SR. NO. 9620

THAILAND NATIONAL PROGRAMME

OF THE

EARTH RESOURCES TECHNOLOGY SATELLITE

Pradisth Cheosakul

Secretary-General

National Research Council

Bangkok 9, Thailand

August 1973

Second Type I Report for period May - July 1973

National Research Council

196 Phahonyothin Road, Bangkhen

Bangkok 9

Thailand

Goddard Space Flight Center

Greenbelt,

Maryland 20171

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Second Type I Report

1. Title of Investigation: The Thailand National Program of the Earth Resources Technology Satellite.

2. Proposal Number: SR 9620

3. Principal Investigator: Dr. Pradisth Cheosakul, Secretary-General, National Research Committee.

4. Objectives: The over all objective of the Thai National ERTS Program is to evaluate the extent to which ERTS data can be applied beneficially in various sectors of the economy. Investigations in each of the following disciplines will be undertaken:

Agriculture

Forestry

Geography/Demography/Cartography

Hydrology/Meteorology

Geology

Oceanography

5. Summary of Accomplishments:

Following the six week training in January-February 1973 Thai scientists and technicians had opportunity to become familiar with ERTS imagery in various aspects of interpretations. The false color enhancement methods were applied, in addition to black and white data received from NASA. A 4-Channel Projector/Viewer provided by USOM was used to make false color composite from the 70 mm positive transparencies. Results were satisfactory because many features were recognized better than in the black and white imagery. A more promising method in making false color transparencies was used. It is called Diazochrome products, which give highly detailed color data because it is made directly from the 9.5 x 9.5 inches positive transparencies.

In the mean time, members of participating agencies were active in their disciplines working with ERTS data. At the Applied Scientific Research Corporation of Thailand, an ERTS MSS Mosaic of Thailand was assembled using black and white data with the least possible cloud cover at a scale of 1:1,000,000. Approximately 48 prints from MSS band 7 were used. Construction of the mosaic was done by ASRCT ERTS staff with Technical supervision from USOM ERTS Project Coordinator. This mosaic was made so that it can be up dated with new ERTS images at any time. Photo copies could be made available to interested users and participating agencies.

During the reporting period, the four week training program was held during the months of May and June 1973. The purpose was to follow up progress made by Thai scientists in various participating agencies. The program was sponsored by the United States Operation Mission to Thailand and administered by the U.S. Geological Survey, Office of International Geology, and taught by the same team of U.S. Remote Sensing experts who came over during the January-February training period. During the training period, lectures and talks were delivered to various government departments on the potential application of ERTS data in planning and management of the national natural resources. Many departments expressed keen interest in the program.

Investigators and scientists who work with ERTS data had an opportunity to present their cases of findings and problems encountered in the course of investigations to the experts to ask for a better solution and exchange of ideas.

Following the four week training program, members of Working Sub-Committee were asked to deliver lecture to approximately 4,200 high school students over a period of about one month on "Potential Application of ERTS data in Analysis of Environment". At the lecture, photo copies of MSS mosaic of Thailand were handed out to students and schools concerned. This has brought a lot of interest from students and school officials because it has never been done before in the past.

Prior to reporting period, USOM put up a set of display using ERTS imagery of Thailand both in black and white and false color prints together with some diazochrome products. The display was put up at USOM for a period of time and then moved to the National Research Committee and the Applied Scientific Research Corporation of Thailand during the entire period of the second phase training course. The display is now being used at the Children's Pavilion of the Ministry of Education for some 4,200 high school students to view during lecture session mentioned above.

During the reporting period, ASRCT's ERTS Staff is getting ready to assemble a MSS band 5 mosaic of Thailand at scale of 1:1,000,000. When finished, it will be put in to use at ASRCT and for other participating agencies to study various aspects of interests, at least it can be used to compare with the one of the MSS band 7 which is finished and being displayed.

