PD-CAD 881

File - TA
493-0314

ASIA/DP/RE, Mr. Vance L. Elliott

April 19, 1979

ASIA/PD, Dennis J. Brennan

THAILAND: Review of PES for ERTS Project (493-180.14

The PES fully addresses issues regarding the impact of the earlier ERTS project. In view of the fact that it was utilized as an input for the preparation of a PID and PP for a follow-on activity--Remote Sensing for Development (493-0314),-- the evaluation has been widely circulated among the Project Committee and the APAC. Therefore, no meeting on the PES appears necessary.

ASIA/PD/EA:MSinding:am

UNCLASSIFIED
CLASSIFICATION

# PROJECT EVALUATION SUMMARY (PES) – PART I

Report Symbol U-447

| 1. PROJECT TITLE | 2. PROJECT NUMBER | 3. MISSION/AID/W OFFICE |
|---|---|---|
| EARTH RESOURCES TECHNOLOGY SATELLITE (ERTS) | 493-11-190-180.14 | THAILAND |

4. EVALUATION NUMBER (Enter the number maintained by the reporting unit e.g., Country or AID/W Administrative Code, Fiscal Year, Serial No. beginning with No. 1 each FY) UNSCHEDULED

☐ REGULAR EVALUATION ☒ SPECIAL EVALUATION

| 5. KEY PROJECT IMPLEMENTATION DATES | | | 6. ESTIMATED PROJECT FUNDING | | 7. PERIOD COVERED BY EVALUATION |
|---|---|---|---|---|---|
| A. First PRO-AG or Equivalent FY 74 | B. Final Obligation Expected FY 78 | C. Final Input Delivery FY 78 | A. Total | $ 276,888.00 | From (month/yr.) 1974 |
| | | | B. U.S. | $ 260,965.00 | To (month/yr.) 1978 |
| | | | | | Date of Evaluation Review 12/78 |

8. ACTION DECISIONS APPROVED BY MISSION OR AID/W OFFICE DIRECTOR

| A. List decisions and/or unresolved issues; cite those items needing further study. (NOTE: Mission decisions which anticipate AID/W or regional office action should specify type of document, e.g., airgram, SPAR, PIO, which will present detailed request.) | B. NAME OF OFFICER RESPONSIBLE FOR ACTION | C. DATE ACTION TO BE COMPLETED |
|---|---|---|
| End of Project Evaluation. Recommend follow-on extension of project. | | |

9. INVENTORY OF DOCUMENTS TO BE REVISED PER ABOVE DECISIONS

- ☐ Project Paper
- ☐ Financial Plan
- ☐ Logical Framework
- ☐ Project Agreement
- ☐ Implementation Plan e.g., CPI Network
- ☐ PIO/T
- ☐ PIO/C
- ☐ PIO/P
- ☐ Other (Specify) _____
- ☐ Other (Specify) _____

10. ALTERNATIVE DECISIONS ON FUTURE OF PROJECT

- A. ☐ Continue Project Without Change
- B. ☐ Change Project Design and/or ☐ Change Implementation Plan
- C. ☐ Discontinue Project

11. PROJECT OFFICER AND HOST COUNTRY OR OTHER RANKING PARTICIPANTS AS APPROPRIATE (Names and Titles)

Mr. Rod F. MacDonald, ASIA/PD/ENGR.
Mr. Robert A. Cahn, Director, O/PDS
Mr. Suvit Vibulsresth, Coordinator, TNRSP, NRC

12. Mission/AID/W Office Director Approval

Signature

Typed Name: Mr. Donald D. Cohen

Date: Director, USAID/Thailand 2/20/79

AID 1330-15 (3-78)

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# EVALUATION REPORT OF ERTS 1 PROJECT
# THAILAND

## Project No. 493-11-190-180.14

## GENERAL BACKGROUND:

Since mid 1972 the U.S. Government through USAID Thailand, has supported the National Research Council (NRC) in developing a system to utilize remote sensing data for resource development planning/implementation. Starting from an experience base of near zero, it was proposed that the technical potential of the Thai's assigned to the project be developed, that the necessary equipment be provided, and that through the provision of technical assistance, a system be set in place to utilize remote sensing effectively in resource development activities.

Certain targets were established in the funding documents which will be utilized as evaluation elements. This evaluation does consider other factors which were not considered in the original planning of the project, but which due to technological changes, or due to the receptivity of the user ministries, make themselves available as measures of the overall effectiveness of the project.

The total grant funding cost of USG support of the project was $260,965. RTG direct support of the AID technical assistance inputs is recorded as $15,913 but this does not count other, more substantial expenditures which the RTG made in carrying out the project.

