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PROJECT ASSISTANCE COMPLETION REPORT

COTE D'IVOIRE REMOTE SENSING PROJECT

(698-0467.24)

REDSO/WCA

July 1989

EXECUTIVE SUMMARY

The CIRS Project is a 2.5 year, US$ 310,000 activity funded under the umbrella of the Africa Bureau Natural Resources Management Support (NRMS) Project. It developed from a personal request made in January 1987 by the President of Cote d'Ivoire to the U.S. Secretary of State for U.S. assistance in remote sensing to help the GOCI plan the rational exploitation of its mineral, agricultural and forest resources.

The goal of the CIRS Project as designed was "to increase natural resource benefits, reduce natural resource development costs, and assist in conservation of the Cote d'Ivoire's remaining tropical forest resources, its soil and water resources, and its biological diversity." The project purpose was "to improve the quality of the GOCI's natural resource-related planning and analytical products prepared in support of development in the minerals, agriculture and forestry sectors."

To effect these results, project inputs consisting of technical assistance (TA), limited training, and commodities were provided, including about 90% coverage of the Cote d'Ivoire in state-of-the-art satellite imagery and acquisition of an image processing system. The specific inputs were developed in full coordination with the GOCI and four other donors, IBRD, UNDP/FAO, FED and the Government of France, with the expected output that the capacity of the national remote sensing facility (the Autonmous Teledetection Service or ATU) would be significantly improved.

Both anticipated project outputs and the project purpose have been demonstrably met by project implementation. An external end-of-project (EOP) evavluation of the CIRS project stated that "the provision of satellite data has stimulated much valuable activity in natural resources analysis. Current activity includes a national forest inventory, the mapping of fallow lands, mapping of forest reserves (and) mapping of geology and structure...Contractors, donors and individual scientists...heard the (ATU) scientific presentations, saw the results of the work by ATU and visited its facilities. There was unanimous approval of these activities from the international scientific community."

In terms of meeting the project goal, both the quality and timeliness of ATU analytical output has improved as a result of project implementation and it is widely considered within the GOCI that this has already resulted in significant improvement in the design, implementation and monitoring of natural resource-related activities using those analytical documents.

An external EOP evaluation of the CIRS Project summarized the project as follows: "It is unanimously agreed that the USAID initiative through REDSO/WCA to assist the DCGTx/ATU in establishing a digital image processing system for natural resources data from remote sensing satellites was successful in every respect. Success is visible in all aspects of the activity, from the multi-donor cooperation to the

coordination of equipment. The initial design was good, based on a blend of good sense and good science, and it was appropriate to the need and executed in a timely manner. The installation of a digital image analysis system for data meets the highest technical standards in the context of the ATU situation. The project was also a major success in cooperation between donors, as well as a significant contribution to natural resources data analysis and management in Cote d'Ivoire...By comparison with remote sensing projects in Khartoum, Ouagadougou and Nairobi funded by USAID, the Abidjan activity was handled rapidly and successfully. REDSO/WCA achieved an outstanding success in meeting the remote sensing needs of the GOCI."

There are three outstanding concerns related to the continued operational viability and quality of the ATU's output: 1) in-house hard copy production capabilities have yet to be realized; 2) development of the role of the national institution to undertake regional responsibilities represents a significant target of opportunity which should be pursued; and 3) the issue of improved access to ATU remote sensing resources of other, non-ATU technicians in the GOCI needs to be resolved.

Two significant project spin-offs occurred in conjunction with the CIRS Project. The first was the convening of the world's largest and longest running international symposium on remote sensing of the environment in Abidjan in October 1988. This symposium, attended by 350 specialists from 37 countries on four continents and widely considered to have been a ringing success, resulted in tremendously favorable publicity for both USAID's use of remote sensing for international development and U.S. private sector capabilities in this technological field. The second spin-off resulted from the process of computer-enhancing imagery acquired under the project, during which a pervasive and longstanding technical problem with satellite imagery applications in West Africa was largely resolved. This can be expected to have far reaching impact on future processing of imagery for West Africa and, consequently, the quality of natural resources analysis dependent thereon.

Seven lessons were learned during the course of the project, believed to have wide applicability to remote sensing activities throughout the world. The four most important of these are summarized as follows:

1. Provision of remote sensing assistance in the right place at the right time can be one of the most high impact and cost effective technical interventions that can be undertaken in support of natural resource management.

2. National remote sensing centers appear to have clear advantages over regional remote sensing centers and, moreover, have the potential to develop effective, responsive and applied regional responsibilities from the bottom up.

3. National remote sensing facilities with applications mandates should be located within a single, strong, operational institution that has direct, immediate and diverse applications needs for the use of the technology.