6. Available ERTS-1 data and Interpretation Equipment and Techniques.

The ERTS-1 satellite acquired images of Thailand repeatedly during the general period from September 1972 to March 1973, when the tape recorder on board the Satellite went out of order. This imagery is now available for inspection and use at ASRCT. Images have been transmitted to Thailand from NASA in the form of 70 mm and 240 mm negative and positive transparencies representing four spectral bands in the range of 0.5 um to 1.1 um. Each scene shows an area of Thailand 185 x 185 km^2. These basic images form the data base for long list of possible uses including:

6.1 Creation of color composite by a diazochrome process using the 240 mm. images.

6.2 Creation of Color composites by an optical color additive viewer using the 70 mm. images (sometimes called 70 mm. chips)

6.3 Enlarge individual images, or set of imaged, to desired map scales for projection on to conventional base maps by using a Zoom transfer scope.

6.4 Extraction of spectral data from imagery to aid more quantitative interpretation of agricultural patterns using a Macbeth TD-504 Transmission Densitometer.

In addition to the above data bases and equipment available for its interpretation, a 4-band camera has been acquired for collecting low altutude aircraft photography. Such photography is needed in a statistical sampling frame work for continuous, in large areas. This camera can be mounted on an RTAFC-47 aircraft. It should be emphasized that all of the satellite imagery and all pieces of equipment are now available for use at ASRCT.

7. Analysis and Findings

Findings are reported below in the areas of Agriculture, Forestry, Land Use, Geology, Hydrology.

Under Agriculture, investigators report the completion of the lower half of crop regional map of the Bangkok frame. The false color composite of the 9th October imagery enlarged to the scale of 1:400,000 were used as a base map. Boundaries for different crop regions were delineated. Field checks and aircraft flights were made to support ERTS data. It was possible to delineate crop boundaries such as rice, orchard, citrous grove, coconut grove, mangrove swamp, salt field and shrimp field. The Alluvian Fan area in the northern part of the central plain were delineated, and soil samples from the area were studied in regard to their suitability for agriculture. In conjunction with the LARS computer system for data analysis, the Agriculture sector did the field checking against the gray scale print outs of Bangkok frame made by LARS, Purdue University. It was found that the LARS System is accurate and useful for cover type identifications, and hoped that it will be paid more attention to and be used in Thailand in the future.

Under Forestry sector, research work continued at test site areas selected to represent forest covertype of the whole Kingdom of Thailand. Findings were:

a) Identification of forest type could not be done by ERTS-1 imagery up to the reporting period;

b) Forest land and agricultural land could be distinguished;

c) Changes in forest cover could be detected.

Findings under Geography sector in Land use mapping was that sugar cane cultivated area in West-Central part was mapped out using diazochrome transparency consisting of yellow, red, and blue overlays. The boundaries of the sugar cane area were delineated with more accuracy and more up-to-date when compared with the Land Use Map done a few years earlier.

Findings under application of ERTS-1 imagery for land use planning and management was done by ASRCT ERTS staff in consultation to many government enterprises and other development advisory groups. One example is the detection of marsh area by using ERTS-1 imagery. Later this year, construction of a 2,800 million Baht nuclear power plant will commence in Sri Racha, whence highvoltage power line will conduct current towards Bangkok. Superficially, the intervening land appeared to be typical paddy land requiring by formula, light 20-meter piles per tower. The contracting company wisely approached ASRCT, however, regarding hidden hazard and was shown an ERTS-1 image indicating a distinct dark area between Samut Prakan and Chon Buri. This suggested that the terrain had a higher moisture content than previously thought, and ASRCT's further findings was that the paddy land had earlier been mangrove swamp. Subsequent tests confirmed the softness, so the number of towers and length of piles were both increased accordingly.