Further assistance has been requested from USAID by the RTG to carry on the project for an additional two years. This will allow the continued development of Thailand's capacity in remote sensing application. It will also provide additional reproduction capability and capacity in the form of color and black and white photography. This need was partially prompted by the change of film negative size available from U.S. LANDSAT receiving stations which exceeds the capacity of the reproduction equipment now available at NRC. For additional background information see Annex I and Annex II.

## EVALUATION ELEMENTS:

In evaluating the effectiveness of the project, as noted above, certain key projected outputs were extracted from the ProAg and PIO/T to be partially addressed in measuring the success or failure of the project. They are as follows:

1. RTG automatic data processing of landsat imagery capability was to have been a project output. Was it?

2. "Full exploitation and realization of the utility of ERTS images and other Remote Sensing data in their ongoing program of work" was to be a project output. Was it achieved?

3. How has operational role of the NRC Remote Sensing Program moved from a "Research" to a "Proven Application" mode.

4. Were applications of Remote Sensing applied to (1) Agriculture, (2) Forestry, (3) Land Use, (4) Hydrology and Irrigation, (5) Geology, and (6) Hydrography and Oceanography as outlined in pages 7 through 12 of the ProAg. If so, how successfully, and if not, why not?

5. What has happened to the 110 trained remote sensing technicians (10 trained in US) - where are they today and what remote sensing work are they doing?

6. Are the Thais successfully producing, and reproducing, black and white imagery? (Status and condition of their photographic laboratory).

7. What direct or indirect links did the ERTS-1 project have to AID's target group?

Each question is addressed separately below either in the narrative or by reference to attachments which address that questions posed. Reports and various published papers of considerable volume are available at NRC. These data were too massive to either fully review in the time frame allowed for the evaluation, or to include as attachments to this evaluation, however a sampling was reviewed and is reflected in the conclusions reached.

In addition to specific outputs which were predicted, the evaluation reflected on the utilization of the commodities purchased through the U.S. funding, and the current condition and functionability of these commodities. The evaluation is included below titled <u>Commodity Utilization</u>.

EVALUATION FINDINGS:

1. RTG capability for automatic data processing of Landsat imagery was to have been a project output. Was it?

The National Research Council (NRC) has successfully implemented two computer programs for LANDSAT image analysis, the LIGMALS and the RECOGX.

LIGMALS: LIGMALS is a simplified economical, easy-to-run computer classifier developed by Mr. Harvey Wagner of the University of Michigan. AID/Washington first transferred this program to an LDC (Sri Lanka) under a grant administered by the Environmental Research Institute of Michigan (ERTM). N.R.C. has LIGMALS set up for running on the Burroughs 1710 at the Burroughs Corporation, a U.S. firm with a branch office in Bangkok. Although most of NRC's effort with LIGMALS has been devoted to getting the program running on the 1720, N.R.C. plans, for cost reasons, to set the program up on an IBM 370/135 at Chulalongkorn University. N.R.C. will fund this adoptation themselves.

RECOGX: N.R.C. was able to play a role to successfully adapt the Colorado State University RECOG image analysis program, which runs on the CDC 6400 computer, to the Asian Institute of Technology (AIT) IBM 370/145 computer. All three basic interpretation features are density level slicing, Euclidean Distance Rule, and the Maximum Likelihood Classifier. The Thai went one step further by adding a cubic convolution subroutine for average brightness levels appropriate when enlarging a LANDSAT sub-image.

The N.R.C. applied the RECOGX software to classify mangrove around the Bang Pakong estuary, land uses around Bang Pra reservoir, and the delta of lower Bang Pakong estuary and Wang Noi District.

No agency, including N.R.C. and AIT, are using the RECOGX frequently at the present time. Operational use is discouraged due to the requirement of having an AIT systems programmer load the program in computer memory core and set up the job control cards to get the program running, As AIT to date has not had the operational charter nor the academic commitment to computer image

processing, a dedicated systems programmer is not available to set RECOGX up whenever a user wishes to process LANDSAT imagery. This situation has discouraged NRC from making ample use of the software system they were instrumental in developing. It is envisioned that the development of a regional remote sensing center at AIT will see a firm commitment to image processing and dedicated programmers who will be charged with maintaining many image analysis programs.