4. State-of-the-art remote sensing technology may clearly be the most appropriate technology, even in non-industrialized countries.

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1.0 PROJECT OVERVIEW

The Cote d'Ivoire Remote Sensing (CIRS) Project (698-0467.24) is a 2.5 year, US$ 310,000 activity, funded under the umbrella of the larger Africa Bureau Natural Resources Management Support Project (NRMS), with a PACD of 31 December 1989. The CIRS project developed originally from a personal request made in January 1987 by the President of the Cote d'Ivoire to the U.S. Secretary of State, for U.S. assistance in remote sensing to help the Government of the Cote d'Ivoire (GOCI) plan the rational exploitation of its mineral, agricultural and forest resources. The CIRS project was developed by REDSO/WCA over the subsequent six months, concurrent with GOCI reorganization and consolidation of its existing human, financial and material remote sensing resources.

At the time of the request for assistance, the GOCI was typical of many African nations in that its remote sensing resources were widely dispersed throughout a number of different ministries and non-ministerial agencies. There existed, consequently, no critical mass of trained personnel and economic, computer and imagery resources in a single functioning unit with the capacity to produce high quality and applied satellite image-related products.

During early 1987, the GOCI brought together key remote sensing resources by establishing the Autonomous Teledetection Unit (ATU) within the Direction et Controle des Grandes Travaux (DCGTx), a superministerial organization located within the GOCI Office of the Presidency. DCGTx is charged with the planning, organization, financing and supervision of all public works activities in Cote d'Ivoire, and employs over 1500 people working in such related fields as urban planning, water and energy resources, agriculture, and the design and construction of transportation routes and primary infrastructure. An external end-of-project (EOP) evaluation of the CIRS Project noted that "in executing these tasks, DCGTx has a need for a wide range of natural resources data, much of which can be updated or improved by reference to satellite remote sensing of natural resources...It is logical therefore to attach a remote sensing unit to DCGTx."

The Autonomous Teledetection Unit established at DCGTx was provided the resources and the mandate to take the lead role in developing the GOCI's capabilities in remote sensing, and the responsibility to respond to ministerial requests for the analysis of imagery for applied purposes related to national development. Specifically, the ATU was given the mandate to 1) prepare and update national land use maps; 2) prepare thematic maps showing deforestation, hydrology, rural and urban infrastructure; 3) prepare an annual summary map of bush fires; 4) prepare studies of drainage basins for hydrologic management purposes; 5) prepare hydrogeology and geology studies; 6) analyze and map change in urban and rural areas; 7) study agricultural activity and estimate cash crop production; and 8) prepare ecological maps and studies of lagoons, coastal environments, savannah conditions, desertification, and other maps and studies of environmental conditions including soil erosion. At the time of project startup, the DCGTx/ATU was composed of a Chief and 21 staff, including six natural resource scientists, nine field technicians and six support staff.

Concurrent with establishment of a central remote sensing unit in DCGTx, the GOCI, USAID, IBRD, UNDP/FAO and FED began developing and coordinating plans to provide the technical assistance, training and commodities required to make the DCGTx/ATU into a first rate institution capable of producing the kinds of directly relevant and applied remote sensing products required by various GOCI ministries to rationally exploit the nation's natural resources. As part of this coordinated intervention, A.I.D. authorized the CIRS project at an LOP funding level of US$ 310,000 in August 1987, and obligated those funds through the provisions of a Grant Agreement with DCGTx on 10 September 1987.

The goal of the CIRS project is "to increase natural resource benefits, reduce natural resource development costs, and assist in conservation of the Cote d'Ivoire's remaining tropical forest resources, its soil and water resources, and its biological diversity". To this end, the purpose of the project is "to improve the quality of the GOCI's natural resource-related planning and analytical products prepared in support of development in the minerals, agriculture and forestry sectors". To achieve this purpose, inputs consisting of technical assistance, training, remote imagery and computer hardware and software were provided to complement, diversify and expand existing remote sensing capabilities in the DCGTx/ATU, with the expected output that the capacity of that institution to produce high quality remote sensing products would be improved.

