of the costs of a ground station, the rationale for investing in a ground station becomes very obscure.

For the most part the U.S. has shied away from direct involvement in the pros and cons of "Phase II". That non-committal posture was maintained at the Round Table meeting. The papers circulated at that meeting, far from strengthening the case for a receiving station, clarify many of the costs and risks it would involve. Clearly, "Phase II" is not a project the U.S. would wish to support.

8.0 Project Objectives and Project Results

8.1 Program or Sector Goal

Because project 698-0420 is a component of a broader, multidonor program in support of the CRTO, the logical framework of the project paper was prepared with this larger context in mind. The program or sector goal of the project is "...to accelerate the economic and social development of West Africa by improving the ability of the countries of the region to carry out development programs through the utilization of remote sensing... Attainment of this goal is dependent upon the institutionalization of the technology within the appropriate government agencies of the West African countries."

Results: The team believes there has been a fair measure of success in achieving the project's program or sector goal. The team's visits to twelve West African countries found evidence that the process of institutionalization of remote sensing had made considerable progress over the past 8-10 years. In most countries visited, remote sensing has become a locally accepted technology for gathering natural resources data. This is partly due to the contact and experience of these countries with donor-financed remote sensing projects and partly due to their acquisition of local expertise through the CRTO's training program. In most of the countries visited there are groups of technicians trained in the technology (by CRTO and/or overseas training) who are capable of applying it, although many would require some supervisory technical guidance.

Constraints to local utilization of the technology include lack of equipment and financing for acquisition of imagery and other operational costs. Also, in some countries, technical people are hampered by the lack of understanding and support of decision makers and supervisors. But in a number of other cases, the decision makers are supportive and have backed or are backing efforts to establish national remote sensing centers. A national center has

establish them in the Cameroon, Ghana, the Ivory Coast, Congo and Mauritania.

The team believes that the above process has contributed to the project's broader goal, namely, to further West African economic and social development. Resource management projects such as the Senegal Mapping and Remote Sensing Project, the Dune Stabilization Program, the Gambia river basin planning, the Mali Land Resources Inventory and the Forestry and Land Use project in Niger have utilized remote sensing and have contributed to the region's development. In addition, the interest in developing national centers in a number of West African countries is facilitating the transfer of remote sensing technology into African hands. To the extent that these centers are "plugged in" to the country's development priorities and budgetary process -- as appears to be the case, for example, in Senegal -- then African-managed remote sensing activities stand an excellent chance of making an important contribution to the overall development of the area.

8.2 Project Purpose

As stated in the logical framework matrix, the project purpose is "To establish a West African Remote Sensing Center with a capacity to:

- develop and demonstrate the use of remote sensing technology in various development projects;
- provide training in use of the technology to a number of user agency personnel;
- establish a satellite data reception station capable of providing repetitive real-time coverage of West Africa."

Results: As indicated elsewhere in this report, the project has been only partially successful in realizing its purpose. The training program has familiarized a cadre of some 250 West African technicians with the principles and techniques of remote sensing and trained them to apply this knowledge

(assuming adequate technical supervision) in their disciplines in their own countries. Many of them are now doing so with varying degrees of success.

In countries like Senegal, Mali, Niger, Ghana and Cameroon, where remote sensing has become a recognized and valued means of data acquisition, CRTO trainees have opportunities to exercise their skills. In other countries, such as Liberia, trainees are frustrated by lack of facilities, unsympathetic administrators and a negative developmental climate. Fortunately, the favorable country situations outnumber the unfavorable in West Africa and provide a predominantly positive environment for the application of the technology.

The project has also been partially successful in bringing together under African leadership at Ouagadougou a multi-national and multi-disciplinary group of African technicians with skills in remote sensing. However, because the Africanization process was slow in getting underway, the African staff has had insufficient opportunity to acquire the training and experience desirable to conduct the CRTO's training program at the same technical standards as that of the expatriate staff. This means that the anglophone training program will drop in quality with the departure of the U.S. contract team. The francophone program may be less affected if the African staff members are able to acquire further training and experience during the remaining period of residence of the French experts.

As noted in Section 5.0, the CRTO has unfortunately not performed the "outreach" functions to the extent envisaged in the project paper. The user assistance program, while valuable, has not had the "spread effect" that was hoped for. Due to staff and funding constraints, the scale of the program has been rather limited. With the exception of the "sensitization" visits carried out by the U.S. team

leader, and by some of the French staff, the CRTO has been rather inactive in terms of publicizing its capabilities or generating interest in and awareness of the technology through seminars, conferences or other means of disseminating information. CRTO's potential role as a provider of services and data products to its West African member states has been rather neglected. This shortcoming, unless corrected, is likely over the long run to adversely affect the Center's ability to attract financial support from within the region. In other words, the CRTO still has quite a distance to go in terms of meeting the project's target of capacity building.