NRC Growth in Computer Analysis: The speculation presented here only influences the regional remote sensing center, as the Thais have not requested from USAID any additional funding under their National Program extension for computer analysis, other than the training for personnel who will operate the LANDSAT receiving station. The computer processing performed at the receiving station will be standard radiometric and geometric corrections to High Density Digital Tapes (HDDT's) and conversion to Computer Compatible Tapes (CCT's). For the next two to three years, NRC will have their hands full developing the receiving station, setting up the visual analysis equipment proposed under the National Program extension, interpreting crop patterns on the area frame sampling project, and carrying on their usual consultative role with other RTG agencies. Especially in light of their withdrawn commitment to actively support LIGMALS and RECOGX, as well as the future availability of image analysis software at AIT, it is recommended that they not divert their responsibilities to their national projects by investing time and staff in computer image classification systems.

2. "Full exploitation and realization of the utility of ERTS images and other remote sensing data in their on going program of work" was to be a project output. Was it achieved?

It was unrealistic to expect such an output from any modest program any where in the world. Certainly it has not been achieved, nor can it be expected to be for some years, if ever.

One problem is that the technology is changing so rapidly that it is difficult to keep up with it. Also the hardware development is moving just as rapidly, and full utilization would require costly procurement on a continuous basis for full utilization. Also NRC is a service unit which supplies products and technical assistance to line ministries for their use. These ministries are starting to use the products, and can be expected to increase the utilization, however the use varies from

ministry to ministry and within departments of each ministry. The fact that the imagery is being used is encouraging, however, the unrealistic target was not met.

3. How has the operational role of the NRC remote sensing program moved from a "research" to a "proven application" mode?

NRC has been in an adaptation role rather than a basic research role. Their purpose as seen by the evaluators was to become skilled in the interpretation of remote sensing data, to make products of remote sensing available to line ministries, and assist them in the utilization of these products in development activities. To this extent NRC has been and is fullfilling this service function. NRC has assembled technology and demonstrated its practical applications to planning and implementing agencies of the RTG. As these agencies accepted the new opportunities provided by remote sensing, RTG would then become the technical resource to assist in application and also to provide remote sensing material, imagery, scaled maps, and computer interpretations. Further NRC was to keep up with the technology and provide additional usable products to the user agencies as they were developed.

NRC is still in the process of fulfilling this role. Eighteen civil service positions have been allotted to the remote sensing section of the NRC, and it is expected that an additional eighteen will soon be allotted. The allotment is approved, but the paper work* is not yet complete. This will bring the total group staff of civil service positions to 36. Some of these positions will be filled by conversion of the current temporary staff. For other positions personnel will have to be located and trained, but once trained and in place they will allow NRC to greatly increase its support in development work and also make possible the support function NRC is to play in the regional remote sensing training center to be developed at AIT.

The NRC organization as now planned calls for the thirty six civil service positions to be assigned to the remote sensing activity as shown in the organization chart below. The temporary positions shown are for employees who have not yet qualified for civil service status through testing or other requirements, or are awaiting additional allotments of civil service positions

* to put personnel in the newly approved positions

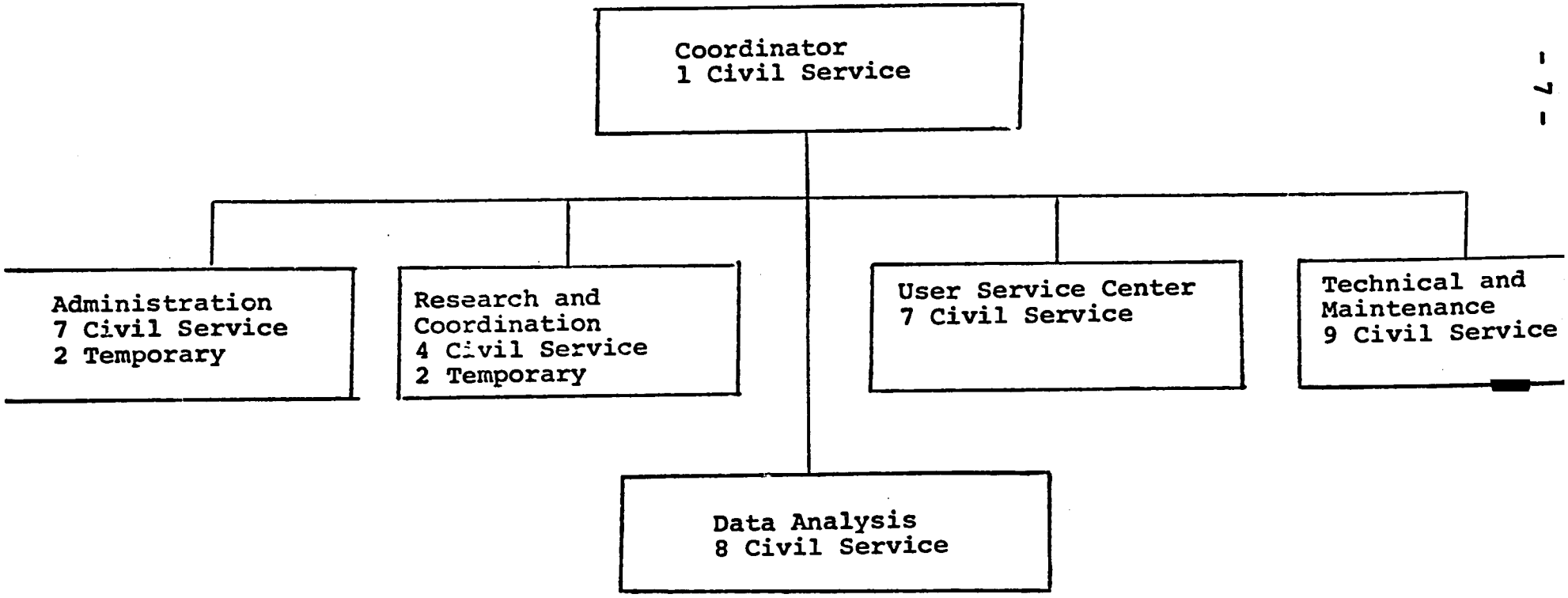
which they would then occupy. The temporary employee catagory doesn't give the incumbent the benefits of civil service status such as yearly salary increments, but the potential offered through the organization is sufficient to keep them with the organization.