An external EOP evaluation of the CIRS Project, based on "a wealth of reactions and comment from African and U.S. scientists and international donors and agencies...plus formal and informal visits to the DCGTx/ATU," summarized the project as follows:

"It is unanimously agreed that the USAID initiative through REDSO/WCA to assist the DCGTx of Cote d'Ivoire in establishing a digital image processing system for natural resources data from remote sensing satellites was successful in every respect. Success is visible in all aspects of the activity, from the multi-donor cooperation to the coordination of equipment. The initial design was good, based on a blend of good sense and good science, and it was appropriate to the need and executed in a timely manner. The installation of a digital image analysis system for data...meets the highest technical standards in the context of the DCGTx situtation. Support by Earthsat consultants under the IQC, by the REDSO/WCA Science and Technology Advisor, and by the staff and consultants of DCGTx and its ATU was a major ingredient in this success...It represents an excellent use of the USAID remote sensing IQC and effective interaction between consultants, USAID staff and the recipient. The project itself was also a major success in cooperation between donors, as well as a significant contribution to natural resources data analysis and management in Cote d'Ivoire."

2.0 PROJECT INPUT COMPLETION STATUS

2.1 TECHNICAL ASSISTANCE

Three discrete technical assistance tasks were originally envisioned for this activity. The first was "up-front" short-term TA to review what high quality satellite imagery of the Cote d'Ivoire was existing and obtainable; review the status of other planned donor inputs into the DCGTx/ATU; inventory and assess existing DCGTx/ATU resources; determine and prepare specifications for imagery, hardware and software to be acquired under the activity; and assess training needs of the DCGTx/ATU. All of these components of the first TA task were to be fully coordinated with other donors and the GOIC to ensure complementarity and functionality of the final product, i.e., the DCGTx/ATU itself. This task was carried out under an IQC arrangement with Earth Satellite Corporation (Earthsat), the output of which was described in an April 1988 report entitled "Recommendations for Procurement of Landsat Imagery and Digital Image Processing System". The external EOP evaluation of the CIRS Project noted that "this study report provided both a valuable overview of the remote sensing activity in Cote d'Ivoire and an excellent set of recommendations for action." The quality of technical assistance provided by Earthsat was considered by REDSO/WCA, the GOIC and relevant donors as being outstanding.

The second TA task was to obtain the raw satellite imagery, prepare computer-enhanced hard copies of a subset of those images to precise specifications, and ensure proper shipment and installation of those commodities. This task was also carried out by Earth Satellite Corporation under an IQC arrangement, and again the quality of technical assistance was considered to be outstanding.

The final TA task, related to hardware and software acquisition, encompassed installation of hardware and software commodities acquired under the project and training in their use. This task was carried out by International Imaging Systems, Inc. (I2S), and their agents, who were responsible for sales, shipping, installation and training of personnel in the use of the I2S-manufactured image processing system acquired under the project. The quality of TA provided was considered by the GOCI, REDSO/WCA and other donors to be generally excellent.

By November 1988, all technical assistance forseen, designed into and/or required under the project had been fully accomplished.

2.2 COMMODITIES

The original project design envisioned acquisition of total or near total coverage of the Cote d'Ivoire in high quality, high resolution satellite imagery, and acquisition of hardware and software necessary to process that imagery. Specific types of imagery and hardware and software to be acquired were purposely not stated in the Grant Agreement in order to provide for development of commodity specifications in

conjunction with the planned input of other donors. Precise specifications were developed by Earth Satellite Corporation in April 1988 after full coordination with the GOCI and other donors.

Imagery resources specified and procured included a combination of digital products, i.e., Landsat multispectral scanner (MSS) and thematic mapper (TM) computer compatible tapes (CCTs), and digitally enhanced hard copy imagery of selected TM scenes. CCTs for a total of 14 1/4 Landsat TM and 4 Landsat MSS scenes were acquired, covering about 90% of the Cote d'Ivoire, and a total of 30 quarter scenes in high priority areas were selected for digital processing and enhancement prior to delivery of the CCTs to the DCGTx/ATU. The 30 quarter scenes selected for special processing covered areas in which high priority natural resource development activities in the agricultural, forestry and mining sectors were ongoing or planned. The special processing included not only digital processing and enhancement, but production of geographically corrected hard copies at a scale of 1:100,000 immediately usable for direct map production purposes. Delivery of enhanced images, procurement of data tapes, and packing and shipping were all completed by mid-1988.

Hardware and software resources specified and procured included a Model 75 Image Processing System manufactured by I2S, I2S system 600 software, and spare parts. This image processing system was described in the external EOP evaluation of the CIRS Project as "an effective tool for the extraction of natural resources information from remote sensing satellite data. It has the power to provide state-of-the-art data processing and the flexibility to expand and adapt to changing conditions. The flexible design of the whole DCGTx system provides for increased computer power if necessary. At the present time the system appears to offer some spare capacity but this will be used as the scientists become more familiar with the system."