The Applied Scientific Research Corporation of Thailand had attempted to set up Research, Development' and Service Project. The purpose was to build up its own in house capability so that, as a center for the Thailand National Program of Earth Resources Technology Satellite, it could be in a better position to serve the potential data users in Thailand. The research' development and service project include basic calculations of relationship between Thailand parameters and those of the ERTS-1, modification of chip mounting frame for 70 mm. positive transparency to fit the acquired 4-channel color composite Projector/Viewer, production of additional data so that they are in desired format and ready to be interpreted by the users. ASRCT ERTS staff was responsible for the projects:

(1) MSS Mosaic of Thailand,

(2) Addition Data Products, Extended Services to users,

(3) Line of Sight Limit, Bangkok to ERTS-1 Orbit, and consideration of Setting up a Data Receiving Station in Bangkok.

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Second Type I Report

Sector: Agriculture

(Reported by Pongpit Piyapongse)

After the completion of the first training and the second visit of the U.S. Team of Remote Sensing experts, the agricultural sector pursued various tasks using ERTS-1 imagery. The objective was to make a maximum use of the available ERTS-1 imagery in connection with field checking and aircraft observations. The results could be concluded:-

1. The completion of the lower half of crops regional map of the Bangkok frame. The false color composite of 9th October imagery enlarged to the scale of 1:400,000 were used as a base map. The methods employed could be summarized as:

1.1 The base map was overlayed with acetate paper and then the boundaries were delineated according to various level of spectral response.

1.2 The areas of 5 x 5 kilometer of various crops was used as a field checking plot for field crops and an orchard test site near temple area. A 10 x 10 kilometer plot was used for paddy near Amphur Wang Noi test site and a 10 x 10 kilometer plot was used for sugar cane near Kampang san area.

1.3 Field Checking was done occationally at various test site.

1.4 Aircraft observations were made twice, the color IR and Ektachrome were used during the observations. The aerial photographs were taken with ordinary 35 mm. camera for field check were made on various crops, namely rice, orchard, citrus grove, coconut grove, mangrove swamp, salt fields and shrimp fields to back up ERTS-1 imagery and vice versa.

2. The Alluvial Fan Area in the northern part of the central plain was detected and deliniated. Field checks and soil samples were taken. The nature of the series of the alluvail fans were defined. The high amount of micaceous parent material sugested a granitic rock origin. Multiple cropping, namely rice, sugar cane, and soy bean are grown successfully in the alluvial fan area. This rich fan is situated in 4 provinces:- Uthai Thani, Chainat, Supan Buri and Kanchana Buri and has an area of about 3080 square kilometers. The area will be an example of agricultural development for the Central Plain. A separate paper on this area will be made after the study.

3. The Feasibility of Utilization of IARS System for data analyses.

The gray scale print-outs of the Bangkok frame was used for field checking around the Temple area for accuracy of identification by the computer.

We found the LARSYS/Computer System was very accurate and useful for the cover type identifications with some modifications.

The symbols have been keyed out as follow.

Symbol	Class	Group	Classification
1. =	NS-4/10	VEG 1	bushes
2. /	NS-5/10	VEG 2	orchard (citrus)
3. +	NS-6/10	VEG 3	tree, wood land
4. (.)	NS-7/10	SOIL URBN	Urban, bare soil
5. 0	NS-8/10	VEG 4	grasses
6. W	NS-9/10	WATER	water + Rice
7. M	NS-10/10	SHAD & H_2O	water + Rice

We found item 1-5 are excellent especially item number 4.

We would recommend a combination of 6 and 7 for better classification of the cover type.

We hope this programme of automatic data processing would be used in Thailand.

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Second Type I Report

Sector: FORESTRY

(Reported by Boonchana Klankamsorn)

The research work at the test site areas ~~still~~ was being continued. Each test site has an area of 625 square kilometers. The application of remote sensing on extensive forest inventories depends on the development of dependable predictors of forest area and timber volume and condition classifications. The questions that need answers are: How can forest be separated from nonforest land; Are changes made by man or natural disturbances ?

The Study Area

The study areas are located in the North and in the East regions of Thailand. There are eight test site areas for each region.

Working Methods

The ERTS-1 imagery, band 5 and band 7 enlarged to the scale of 1:500,000, were used as a base map. These prints were super imposed by microtrace drafting paper and the boundaries delineated were according to various tone contrasts. Some more details were taken from diazochrome products and the false color composite viewer screen.