It is an important indication of Thailand's dedication to the program that 36 civil service positions have or soon will be allotted to the remote sensing activity. True the coordinator requested 45 positions, but in receiving 36 outstripped other competing organizations for these limited allotments. A request for an additional 5 positions for the first planning staff of the ground receiving station staff has been generated from the prime minister's level, and is expected to be approved. All of this solidly supports Thailand's contentions that utilisation of current remote sensing data is of great benefit, and the future potential substantial enough for them to dedicate major resources to further the use of this technology.

4. Were applications of remote sensing applied to (1) agriculture, (2) forestry, (3) landuse, (4) hydrology and irrigation, (5) geology and (6) hydrography and oceanography as outlined in the ProAg?

Clearly this has been the case. Examples are shown of some uses in the answer to question 7 below, but a more complete documentation of these applications is included in the project report "type III final report for period June 1975 - July 1977" of the "Thailand National Programme of the Earth Resources Technology Satellite". Copies of this document are available at USAID/Thailand and ASIA/PD/ENGR, in Rosslyn Va. In addition to the cases cited in that document, the NRC has produced data from imagery which was used to plan a new deep water port, to study accretion due to sediment deposition off shore of river mouths and mapping of mangrove cover along coastal areas. Applications are being made in all of the above mentioned fields, and use can be expected to increase.

REMOTE SENSING ORGANIZATION
NATIONAL RESEARCH COUNCIL
ORGANIZATION CHART



5. What happened to the 110 trained technicians (10 trained in U.S.) - where are they today, and what remote sensing work are they doing?

The nature of the training must first be understood before the reader can appreciate the findings. First with regard to the U.S. training.

Since the remote sensing group were in a "temporary employee" status, (excepting for the coordinator), they were not allowed to take part in training outside of Thailand. Therefore only the coordinator received U.S. training, while other training was given to user ministries.

(A) U.S. TRAINING:

The U.S. training was in the main only short course training i.e.

| | | |
|---|---|---|
| 3 | participants | 1 month training |
| 2 | participants | 2 months training |
| 3 | participants | 3 months training |
| 1 | participant | 4 months training |
| 1 | participant | 24 months training for M.S. degree |

Of these ten trainees, eight are still working for the same agency for which they worked prior to the training. One of those who changed jobs left the National Statistical Office Computer Center for a job in private industry. His training was for a period of two months and to the best of our knowledge he is not using his remote sensing training in his present work.

The other trainee who changed jobs was Ms. Phacharee Mekharosathamkul. Ms. Phacharee worked for the Royal Irrigation Department prior to her three months training at the Eros Data Center. Soon after her return Ms. Phacharee accepted a position teaching geography at Silapakorn University. She uses remote sensing in her teaching, and is still very active in the National Committee on remote sensing.

The following is the list of participants with their sponsoring and current agency affiliation.