The I2S image processing system was acquired under a sole source arrangement for four principal reasons: 1) its compatibility with the overall configuration of the image processing facility proposed for the DCGTx/ATU, as developed by multiple donors; 2) its adequacy for the current and projected future kinds of image processing to be conducted by the DCGTx/ATU; 3) the substantial experience that both French and Ivorian technicians already had with this and other I2S systems; and 4) the availability of an I2S agent in France, from which DCGTx could obtain maintenance and repair services, and available documentation in French for the system.

The consultant's recommendation, after full donor coordination, for sole source procurement of the I2S system was adopted by USAID in March 1988, and delivery of the system, installation and acceptance tests were complete five months later. The external EOP evaluation of the CIRS Project stated in this regard that "sole source justification for system procurement was based upon a clear understanding of operating conditions, the suitability of equipment for follow-up maintenance by the vendor, and compatibility with other donor-supplied equipment. This equipment is now in place and working well."

2.3 TRAINING

Training provided under the provisions of the USAID grant was limited to approximately one person-week of training in use, storage and care of the CCT and hard copy prints, and approximately three person-weeks of training in operation and maintenance of the I2S image processing system and associated hardware. It was possible to limit training under the grant by virtue of the substantial past, present and committed future roles of French technical assistance to the DCGTx/ATU; indeed, the fact that French and Ivorian technicians had already been trained on and had substantial experience with operating the I2S hardware and software packages were major reasons for acquisition of this particular system.

3.0 SUMMARY OF CONTRIBUTIONS

The total contribution to development of the DCGTx/ATU from the GOCI and all donors combined was approximately US$ 1,668,000. About 24.6% of this was for technical assistance and miscellaneous contributions, 51.6% for equipment, 9.7% for satellite imagery, 4.3% for installation and training, and 9.8% for operations support. The total US contribution to the activity was approximately US$ 310,000, split between image acquisition (US$ 83,500; 50% of the total imagery input from all sources into the DCGTx/ATU); hardware and software acquisition (US$ 167,000; 20%); technical assistance (US$ 32,500; 8%); and installation and training (US$ 27,000; 37%).

The Grantee contribution to this activity included about US$ 163,000 in operations support (e.g., office and laboratory space, trained personnel, recurrent costs, acquisition of short term technical assistance), and approximately US$ 123,500 in FY'88 alone in hardware (i.e., a power supply, 30 KWA regulator and a Film recorder).

Four other donors made substantial contributions to the development of the DCGTx/ATU facility. The World Bank provided approximately US$ 370,000 worth of computer hardware and software, US$ 264,000 in technical assistance and miscellaneous contributions, and US$ 63,000 in satellite imagery. UNDP/FAO committed to provision of about US$ 101,000 worth of photographic laboratory equipment, US$ 114,000 in technical assistance and miscellaneous contributions, US$ 15,000 in imagery, and US$ 47,000 in installation and training. The European Development Fund (FED) provided a Numelec Pericolor System worth approximately US$ 100,000. And, last but certainly not least, the Government of France has continued to provide both long and short term technical assistance in remote sensing and related sectors (e.g., computer technology), as well as providing selective SPOT imagery.

By October 1988, all of the principal components of the DCGTx/ATU facility were in place and operational, including computer systems and imagery, except for the photographic laboratory to be installed by UNDP/FAO.

4.0 PROJECT OUTPUTS

The provision of project inputs (technical assistance, training, imagery and computer hardware and software) was designed to complement, diversify and expand the existing remote sensing capabilities of the DCGTx/ATU, with the expected output that "the capacity of that institution to produce high quality remote sensing products would be improved". This output has been fully realized. Prior to project implementation, the DCGTx/ATU had very limited imagery resources available for use. Isolated Landsat MSS and TM imagery, SPOT imagery and miscellaneous imagery from a range of different dates, at different scales and of different portions of the country were being used for analytical purposes, and for the most part such analysis was conducted painstakingly by hand due to a near absence of computer resources. After project implementation, and with the assistance of other donors, the teledetection unit had a demonstrably and significantly improved capacity to produce high quality remote sensing products. Near total coverage of the country in recent, very high quality imagery was available in-house, both in digital and hard copy format; the image processing system to digitally manipulate those data were operational and functional; and both the imagery and computer resources provided by the project were in active use.

5.0 PROGRESS TOWARDS ACHIEVEMENT OF PROJECT PURPOSE

The purpose of the CIRS Project is "to improve the quality of the GOCI's natural resource-related planning and analytical products prepared in support of development in the minerals, agriculture and forestry sectors". This purpose has also been demonstrably met by project interventions.