The project purpose of establishing a receiving station is discussed at length in the previous section of this report. The passage of time has vitiated the validity of that part of the project's original design, at least so far as U.S. participation is concerned.

9.0 Lessons Learned

In addition to specific project-related issues and recommendations contained in the following section, project 698-0420 also offers some broader lessons or implications which may be of value. These are discussed below.

9.1 The effectiveness of technical assistance is as much a function of its continuity and management as it is of its technical quality.

The project's technical assistance contractor did a remarkable job during 1979-82 in assembling a group of multi-disciplinary specialists competent in remote sensing, well suited to working in the Sahel and with moderate to fluent facility in French. This combination permitted a solid U.S. technical input to the project in terms of the calibre of instruction, establishment of the photo lab and involvement in the Center's affairs. Since mid-1982 contracting and funding problems resulted in discontinuities in technical

services. Although these discontinuities were partially mitigated by repetitive use of original team members, they nevertheless had a negative effect on the training program, the functioning of the photo lab and U.S. involvement in the Center as a whole.

9.2 Regional programs may be a good way to introduce a new technology but may not be the best way to apply it.

In retrospect, the establishment of CRTO was probably an appropriate choice as a means of introducing remote sensing in West Africa. Not only was it the approach advocated by the Africans but it was a logical way to both concentrate donor resources and to make them available regionally. The regional approach especially commends itself as a means for conducting technical training. It permits the introduction of the new technology in a local environment and its application to local conditions or problems to which trainees can more readily relate. It avoids the cultural and logistic difficulties attendant to training in the West.

The CRTO experience suggests, however, that the regional approach is a less appropriate vehicle for utilizing the technology. By definition, utilization of remote sensing data is location or project specific. With its small staff and limited budget, CRTO is unable to respond quickly and adequately to requests from member countries for data and for image interpretation services. Countries wishing to draw on CRTO services must come to the Center. The result is that member countries have felt and responded to a need to develop a local capability. National centers are in a better position to respond to local needs and priorities for remote sensing services than one located in Ouagadougou.

9.3 Technology-driven projects run the risk of confusing ends and means.

CRTO was established in the flush of Western and African enthusiasm about the potential of satellite imagery which followed the launching of the first LANDSAT satellites. There was an implicit assumption that the technology was so valuable, so readily

accessible and had so many varied uses that it would create its own demand. The bottlenecks to its usage were thought to be the lack of LDC personnel trained in the technology and lack of understanding and knowledge as to its benefits. Regional centers were needed to train such personnel and to diffuse information as to the technology's capabilities.

However, the reality of the situation is somewhat different. Technical innovations are not ends in themselves but means to serve economic and social purposes for human betterment. Remote sensing is a tool with which development institutions can gather and analyze data for planning development projects, measuring environmental problems or identifying an area's physical resources. The availability of trained personnel is a necessary but not sufficient condition of a country's ability to undertake these tasks. By emphasizing the technology rather than its broader purposes, donors (and their African colleagues) tended to confuse means and ends. A refocussing of approach is needed in which remote sensing takes its place as one of a number of tools for addressing natural resource problems. This is the approach recommended in Section 10.0.

9.4 Project management suffers if there is ambiguity as to who is responsible for field implementation.

As noted in Section 6.1, a certain ambiguity has persisted throughout the project as to USAID and AID/W roles for field implementation. This factor probably contributed to indecision and conflict within AID on the future of the project during 1982-84 and to an overly deferential USAID attitude toward the CRTO.

9.5 Remote Sensing data does not require high technology equipment and training to be an effective tool in resource evaluation and development.

The 3 months and 6 months training course offered by CRTO have provided training for 251 West Africans. Not all of these trainees when returning to their countries can in fact interpret satellite imagery and map the resources of their country. Yet, the fact

remains that nearly every one of the trainees has understood remote sensing and could, with further experience, financial support and simple equipment (light table, stereoscope) interpret LANDSAT and SPOT imagery and aerial photos to map the resources of their countries. This conclusion belies the notion that complex equipment and massive investment are required to institutionalize remote sensing. It should be noted in passing that expensive equipment and complex techniques can improve the quality and validity of remote sensing derived data but these techniques are still in the developmental/research stage in the most advanced countries and should not be imposed in West Africa where the simplest approach has shown that it can yield results of great value.