1. Mr. Manit Nayenart

   Sponsoring Agency: Forest Management Division
   Royal Forestry Department

   Job Title: Chief of the Remote Sensing Section

   Current Agency: As above

   Length of Training: 1 month

2. Ms. Punnee Wara-Aswapati

   Sponsoring Agency: Chiengmai University

   Job Title: Assistant Professor of Geography

   Current Agency: As above

   Length of Training: 4 months

3. Ms. Valairat Vunpiyarat

   Sponsoring Agency: Land Use Classification Division
   Land Development Department

   Job Title: Agonomist

   Current Agency: As above

   Length of Training: 2 years

4. Mr. Prayong Angsuwathana

   Sponsoring Agency: Department of Mineral Resources

   Job Title: Senior Geologist

   Current Agency: As above

   Length of Training: 2 months

5. Ms. Phacharee Mexharosathamkul

Sponsoring Agency: Royal Irrigation Department

Job Title: Assistant Professor of Geography

Current Agency: Silapakorn University

Length of Training: 3 months

6. Ms. Annie Skunasingha

Sponsoring Agency: National Statistical Office

Job Title: Chief of Cartography Section

Current Agency: As above

Length of Training: 3 months

7. Mr. Vichit Amornviratsakul

Sponsoring Agency: National Statistical Office Computer Center

Job Title: Not applicable

Current Agency: Now working for private industry in non remote sensing related work

Length of Training: 2 months

8. Mr. Suvit Vibulsresth

Sponsoring Agency: National Research Council

Job Title: Coordinator for Remote Sensing

Current Agency: As above

Length of Training: 1 month

9. Vice Marshal Sukit Semangern

Sponsoring Agency: Royal Thai Air Force

Job Title: Chief of Photographic/Tactical Division Air Command

Current Agency: Advisor to Photographic Department Royal Thai Air Force

Length of Training: 1 month

10. Mr. Lertchai Nilsadab

Sponsoring Agency: Div. of Agricultural Economics

Job Title: Computer Programmer

Current Agency: As above

Length of Training: 3 months

Interviews were held with three of the participants plus one recipient of invitational travel to attend the LACEIE Seminar in Houston, Texas this year. The information gathered during these interviews follows:

On December 13 Rod MacDonald interviewed Ms. Valairat Vunpiyarat at the Land Development Dept. Ms. Valairat returned from her two years of training in the U.S. with heavy emphasis on applied remote sensing including computer applications. Her thesis work related to land classification in central Thailand utilizing satellite imagery and computer analysis. Purdue University is very interested in ground truth verification of the analysis, and plans to publish the study. Due to the priorities of other Dept. work the ground truthing effort was not scheduled until January 1979. This will give the additional information necessary to validate the land classification mapping done by Ms. Valairat.

Ms. Valairat is now working on land classification work in south central Thailand using aerial photography and LANDSAT imagery. Both Ms. Valairat and her Division Chief have a keen interest in applied uses of remote sensing and plan to expand the Division's capability in the technology to more fully utilize these techniques in their operation. In the past the Division has relied heavily on NRC to provide skills and equipment to assist in land classification using remote sensing analysis. Due to the success of the initial program they now wish to develop a divisional capability to carry out production application of the technology.

The Division has obtained a multispectral projector for analysing imagery. They also hope to utilize AIT's computer to analyse satellite data for land use classification. As noted above Ms. Valairat has used computer assisted evaluation techniques in the past for this purpose, and is very eager to install this capability in the Division through use of the AIT computer.

Several meetings were held with Mr. Suvit Vibulsresth of the National Research Council who is the Coordinator of Remote Sensing for the NRC. Mr. Suvit gave most generously of his time, and proved to be the major resource for the evaluation. His knowledge of all Ministry's use of, and successes with, remote sensing applications, as well as his in-depth knowledge of the how-to-do-it details, provided a wealth of information. Latter visits to Ministries proved that his candor provided a factual view of the true picture.

His intriguing and searching personality made time spent with him not only extremely pleasant, but highly beneficial from an evaluative standpoint. It is difficult not to be swept away with his enthusiasm with the field and his innovative plans for the future of the program. Suffice it to say that Thailand has a most capable dedicated leader for their remote sensing technology. Much of the data included in the report flowed from and through Mr. Suvit, and wor't be repeated in this section.

On December 12 Mr. Robert Cahn and Rod MacDonald met with Mr. Manit Nayenart, Chief of the Remote Sensing Section of the Forestry Department. This Section was established in 1972, and is responsible for application of remote sensing technology to forest management and watershed management throughout Thailand. The Section is staffed with 50 personnel, 20 of which are working in interpretation of remote sensing data. The other 30 are support staff working in the photo lab, printing shop, report writing and stenographic areas.