The DCGTx/ATU was established by the GOCI as an applied technology unit, and prior to project implementation it had already produced and was still in the process of producing specific analytical reports in response to the requests of other GOCI ministries involved in natural resource development. Those reports consisted of the findings of analyses conducted using satellite imagery in support of the agricultural, forestry and mining sectors, and for infrastructural and urban development purposes. There were, however, two perceived problems with the analytical documents produced by the DCGTx/ATU at the time of project development: product quality, and product turnaround time.

The analytical quality of DCGTx/ATU Products in 1987 was limited by three principal factors: 1) the generally poor quality of the data available in Cote d'Ivoire, with heavy reliance on bulk prints of 80 meter resolution MSS data (Bands 1-3-4 at 1:200,000 scale) over broad areas of the country, a total absence of TM data, and only about 10% of the country covered by SPOT imagery; 2) limited geographical coverage of the country and adjacent areas, again with most of the Cote d'Ivoire being covered only by MSS data; and 3) the currency of the data, with most imagery dating to the 1970's. This problem was solved by provision of

near total coverage of the Cote d'Ivoire in recent high resolution imagery, including geographically-corrected hard copy prints from which direct mapping at a scale of 1:100,000 could be accomplished.

The second problem perceived with analytical documents produced by DCGTx/ATU at the time of project design was the slow turnaround time experienced by DCGTx in fulfilling their mandate to produce technical analyses in response to ministerial requests. This was largely a function of the need to conduct analyses by hand, from hard copy prints of marginal quality, and the constraint of having to wait on facilities in France for special processing needs. Provision of digital data and an image processing system went a long way towards relieving this constraint, and in conjunction with the hardware and software provided by other donors both the quality of the end product and the turnaround time required to produce that end product have greatly improved.

As evidence of this, the external EOP evaluation of the CIRS Project noted that "the provision of satellite data has stimulated much valuable activity in natural resources analysis, and present activity appears to be fully approved by all concerned...Demonstrations of the system capability were being given in October 1988. As demonstrated at the 22nd International Symposium on Remote Sensing of the Environment (held in Abidjan), current activity included a national forest inventory, the mapping of fallowlands, mapping of forest reserves, mapping of geology and structure, and the use of aircraft data...There can be few situations in which criticism would be more readily voiced, and in which the ATU would be more closely scrutinized. Competing contractors, other donors and individual scientists were all present at the Symposium, they heard the scientific presentations, saw the results of the work by ATU and visited its facilities. There was unanimous approval of these activities (which) received favorable comment from the international scientific community...By comparison with remote sensing projects in Khartoum, Ouagadougou and Nairobi funded by USAID, the Abidjan activity was handled rapidly and successfully. REDSO/WCA achieved an outstanding success in meeting the remote sensing needs of DCGTx."

A significant constraint to achieving the purpose of the CIRS Project materialized early in project implementation, when it became apparent that the photo lab to be provided by UNDP/FAO would likely be unavailable until well after all other donor inputs had been provided. The response to this was that a decision was made to compensate by providing state-of-the-art computer enhanced imagery. The external EOP evaluation of the CIRS Project best describes the impact of this decision as follows: "Because of the time required for the installation and commissioning of the digital analysis system and the uncertainty about the completion of the colour photographic laboratories, the EarthSat report recommended that selection of TM scenes (be) processed as high quality digitally enhanced images prior to the delivery of the data tapes...The overall impact of implementing this recommendation was excellent. State-of-the-art data products became available in DCGTx and were used by scientists involved in project (activities)." Just as importantly, and as discussed in Sct. 11.0, the process of producing these state-of-the-art digitally enhanced prints resulted in technical resolution of a pervasive and longstanding problem with satellite imagery applications in West Africa which is expected to have substantial long-term impact over and above that forseen at the time of project design.

6.0 PROGRESS TOWARDS ACHIEVEMENT OF PROJECT GOAL

The goal of the CIRS project is "to increase natural resource benefits, reduce natural resource development costs, and assist in conservation of the Cote d'Ivoire's remaining tropical forest resources, its soil and water resources, and its biological diversity".

During the project development phase of this activity, the Ministers of all major ministries related to natural resources development (Agriculture, Forestry and Water, Mining, and Scientific Research) were interviewed to obtain their views on constraints to natural resources development which remote sensing technology might significantly ease. All of the Ministers agreed fully that remote sensing had immediate and direct application to their particular areas of responsibility, and each stated specific planned and ongoing activities where such application could have particular impact. Examples of this were locating geological faults for minerals exploration; mapping fallow land for both forest resource and agricultural development; updating and improving topographical and infrastructural mapping; and mapping and evaluating surface water resources.