10.0 Issues and Recommendations

10.1 Phase II - CRTO Receiving Station

As indicated in Section 7, the team recommends against U.S. participation in a project to establish a LANDSAT/SPOT receiving station at CRTO in Ouagadougou. The initial and continuing costs of such a project, its dependence on external technical and financial support over an indefinitely prolonged period, and its uncertain benefits in relation to alternative means of data acquisition all argue against U.S. participation.

10.2 The Issue of U.S. Assistance to CRTO

The evaluation team believes that the current U.S. project (698-0420) will have, by the time of its completion, accomplished some if not all of the objectives that were sought when the project was initiated in 1978 (see Section 8.0 above). It is not clear that additional U.S. aid would move the project closer to its unrealized objectives. In addition, the incremental benefits of assisting CRTO to do "more of the same" -- i.e. turning out additional anglophone trainees, continuing support for the photo lab and renewed involvement in user assistance -- would not, in the team's judgment, justify the additional AID costs that would be required.

CRTO has helped the technology of remote sensing to establish itself in West Africa, primarily through its training function. The future role of the technology will depend more on its utilization at the national level in the context of specific projects than on the training of additional technicians. The team believes the former kinds of activities should become the focus for future AID support for remote sensing in West Africa, and that assistance for CRTO activities should end with the completion of the present project.*

The team appreciates that the above recommendation, if followed, is bound to affect the character and program of the CRTO. The absence of expatriate anglophone teaching staff will affect the quality of the anglophone training program and will probably require the shelving of plans for a nine month "degree level" course, at least for the anglophone trainees. Without the AID-financed fellowships, the number of anglophone trainees can be expected to decline. Thus cessation of U.S. assistance will increase even further the francophone character of the CRTO and will increase its dependence on French assistance. The cost of such assistance to France is also likely to increase since at present the U.S. is financing a number of costs (such as supplies and materials for the photo lab) which are essential for the Center's continued operations.

How France will respond to these changed circumstances in its relationship to CRTO is difficult to judge. France has historic and cultural ties with the area which may influence its actions. Be that as it may, the U.S. and France have enjoyed a close and cooperative relationship with respect to the CRTO. It therefore behooves the U.S. to give France maximum advance notice of its intentions and to do whatever it can reasonably do to ease the transition accompanying the cessation of U.S. assistance. The same considerations obviously apply with even greater force to the CRTO and its leadership.

* As indicated below, the team recommends the inclusion of several items in the present project that will require additional funding and a time extension.

Therefore, if AID accepts the above recommendation, the team further recommends that the French and CRTO be informed as promptly as possible. It recommends that discussions be held with the French and CRTO leadership -- first separately and then jointly -- to discuss end of project matters and to identify those important steps that AID may wish to take to ease or facilitate the "turning over" process. It is probable that such steps will require additional funding, and an extension in the Spectral Data contract and the project's PACD. The team believes such actions should be taken to complete U.S. participation in a tidy and responsible manner.

In this vein, the following measures are recommended:

1. Retention of the Spectral Data photo lab engineer for seven months (beginning in October) to provide an adequate overlap with his newly designated Malian counterpart. Part of that overlap will involve "holding the fort" at the photo lab while the counterpart receives practical training abroad in the operation and maintenance of photo lab equipment. Training at Toulouse would also be desirable so that the counterpart is familiar with the requirements for processing SPOT data.
2. Retention of the Spectral Data team leader for several months to permit him to complete the round of "sensitization" missions which were called for in the contract and which have been so successful in building interest in CRTO and in providing practical advice to those countries that have expressed an interest in remote sensing and in establishing national centers. Visits would be desirable to Senegal, Guinea, Sierra Leone, Liberia, Ivory Coast, Benin, Togo, Mali and Gabon.
3. Provision of funding (estimated at \$56,000) to provide supplies and materials for the photo lab to permit it to carry on normal operations through mid-1987. This would provide transitional support prior to the assumption of this function by France, another donor or CRTO itself. Two items of equipment for the photolab are also included. A list of these requirements is given in Section 4.3.5.2.