Field checking were done occasionally at the test sites. Aircraft observations were made in the East Region to find out the existing forest and the condition of disturbances. The forester team went to the various test site areas for ground observation. The area of 25 x 25 kilometer was used as the size of the Test site areas, and the sample plots of the size 25 x 25, 50 x 50, or 100 x 100 meters were used for research work. The photographs were taken with ordinary 35 mm. camera for field checks and were made of various tone contrasts on the imagery at each test site area.

Comments

Although the application of ERTS-1 imagery is in preliminary stages, we could mention that:

1. The ERTS-1 imagery in Black-White print of the scale of 1:500,000 could not help to identify the type of forest.

2. It was possible that we could separate forest land from the agricultural land.

3. Forest changes due to man-made or natural disturbances could be detected.

4. Small field in dark forested areas and small farm in lighter toned agricultural areas were not resolved.

5. The size of sample plot for checking depends on the location of the test site, for instance, for the mountainous areas the small sized plots should be used but for the plain area or gently slope the big-sized plot should be used.

6. The best bands for forestry inventories are the combination of the MSS band 5 and band 7.

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Application of ERTS-1 Image in Land Use Mapping

Sector: Geography

(Reported by Salaisophin Komarakul Na Nakorn)

Resources Inventory Group, ASRCT

The Study

An ERTS image was taken on January 7, 1973 over the Mae Klong River basin. The image was referred to as NASA Observation I.D. No. 1168-03122. The purpose was to evaluate the applicabality of the ERTS technology compared with other conventional methods of survey. The image was in the form of Diazochrome Transparency consisting of overlays of yellow, red, and blue transparencies. An area to the north of the Mae Klong River including Ban Pong District, Kanchanaburi Province, and a part of Suphanburi Province, appears in the image, to be in a relatively uniform cluster of tones and colors of orange-red shade. This area was distinctly different from those of the surrounding areas indicating an agricultural area. Crops growing in this area could not be rice because January was not the rice growing season. Additional information obtained from a ground survey further showed that the area was infact, a sugar-cane cultivation area.

The boundaries of this sugar-cane cultivation area were delineated. The derived figure was compared in Fig. 1 with the figure of the same area worked out from a land development and land use map of the same scale (1:1,000,000) printed in 1972. It can be seen that the two figures of this particular area are almost identical. Areas of the two figures were then measured using planimeter to quantitatively assess their resemblance. The areas were found to be 1860 and 1670 square kilometers respectively. The discrepancy of only 10.2% might be due to error in delineating the figures and in measuring the areas. This error was however in an acceptable limit.

Conclusions

Results of this study clearly indicate that the ERTS data is applicable in land use mapping. However, a ground survey is needed to make the obtained data more complete and reliable. In addition, comparison of satellite images, taken over the same area on different occasions, will reveal the rate of growth of sugar-cane and or other supplemental crops; and also soil moistures in various seasons. These information will undoubtedly be extremely useful in crop and land management.

Figure 1 Two Figures of the Same Area Derived from ERTS Image and Land Use Map

ERTS-1 Image has a role in construction engineering

(Reported by Boon Indrambarya)

In may 1973, a representative of the Thai Machinery Industry Company Limited visited the Resources Inventory Group of the Applied Scientific Research Corporation of Thailand (ASRCT) and asked for an advice on the condition of the terrain between Samut Prakan and Chon Buri.

The Company just obtained a contract from the Electrical Generating Authority of Thailand (EGAT) to make concrete piles which will be used in the construction of high-power transmission towers along a route of 110 kilometers from Bang Pli District of Samut Prakan to Aow Thai, Si Racha District of Chon Buri, where the approved 2,800 million baht nuclear plant will be built in late 1973. According to the plan, one tower will require eight piles, each of which will have the length of 20 meters. The cost agreed is 300 baht per one meter in length. The total number of the towers is approximately 320.