Since this time, and largely as a result of providing commodities, technical assistance and training under the project, the quality and timeliness of DCGTx/ATU output in response to these requests have improved. This is widely considered within the DCGTx to have resulted in a significant improvement in the availability of credible quantitative information on the extent and distribution of natural resources in Cote d'Ivoire, and to have already resulted in significant improvement in the design, implementation and monitoring of natural resource-related activities using those analytical documents.

7.0 RECOMMENDATIONS FOR PRE-PACD PROJECT ADJUSTMENTS

No final adjustments in project design or implementation prior to the PACD are recommended here, nor do there exist any outstanding conditions, covenants or Grantee reporting requirements.

8.0 CONTINUED AID MONITORING

The CIRS Project was unusually seminal in development of what is now generally recognized as the best national remote sensing institution in West and perhaps all of sub-Saharan Africa. No continued or post-project AID monitoring of this activity or of the DCGTx/ATU are required for the project to continue to have the kind of impact originally envisioned. The continued operational viability and quality of the unit's output, however, remain to be assured and A.I.D. visibility is very high due principally to the outstanding quality of the enhanced imagery provided. There are three major outstanding concerns related to such continued viability.

8.1 IN-HOUSE HARD COPY PRODUCTION CAPABILITIES

The first major concern is that the final operational step be taken at DCGTx/ATU, i.e., realization of on-site hard copy production capabilities. When existing plans to install a film writer and a full photographic laboratory capable of high quality processing of color materials at the unit are realized, the unit will have a comprehensive system capable of accepting a magnetic tape, analyzing it, displaying the result onto a color screen, manipulating the data, printing it in either black and white or color, transferring it to color photographic film, and enlarging and printing the result at a variety of scales matched to existing map bases. A significant limitation in this respect, however, is that the image writer and photo lab portions of the ATU system are still under consideration and neither sources of funds nor final technical specifications have yet to be precisely defined.

8.2 THE FUTURE ROLE OF DCGTx/ATU

The second major concern relates to the future role the DCGTx/ATU will play. While the unit is now strictly a national remote sensing institution, there exists a real opportunity to expand the role of the teledetection unit into a national unit with regional responsibilities. There are three specific types of regional services that would appear perfectly suited for the DCGTx/ATU. First is as a training service for francophone technicians, with small, applied training programs being held at the unit on specific themes related to remote sensing applications (e.g., for minerals exploration, forestry, crop monitoring, infrastructure mapping, hydrology, etc.). A second important service would be for the DCGTx/ATU to serve West and perhaps Central African states as a data analysis center, performing the kinds of technical analytical tasks which other countries may not have the trained human or material resources to perform.

A third and perhaps the most important services the DCGTx/ATU could provide would be to undertake project-related remote sensing analyses for donors involved in project planning, design or monitoring in Africa (e.g., USAID, UNDP, IBRD, AfDB). This third alternative could be particularly fruitful if developed in conjunction with the AfDB, since it could possiblly solve three problems at one time: first, it would bring in much-needed funds to help further develop, maintain and operate the DCGTx/ATU; second it would provide the ADB much needed analytical capabilities with which to improve project performance, without having to finance the expense of establishing an in-house capability; and third, it would support long-term development and financial soundness of an indigenous remote sensing facility which has proven, by virtue of it's national rather than regional institutional status, that it can avoid most of the major pitfalls of regional remote sensing facilities whose continued performance depends on payment of member dues and which are therefore responsible to numerous masters.

The external EOP evaluation of the CIRS Project addressed the future development of the DCGTx/ATU and the issue of potential service roles on two different levels. First, it noted that "further activity (at

DCGTx/ATU) will develop in relation to the success of the existing system and the demands this produces. In general the expected demands will be for additional data, and for training and technical assistance. If these demands are large enough they may also generate a demand for more equipment. If regional use of the (ATU) is allowed to grow, a major effort to establish an additional unit to serve this need may be required. In all cases, there will be a need to disseminate the results of successful projects and to provide a forum for African users of remote sensing technology to meet on a regular basis."

In addressing how such a developing role might be accommodated within the existing mandate of the DCGTx/ATU, the EOP evaluation stated that "it is not clear at what level such activity would seriously affect the flow of work in DCGTx. Perhaps DCGTx could charge for work from the region and accept only the tasks which fitted its schedule. Alternatively, if a training and user services unit were established in collaboration with the African Development Bank or similar institution, DCGTx could offer contract services exclusively through this unit. Such a unit might require an independent image analysis and computer system. REDSO/WCA might wish to have a part in establishing such a unit."