Since 1972 the Section has produced a overall forest survey which is noted under question 7, and mapped existing forested areas at a scale of 1:500,000 and 1:1,000,000. As a result of comparison of this 1961 data and 1973 data it was shown that 30% of Thailand's forested lands had been taken out of production during that time frame, and that watersheds were endangered due to the indiscriminate deforestation.

As a result of this study the RTG established a national policy for intensive management of the forest resource including a five year plan/mandate to increase the forested lands from 38.6% to 40% of the total Thai land area. All land was divided into three classifications; class 1 which allows no exploitation, class 2 allowing controlled exploitation, and class 3 dedicated to agricultural use.

An intensive river basin study was completed for the upper Chaophya River, and the watershed management plan which resulted has been accepted by the RTG, and implementation is now underway.

Change studies are being designed to continously monitor the forested areas, to provide up to date planning data. Additional watershed management plans are under study, accurate forest maps have been produced, and as computer programs are made available - hopefully through the AIT Regional TrainingCenter - a program of species inventory and disease detection will be initiated.

The Ministry has utilized and is continuing to utilize, remote sensing (both satellite and aerial photograph), to more intensively manage the forested lands within Thailand. They would like to have additional interpretative equipment, but are making good use of the data and equipment now available to them.

On December 15 Rod MacDonald, AID/W and Mr. Suvit of NRC met with Dr. Kluen and his staff of the DAOE to discuss their use of remote sensing, especially as it related to crop forcasting.

It was explained that the DAOE had tried to use Landsat II imagery in conjunction with simultaneous ground truthing to forecast food production. Due to the lack of memory on Landsat II to meet the demands for data, NASA could only provide imagery on every other pass over Thailand. This meant every thirty six days instead of every eighteen.

The DAOE mobilized three teams to collect data on soil moisture content, soil texture, crop growth condition, weather, and on the initial trip the slope of the planted area. These data were gathered every 18 days, even though satellite data was collected every 36 days.

The project was only partially successful for the following reasons.

A. Even though cloud cover-free imagery was collected in 1972 and 1973, it seemed that the thirty six day collection always occurred on cloudy days. Other days were often cloud-free, and especially exasperating, on the eighteen day satellite non data collecting pass the area was almost always cloud-free. Therefore no good imagery was received over the area frame plots. Late in the four month program aerial photography was flown which proved useful.

B. Satellite Imagery, in this case largely cloud covered, was received too long after being taken to be of real value in predicting crop production.

C. Farmer holdings are so small, and species planted so intermingled, that it is difficult to determine what is planted from satellite imagery. Planted areas can be determined, and rice paddy can be distinguished from field crops, but fields are planted in crops which vary from year to year making specific crop projections difficult.

Due to the above the program was only marginally successful, and until some homogeneity of planting comes into existence, it is unlikely that any precision in crop forcasting, by species, can be expected.

Some success in locust damage evaluation and locust spread was accomplished using an aerial survey with infrared photography. The DAOE plans to continue applied research in this area. Also they plan to continue the area frame sampling program which they feel gives them usable data in spite of its limitations.

Of interest is the fact that small farmers decide what to plant this year based on last years market value for crops produced in their area. This causes trends which upset supply and demand and therefore market payments received. The farmers are too often one year too late in their attempts to produce the high value crop.

Some attempts have been made to stabilize produce prices, which might result in more homogeneous planting, but as yet doesn't include enough of the species grown.

The DAOE now has twenty five people working on their remote sensing application work. They are dedicated to the task of expanding on their current successful programs, and developing additional applications which would be successful in the DAOE activities.

(B) IN COUNTRY TRAINING:

The second category of training were the two six week courses taught in Thailand. These were intensive classroom instructions in fundamentals of remote sensing technology, and applications of satellite data in development activities. To follow a significant sample of these trainees to their work place, and evaluate their current use of remote sensing was felt to be unnecessary. Instead we relied on the knowledge and candor of the NRC for evaluating the effectiveness of this training. Their evaluation is as follows:

The first seventy-eight trainees were selected for evaluation by the NRC. They were graded as to the known present use of remote sensing technology. Also those who were known to have had technical specialities were listed by those specialties.

| Intensive Use and in continuous Coordination Advisory Role with NRC | Continuously Using Remote Sensing in Their Work | Using Remote Sensing Part-Time in Their Work | Use of Remote Sensing Unknown to NRC | Not Using Remote Sensing in Their Current Work |
|---|---|---|---|---|
| 7 | 35 | 17 | 13 | 6 |

Those participants taking the NRC training who had a technical specialty were in the following fields:

| | |
|---|---|
| Geology | 14 |
| Hydrology-Oceanography | 17 |
| Land Use | 15 |
| Forestry | 12 |
| Agriculture | 13 |
| Total | 71 |

The reader can draw his own conclusions from these data, but the number known to be using remote sensing is impressive and constitutes 71% of the total group given the six week training.