The ASRCT geographer showed the Company's representative one ERTS-1 image, frame E-1167-03070-5 (Band 5) of 6 January 1973, which had a distinct dark area between Samut Prakan and Chon Buri. The dark color suggested that the area still had high moisture content. Being acquainted with the development of the area, the geographer strongly advised the Company's representative to consider the ground's softness because the area, though now paddy land, was fifty years ago a mangrove tract.

On 7 June 1973, at a dinner party, the Company's Manager informed the Secretary General of the National Research Council, who is concurrently Chairman of the National Coordinating Committee for ERTS Programme, that his men, who were sent out to check the ground condition in the area, reported that the ground there was much more softer than it was thought of before. Therefore, for the towers on the soft ground, each pile should have the length of 24 meters instead of 20 meters. It was estimated that 100 towers would be set up on the soft tract. The total cost would then be increased by 960,000 baht and was approved in principle immediately by the EGAT.

Public Lectures

on

Remote Sensing Techniques

and

Interpretation of ERTS-1 Images of Thailand

(Reported by Secretariat of the Working Sub-Committee,
the Thailand National Program of ERTS.)

The USGS Team of experts after departure from Thailand in June 1973, stirred up interests of many sectors of community, including students in Bangkok, relating to the applications of remote sensing techniques and the interpretation of the ERTS-1 images of Thailand. Through the management of the Children Hall (Sala Wan Dek) of the Ministry of Education, some 20 lectures on the topic were delivered by the members of the Working Sub-Committee. One lecture had the audience of about 200 high school students. The Sala Wan Dek authority commented that the activities were educational and informative to the students, and they had 20 more requests in their list up to October 1973.

The authority was also adventurous in that they had 2,500 copies black and white photo map of Thailand reproduced at the scale of 1:4,500,000 from the original MSS photo mosaic of Thailand at the scale of 1:1,000,000, which was assembled by the ASRCT ERTS staff as mentioned under ASRCT Research Development, and Service Project. The photomaps were handed out to students and educational institutes as educational materials. The Rotary Club of Dhonburi, up on request, agreed to be another sponsor for producing more photomaps.

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ASRCT Research, Development,and Service Project

(Compiled by Secretariat of the Working Subcommittee, the Thailand National Program of ERTS)

The Applied Scientific Research Corporation of Thailand, being a focal point for a cooperative program, such as the Thailand National Program of Earth Resources Technology Satellite, is well aware of its role in keeping up with the dynamic pace of a remote sensing field, especially one with which satellite is being employed. The Thailand National Program of Earth Resources Technology Satellite consists of some 19 Government Departments whose multidiscipline interests need some activation from the focal point in order for the joint efforts to be functioning well. Therefore, ASRCT, being an action agent for the National Research Council, has to provide the necessary supporting services and logistics as required to assure an efficient implementation of the National ERTS Program. Many research, development, and service program initiated by ASRCT has been extended to potential users in Thailand. Some examples include:-

1. ERTS-1 MSS Photo Mosaic of Thailand

2. Additional Data Products

3. Line of Sight Limit, Bangkok to ERTS-1 orbit, and consideration of setting up a Data Receiving Station in Bangkok.

The above topics are reported individually as follows:-

1. MSS Mosaic of Thailand

This photomap of Thailand, the first to be produced from imagery made by the NASA ERTS-1 satellite, is a composite of 49 individual scenes recorded on various dates during the period October 23, 1972 to March 1, 1973. The near infrared band 7 images were selected for this first effort because of the distinctive recording of land-water boundaries, inland waterways, and geological details in this wavelength region.

Selection of the scenes used, from among more than 200 furnished by NASA, involved a number of considerations and compromises. One primary criterion, freedom from excessive obscuring cloud cover, had to be balanced against the desire to use images produced on the same date for a given north-south line, which gives the best uniformity of sun angle and tonal rendition, and a more pleasing frame-to-frame continuity in the cloud and ground fog formations. Images made during October were avoided when possible because of extensive wet conditions and flooding during that time, which results in very contrasty images that, while they are extremely interesting and contain much visible detail, do not match well with neighboring images produced during later months.