8.3 INTRAGOVERNMENTAL ACCESS TO DCGTx/ATU RESOURCES

The third major concern regarding DCGTx/ATU is intragovernmental access to its resources. In part this concern is a result of political and budgetary factors, and in part it is a function of the distribution of human and material resources. From the political/operational perspective, and as noted in the external EOP evaluation of the CIRS Project, the "DCGTx is viewed as a competitor for funds by several ministries, and clearly DCGTx enjoys a privileged position in relation to other ministries in view of its major project activity which makes it conspicuous at the national level." From the resource distribution perspective, and while the DCGTx/ATU has the mandate to respond to ministerial requests for technical analysis, there is an increasingly large number of technicians in other ministries which could significantly further ministerial objectives if they had access to DCGTx/ATU image and computer resources. Most, however, do not have such access. While this is in large part attributable to the very limited number of hard copy prints which DCGTx/ATU possesses, and the significant proportion of the time those limited prints are in use for completing DCGTx-mandated tasks, there also clearly exists a perception on the part of non-DCGTx technicians that there is a political element to image unavailability .

The external EOP evaluation of the CIRS Project suggested establishment of a separate unit to help resolve this issue, perhaps at the national university at Yamossoukro, with links to the main computer and ancillary hardware and software to ensure that it functions properly. At such a unit, other government ministries and agencies might be supplied with work stations linked to the computers in DCGTx to facilitiate their use of the ATU system. The evaluation noted that "there is clearly potential and need for these activities, but the precise definition of their operation requires further study."

9.0 REMAINING DATA COLLECTION AND EVALUATION ACTIVITIES

There remain no outstanding data collection or evaluation activities. An-end-of-project evaluation of the CIRS Project ("Evaluation Report, Cote d'Ivoire Remote Sensing Assistance Project, Alan Falconer, Regional Centre for Services in Surveying, Mapping and Remote Sensing, Nairobi, Kenya) was performed by an external consultant familiar with remote sensing facilities in Africa in October 1988. The principal observations and conclusions of that report are cited in this document.

10.0 FINANCIAL SUMMARY

The CIRS Project summary financial report by project element as of 12 July 1989 can be synopsized as follows:

Element	Obligated/Earmarked	Committed	Disbursed	Pipeline
Project:	$310,000	$306,437	$306,437	$ 3,563
Commodities:	192,795	192,795	192,795	0
TA:	113,642	113,642	113,642	0
Contingency:	3,563	0	0	3,563
Unidentified:	0	0	0	0
TOTALS:	$310,000	$306,437	$306,437	$ 3,563

11.0 PROJECT SPIN-OFFS

There were two very significant spin-offs to this project, one of which resulted in substantial publicity and exposure of USAID remote sensing activities for development worldwide and the other which resulted in the technical resolution of a longstanding, major, and critical constraint to remote sensing applications in West Africa.

The first spin-off of the project was the acceptance of Cote d'Ivoire's application, over competition from Indonesia and other mid-level income countries, to be the host of the 22nd International Symposium on Remote Sensing of Environment by the Symposium Program Committee. Held 20-26 October 1988 in Abidjan, this forum was attended by approximately 350 scientists from 37 African, Asian, European, Near and Middle Eastern and North American countries representing about 150 different institutions. The symposium was widely regarded by participants as the best overseas symposium to date for four reasons: 1) extraordinary interest on the part of the GOCI and the role played by the DCGTx/ATU; 2) a marked emphasis on practical, real world applications of remote sensing in solving identified problems vs. the theoretical and academic flavor of earlier symposia; 3) a significant increase in private sector interest; and 4) a marked improvement in international cooperation, especially notable between French and U.S. attendees (88 Abidjan 22857).

This project spin-off had tremendous impact, with USAID's use of remote sensing for international development and U.S. private sector capabilities receiving tremendous publicity at both the national and international levels. Concurrently, and as noted by the EOP evaluation of the CIRS Project, the symposium "gave some urgency to the execution of the subject project and a target date for its implementation. This international exposure of the project at the symposium provided a wealth of reactions and comment from African and U.S. scientists and international donors and agencies."

The second spin-off of the CIRS Project evolved from the decision to conduct special computer-enhancement of a subset of the images acquired for the DCGTx/ATU. Adverse atmospheric conditions between the Sahara Desert and the Gulf of Guinea in West Africa have always presented unique constraints to the acquisition, processing and analysis of high quality satellite imagery. Briefly, these constraints arise because of the adverse impact on image quality of atmospheric water vapor, smoke from bush fires, and harmattan-generated atmospheric dust. This has typically result in such poor image quality that distributors of digital data have issued blanket disclaimers regarding the quality of West African image data. During the special processing of subscenes acquired under the CIRS Project, however, a system of digital interactive testing of a series of spectral band combinations and linear histogram adjustments for contrast enhancement led to minimization of visual impact from water vapor, smoke and wind-borne dust, and maximization of scene interpretability. The result, as confirmed by international specialists at the 22nd International Remote Sensing Symposium, was by far the most consistently outstanding print quality for any imagery ever produced in the region. This development can be expected to have a remarkable impact on future processing of imagery for this region and, consequently, the quality of natural resource analysis dependent thereon.