6. Are the Thais successfully producing and reproducing, black and white imagery Status and condition of their photographic lab

The quality of the imagery being produced in the NRC lab is, according to several knowledgeable sources, of better quality than can be obtained from the EROS Data Center in the USA. This includes both color and black and white imagery. Some examples are attached to this report. (Attachment IV to original of the report only).

Early in the project life, the remote sensing group was competing for space with other NRC functional groups, and no acceptable laboratory space was made available for their use. With the completion of the new NRC/ASRCT (National Research Council/Applied Scientific Research Corporation of Thailand) building in December 1976, space became available and a functional photo laboratory was developed. The products are of high quality, and are being ordered by the line agencies for use in development activities.

7. What direct or indirect links did the ERTS 1 project have to AID's target Group?

In answer to the question of what direct or indirect links the ERTS project has developed to the rural poor, the only linkages are indirect, but they can be demonstrated. philosophically one must accept the premise that improvements to environmental planning benefit all, both rich and poor, and that tracing the linkage all the way to a poor farmer in the field is unnecessary. This would be the case in both land classification and forest management.

By utilizing satellite imagery, the Department of Forestry observed that 30% of the forests were cut between 1961, when aerial photography and ground checks showed that 55% of the country was forested, and 1973, when satellite imagery showed that 38.6% was forested. The cost of the 1973 inventory was comparatively cheap, and currently satellite data visually demonstrated the critical trend of deforestation. Deforestation was due to illegal cutting, shifting cultivation practices, and concession logging. This knowledge stimulated the RTG to move to a more intensive forest management system in order to properly control timber extraction and to initiate replanting of certain exposed forest lands.

To the extent that proper watershed management and erosion prevention benefit the poor, there is a linkage to the poor as shown in the above example. The method of addressing shifting cultivation practices could be beneficial or adverse to those farmers involved, depending on the plan developed.

Another use of satellite imagery was in the production of land use maps of large sections of the country. These maps are used in planning development activities throughout the nation, and changes in land use are important indicators in food production, population movements, soil depleting erosion, and many other resource and environmental trends. National planners armed with current information can move more rapidly and more accurately to take advantage of changes which are progressive or to plan corrective action when changes are regressive.

Another example of productive use of NRC's imagery is in irrigation planning for river basins. Recently an entire water course network in a major river basin was mapped accurately during a two day period. This new map revealed discrepancies in the old map caused by changing river beds, poor accuracy of the original map, or both. The new map will be used in designing an irrigation system to increase crop production in the area.

Still another use of imagery is in crop forcasting. By use of imagery and statistical sampling through ground survey, crop areas and yields can be measured with acceptable accuracy to predict surpluses and shortfalls in advance. This provides planning time for marketing excesses, or importing food in areas of shortfall. Famine affects the poor more significantly than the rich, and

corrective measures, made possible by accurate forecasts from remote sensing, would certainly benefit the poor directly.

In some cases satellite imagery can be used as an early warning system for flood conditions. Too often however, cloud cover will block out the ground surface from remote sensors. The use of weather satellite data, a form of remote sensing, can, however, be utilized to study cloud temperatures and study storm patterns manifested by clouds to forecast occurence of flooding.

Satellite imagery and its interpretative outputs are tools, which used in connection with other technology, can produce data for better resource development planning. Taken by itself, it doesn't result in change any more than any other planning tool. Used in the design and implementation of projects, it can greatly increase the chances of success, and it has a solid role to play in that process, especially in the less developed countries where data are so difficult to obtain.

See Attachment 3 for additional information which attemts to link agricultural data to the rural poor.

8. Commodity Utilization

The major items of equipment procured through project funding and their current condition and use are as follows:

1. Multispectral/projector

Maker: Spectral data

This piece of equipment is in excellent condition, and in continuous use.

2. Zoom Transfer Scope

Maker: Bausch & Lomb

This piece of equipment is in excellent condition and in continuous use.

3. Diazo Printer/Developer

This piece of equipment is in excellent condition and in continuous use.

4. Densitometer

Maker: MacBeth TD504

This piece of equipment was malfunctioning when first received. After repeated attempts to have the company put it in good order the NRC had their own technician take it apart and repair the electronics. He was able to accomplish the repair, and the unit has performed well and has been in continuous use since that time.