Construction of the mosaic is unusual in several respects. Since we were confident that the ERTS images contain much less distortion than conventional aerial photographs, the traditional wet print, stretch and squeeze mosaic technique was discarded in favor of a dry process in which the print edges are butted together rather than feathered and overlapped. Discrepancies in matching around the edges of the mosaic are largely due to the fact that the pictures represent a spherical surface.

Transparent plexiglass, one eighth inch in thickness, was selected for the base so that the prints could be placed over a base map taped to the back side of the plexiglass. Dry mounting tissue and a common travel iron were used to attach the prints to the base.

Some difficulty was experienced in making enlargements to the exact scale of the base map, and this was aggravated by extensive changes that have taken place, especially along some coastal shorelines, since the base maps were made. Where shorelines differ considerably, as is the case in many areas, the photomap is considered to be more nearly correct than the base map in virtually all cases.

Certain comparisons between conventional aerial photography and the satellite imagery are of interest. Scale of the 70 mm. ERTS negatives supplied by NASA is 1:3,369,000, as compared to attainable scales of the order 1:10,000 to 1:100,000 for aircraft photography. The high altitude of 914 km, together with the comparatively narrow total viewing angle of the multispectral scanner (about 13°) yields pictures with very little parallax and very little radial distortion. This, together with the fact that all of the satellite pictures are made at nearly the same local time, accounts for the relatively smooth overall appearance of the ERTS mosaic as compared to one composed of hundreds of aerial photographs.

Another point of interest is the fact that the total "flying time" required for production of the 49 frames of imagery used in this mosaic was about 20 minutes. (Scanner operating time for production of each picture is 25 seconds.) The satellite, travelling at slightly more than 7 km/sec., passes over the entire length of Thailand (about 1,800 km.) in less than five minutes.

The sequence of events involved in data acquisition and in production of prints comprising the mosaic are worthy of notice. Electronic signals representing the intensity of reflected sunlight are generated, in four discrete wavelength bands, by the ERTS multispectral scanner. The signal strength in each band is recorded, in real time, by an on-board magnetic tape recorder. The tape is rewound, and the recorded signals are played back to a receiving station in the U.S. approximately one hour later, and are again recorded on magnetic tape. A 70 mm. master negative is then printed on film by means of an electron beam printer driven by the tape recorded signals. Subsequent products (7 mm. and 9.5 inch transparencies) are printed by conventional photographic contact and projection methods from the master negatives. Prints for the mosaic were made from negatives received from NASA.

The dry mounting process used in assembly of the photomap permits easy updating by substitution of later images. When more informative or more nearly cloud free images are received, they can be mounted over or in place of the images used in this construction.

The accompanying index map gives the date of acquisition and the identification number of each ERTS frame used in construction of the mosaic.

Notes on Interpretation

White objects accompanied by distinct black shadows near their upper left edges are clouds ____ the sun is in the southeast in all pictures. (clouds over water do not cast visible shadows)

White objects usually contouring valley floors and not accompanied by shadows are ground fog. Large patches are seen in the north.

Uniform jet black areas are free water surfaces.

Mottled medium gray areas are mostly agricultural regions. Forested areas are generally darker and more uniform in tone.

Credits

The photomap was composed and assembled in space made available by the Resources Inventory Group (RIG) of the Applied Scientific Research Corporation of Thailand (ASRCT). The ASRCT ERTS staff and several members of the RIG group, some of whom participated in the USOM sponsored remote sensing training course, participated in the work and produced the legend and coordinate markings.

This miniature map depicts the most faithful reproduction of Thailand's landscape yet available.

The map was made from photoprints of the MSS Band 7 (0.8 - 1.1 um) images taken by the Earth Resources Technology Satellite (ERTS-1) as received from NASA.

The work of putting together the original prints of 1:1,000,000 scale in the from of mosaic to produce this map was done at the Applied Scientific Research Corporation of Thailand by the Working Sub-Committee of the Thailand National Co-ordinating Committee for the ERTS Program with technical assistance from USOM project Co-ordinator.