12.0 LESSONS LEARNED

The following principal lessons, of wide applicability to remote sensing projects in Africa and perhaps worldwide, are believed to have been learned from implementation of the CIRS Project:

1. Provision of remote sensing assistance in the right place at the right time can be one of the most high impact and cost effective technical interventions that can be undertaken in support of natural resource management. Remote sensing technology is not only applicable to virtually all natural resource-related sectors, but its use permits objective, quantitative and independently reconfirmable evaluation of natural resources issues on their technical merits.

2. National remote sensing institutions appear to have three clear advantages over regional institutions in terms of sustainability and operational foci. First, national institutions do not rely on voluntary

member state contributions, and thus their financial stability is not subject to the vagaries of member state budgets and funding priorities. Second, because national institutions serve only one master, the government, rather than the diverse masters which must be served by regional institutions, priorities are more clearly establishable. National institutions thus appear to be much better suited to the consistent production of a cohesive and integrated output of high quality analytical products, as a result of their ability to focus on a single set of national development priorities based on natural resources located within a discrete geographical area. This is in contrast to regional institutions, which are required to respond to the highly disjunct development needs of member states in a climate of oft-shifting priorities by analyzing highly diverse natural resources located over broad geographical areas. Finally, national institutions appear to be more conducive environments for the development of a smoothly operating and more consistent organizational structure, and appear to be characterized by a better climate of internal cooperation by virtue of the national, cultural and economic similarity prevailing among operations and management personnel.

3. An effective national remote sensing institution requires a critical mass of computer hardware and software; a critical mass of trained, interdisciplinary personnel; sound economic support; and the infrastructure within which to house and operate that institution. While all institutions and facilities evolve, the piecemeal approach to development of a remote sensing facility cannot satisfy the need to fully integrate facility components.

4. National remote sensing facilities with applications mandates should be located within a single, strong, operational institution that has direct, immediate and diverse applications needs for the use of the technology. As noted in the external EOP evaluation of the CIRS Project, "the activities of DCGTx are multi-disciplinary and of necessity cut across established borders between ministries and departments. Remote sensing technology provides data of value to a variety of users and is therefore interdisciplinary in nature. Institutionally a central unit of remote sensing expertise capable of working with and providing services to other units is a viable structure." It is unlikely that the ATU would have witnessed similar success had it been placed in a university or in a weaker or less applications-oriented ministry.

5. Where the strengths of individual donors in relation to the Borrower/Grantee are clearly assessed in a particular development context, donor-Borrower/Grantee coordination and cooperation can be extremely effective in developing and sustaining a national remote sensing institution. Under the CIRS Project, donor roles were partitioned largely based upon donor strengths in the Ivorian context. The French, for example, took the lead in continued training and TA, the Americans took the lead in provision of imagery and image processing systems, and IBRD took the lead in provision of computer hardware and software. This permitted not only limited funds to be focussed on individual donor strengths, but also greatly streamlined implementation. It required, however, strong diplomatic skills among the highly qualified specialist technicians working out specifications for the ultimate design

of the facility, as well as a single person taking the lead role in overseeing donor coordination. In this case, that person was a French technician hired on a short-term consultancy by DCGTx/ATU itself to play this role.

6. State-of-the-art remote sensing technology may clearly be the appropriate technology, even in non-industrialized nations. The powers and strengths of digital processing technology, coupled with its relatively low costs, argue strongly for acquisition of such technology in development of remote sensing facilities so long as the infrastructure to house and maintain that equipment is available, recurrent costs can be met, and trained personnel are available to exercise the capabilities of the technology. Hand planimetering of old, low resolution satellite imagery is as obsolete as the manual typewriter. Opting for such an approach in non-industrialized nations may not only serve to discourage technicians trained with far more current technologies, but may also result in production of grossly substandard and/or obsolete analytical products.

7. Limited funds do not necessarily mean limited impact where remote sensing assistance is concerned. The payoff to be realized from provision of recent, high quality computer-enhanced TM imagery to technicians involved in natural resource assessment is far in excess of the few thousand dollars per scene required to acquire and process that imagery. This payoff was evidenced by the continuous flow of governmental, industrial, academic and commercial personnel requesting access to or acquisition of such imagery after the public became aware of its existence.