5. Four Channel Aerial Camera

When received this piece of equipment had a malfunctioning lens adjustment. We were informed that Mr. Joseph O. Morgan of the U.S. Geological Survey, (then the Project Coordinator), had the camera returned to the manufacturer for repairs. We were told that it had not been returned to NRC. Mr. Morgan should be contacted in this regard, and the unit should be traced and returned to NRC in good condition.

9. Production of Imagery for Line Agencies

The following is a list of requests and resulting production of 1/250,000 imagery. The NRC moved it's photolab to the new building during September 1978, and this move stopped production during that month and resulted in a backlog.

| Month (1978) | Requests Received | Orders Filled |
|---|---|---|
| July | 12 | 12 |
| Aug. | 77 | 77 |
| Sept. | 258 | 0 |
| Oct. | None-New F.Y. Started Oct. 1 | 100 |
| Nov. | 49 | 150 |

The following is a similar table for diazo transparencies of satellite imagery.

| Month (1978 | Requests Received | Orders Filled |
|---|---|---|
| Aug. | 45 | 21 |
| Sept. | 7 | 0 |
| Oct. | 19 | 19 |
| Nov. | 34 | 34 |
| Through Dec. 12 | 21 | 21 |

It should be noted that when the photo lab is fully operational, with trained staff and some additional equipment, they expect to be able to process up to 300 images per month of 1/250,000 scale. (Prints of larger scale of Landsat II imagery tend to loose their accuracy).

With two operators on the diazo printer/developer NRC projects a production capability of 70 imagery transparencies per month.

TheNRC expects to effect a response time for routine orders of seven to ten days when the lab is fully operational. At the present time due to moving the lab, and the backlog that developed, the response time is about one month on routine orders.

10. NRC Remote Sensing Budget

| F. Yr. | Gross Budget | Special Line Item | Budget Net |
|---|---|---|---|
| 1974 | $ 79,640 | None | 79,640 |
| 1975 | 237,500 | 150,000 (Building) | 87,500 |
| 1976 | 183,175 | 75,000 " | 108,175 |
| 1977 | 177,345 | 40,000 " | 137,345 |
| 1978 | 208,275 | None | 208,275 |
| 1979 | 669,800 | 382,500 Rec.-Station | 287,300 |
| 1980 (proposed) | 4,835,000 | 4,000,000 Rec.-Station | |
| | | 150,000 Building | 685,000 |

The breakdown of the 1979 Budget was as follows:

| | |
|---|---|
| Wages | $40,000 |
| Plant Maintenance & Ground Truth | 36,000 |
| Expendables | 97,500 |
| Equipment Purchase | 82,500 |
| Research Grants | 25,000 |
| Funding for Satellite Ground Station | 382,500 |
| Unspecified | 6,300 |

The above figures reflect Thailand's interest in remote sensing and their evaluation of the effectiveness of the program to date.

Conclusion:

The real life applications of the NRC remote sensing data outputs through the line agency's of RTG have demonstrated to the evaluators'satisfaction that the project has been successful. NRC, has firmly established the technology as a meaningful tool in the development process throughout Thailand. The need for current information in appropriate policy generation is a given, and the current speed and cost of developing this information through remote sensing has convinced the Thais that it should play an ever increasing role in the prudent development of Thailand's resources.

To fully apply the technology, and stay alert to additional application potentials of the existing technology, and of more importance - the new evolving technology, is a challenging opportunity. Thailand has accepted the challenge, and is making amazing progress in developing the human and material resources to accomplish their goal.

USAID contributions were instrumental in supporting Thailand's effort, however the Netherlands, UNDP, and other donors have contributed training, information exchange seminars, and other inputs to support the Thai's in this endeavor.

Several factors have satisfied the Thai's and USAID Thailand, that there is a logical rational for continuing USG support for an additional phase. They are as follows:

1. The constraint of not being allowed to train non-civil servants in U.S. institutions through project funding was unfortunate. Only one of the project group was a civil servant. This constraint has been overcome by the conversion of NRC personnel to civil service status. If NRC is to guide, plan, coordinate and train in the remote sensing activities in Thailand it is important that they stay abreast of the technology so that they are, and are accepted as, the center of Thailand's excellence in that field. Additional training is required.

2. Additional equipment is needed to answer the ever expanding requests for imagery and aerial photos generated by the user agencies within Thailand. This coupled with the need to support the proposed regional remote sensing training project at AIT and the changes in satellite film size output, require that NRC procure additional lab equipment.

3. There is still a need for a reduced level of technical support to assist in planning and implementing the RTG program.

The evaluation team concludes that the ERTS project was successful, and that the follow on project be favorably considered.