2. Additional Data Products, Extended Services to Users.

The ERTS-1 satellite acquired images of Thailand repeatedly during the period form September 1972 to March 1973, when the tape recorder on board the satellite went out of order. Images have been transmitted to Thailand from NASA in the form of 70 mm. and 240 mm. negative and positive transparencies representing four spectral bands in the range of 0.5 µm. to 1.1 µm. Each scene shows an area of Thailand 185 x 185 km^2. The basic imageries received were then transformed into various forms which would make interpretations easier for specific fields of interests. The products include:-

2.1 Diazochrome Transparency:

Diazochrome transparency is very popular among researchers in the U.S. ASRCT ERTS staff had tried successfully to make diazochrome color transparencies for users. Up to now, the National ERTS Program has acquired, practically, the diazochrome coverage over the whole Kingdom of Thailand. A diazochrome transparency is obtained by a normal color composite process using diazosheet of different colors for different wave bands of the same scene. The color selected for the purpose are mostly yellow for band 4, red for band 5, and blue for band 7. A complete set of diazochrome transparency gives highly detailed data because it is made directly from the original 9.5 x 9.5 inch positive transparencies. Some examples of photograph of diazochrome transparencies appear below:

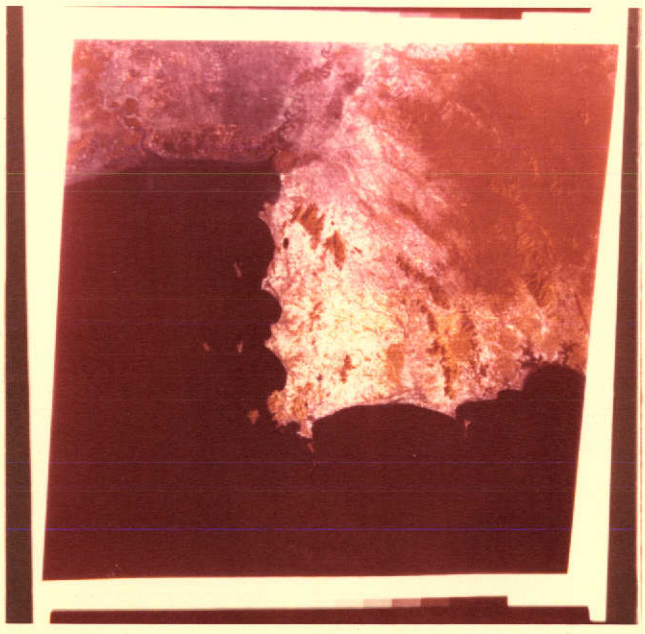

Fig. 1 A photograph of diazochrome color transparency, the area covers Bangkok Plain and Southeast Thailand. Frame NASA E-1167-03070, 6 January 1973