4. Provision of funding to permit CRTO to offer fellowships for the anglophone training course which is scheduled to begin in April 1987. Such action will provide lead time for CRTO to negotiate fellowships for future courses from other donors and for AID to include fellowships for CRTO in the Africa Bureau's regional manpower development programs.
5. Funding should be provided to enable Spectral Data to offer instruction to the African staff members who will be giving the next anglophone course. Instruction should be offered (for 2-3 months between January-April 1987) in the organization and content of such a course, the availability and use of texts, teaching aids and course materials, and refresher training in remote sensing technology. It would be beneficial if Dr. Mika one of Spectral Data's previous CRTO instructors could carry out this task. He should be assisted by the contractor's present chief of party. A precondition for offering the instruction would be the designation by CRTO of the African staff members to give the next anglophone course.
6. Funding for a facility (estimated at \$15,000 in PIL #20 of May 1985) to treat the chemical effluent of the photo lab and a plan of action for construction should be agreed upon and implementation initiated well before the deadline of the project's new PACD. The contract team leader, who is a geologist, should supervise action on this matter with the assistance of the photo lab engineer. As indicated in the technical analysis (Section 4 above), the 1981 soils study commissioned by CRTO points to a geological profile which would warrant taking such precautionary measures.
7. USAID should adhere to its intention of conducting an audit of project 698-0420. If possible, such an audit should be conducted concurrently with one by France of its assistance, since the two projects are so interrelated.

There may be other important steps that AID should take to assure as smooth a "handing over" as is feasible. AID representatives need to meet with those of France and CRTO at an early date on this subject. The Spectral Data advisers will be a valuable source of technical information for such talks. Given the importance of these discussions to CRTO, AID should not limit them to the Director General but should also seek to consult with the head of the Regional Management Committee.

10.3 Future AID Assistance for Remote Sensing in West Africa

There is no question but that remote sensing has an important and continuing role to play in Africa, including West Africa. Its value has been demonstrated in its use for resource assessments, forestry inventories, river basin planning and environmental analyses.* Moreover, thanks to U.S. assistance to CRTO, the Africans are now in a far better position than before to participate in such activities and to utilize the data.

The team believes therefore that AID should continue to look to remote sensing as an important tool in its efforts to help African countries to address their environmental and natural resource planning problems and as a means by which AID can carry out environmental analysis on AID projects themselves. Clearly, however, remote sensing is a means to achieve such ends and not an end in itself. The team believes that future support for remote sensing should be provided in a broader context of programs and projects to help African countries to plan and manage and monitor their development programs, particularly those involving agriculture, forestry, water and other natural resources. Africa's staggering problems of agricultural productivity and environmental degradation argue for a special effort by AID in those directions.

* Examples are The National Resources Inventory project in Mali, The Forestry and Land Use Planning Project in Niger, the sand dune stabilization program in Senegal, the Gambia river environmental assessment and the Cartography and Remote Sensing project in Senegal.

Remote sensing could play an important role in such a special effort in three ways. First, the technology itself will continue to be drawn upon as a means of carrying out surveys, preparing resource maps and monitoring environmental conditions -- applications that are critical for resource planning and management in Africa. Second, a number of African countries have reached a point of interest and competence in remote sensing that they wish to establish a local capacity in the technology. These efforts should be encouraged. Third, the CRTO itself will hopefully continue as a regional resource which can be used by AID as a source of data on West African resources and for training activities or special meetings dealing with natural resource issues in West Africa. The team believes that each of these aspects could and should become part of a broader and more comprehensive expression of AID concern with the African environment and to help African countries to increase their capacity to deal with their natural resource problems.

As a result of its travels in West Africa and its visits to AID Missions, the team has been impressed with the desirability of enabling USAIDs to more effectively call upon environmental and natural resource expertise than is presently the case. It is believed that if a mechanism were established through which USAIDs could readily obtain environmental expertise and resources -- e.g. advisory services on natural resource issues, satellite imagery and ground truthing of an agricultural or forest area under consideration, funding and technical help to organize a training program or set up a small national center, assistance to monitor or evaluate an environmentally sensitive project -- that such a mechanism would be heavily utilized once its availability became known. AID's WASH project, the Forestry Support Program, the Energy Initiatives for Africa and the Environmental Training and Management in Africa offer possible models that might be followed.

In particular, the team has seen preliminary papers outlining the aims and scope of the "National Resources and Energy Management in Africa (NREMA)" project. It believes an effort along those lines -- which should include support for the kinds of remote sensing activities suggested above -- would constitute a logical and much

needed follow on the CRTO project. It would build on African technical capacity that CRTO has helped to create. And it would encourage the utilization of that capacity for work on Africa's pressing agricultural, forestry and physical planning problems. A start up of such an effort by FY 1988 would be highly desirable.