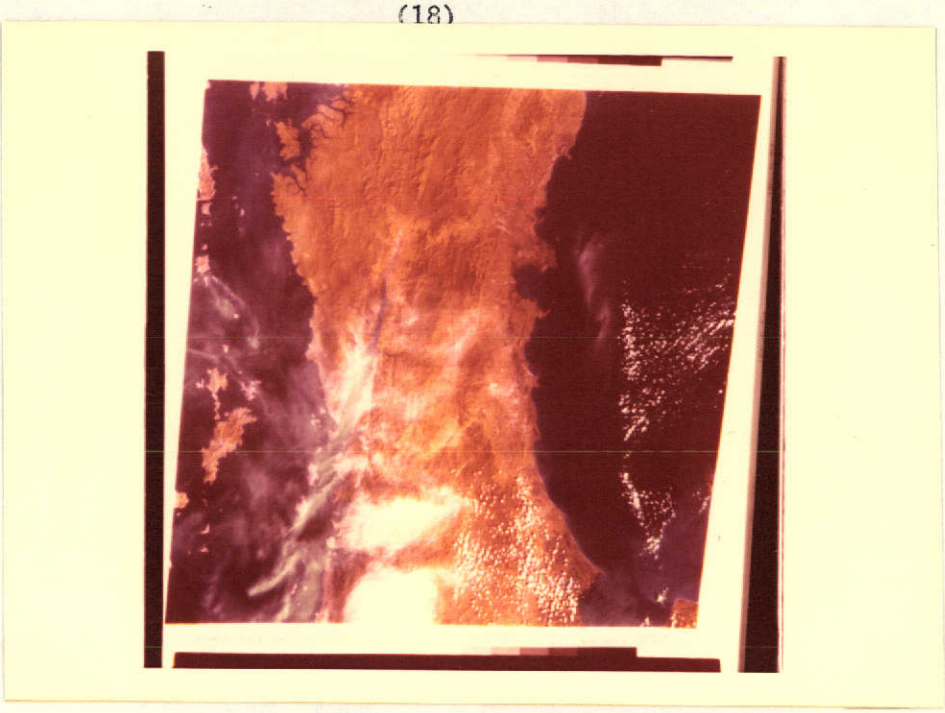

Fig 2 A photograph of diazochrome color transparency, the area covers middle part of the peninsular of South Thailand. Frame NASA E-1168-03133, 7 January 1973

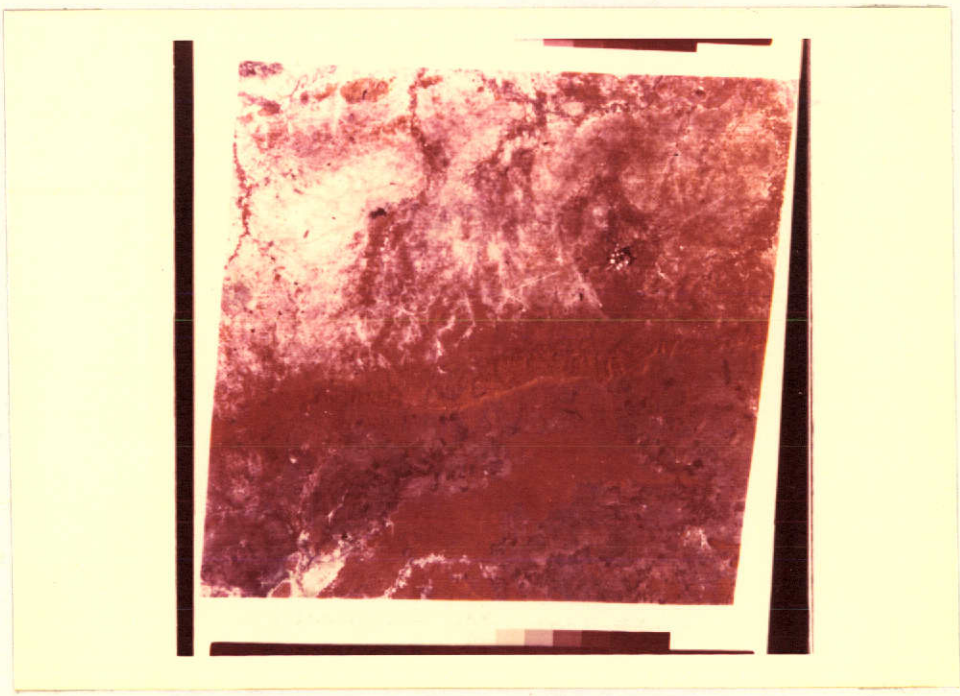

Fig. 3 A photograph of diazochrome color transparency, the area covers part of Northeast Thailand.
Frame NASA E-1219-02554, 27 February 1973.

2.2 35 mm. black and white and color slides:

This was done by photograph of screen of the 4-Channel color composite projector/viewer, or photograph of a diazochrome transparency.

2.3 35 mm., 70 mm., 4 x 5 inch black and white and color photography of the viewer screen.

2.4 Photographic printing and enlarging services, using negative transparencies form NASA or negative produced by ASRCT additional data products:

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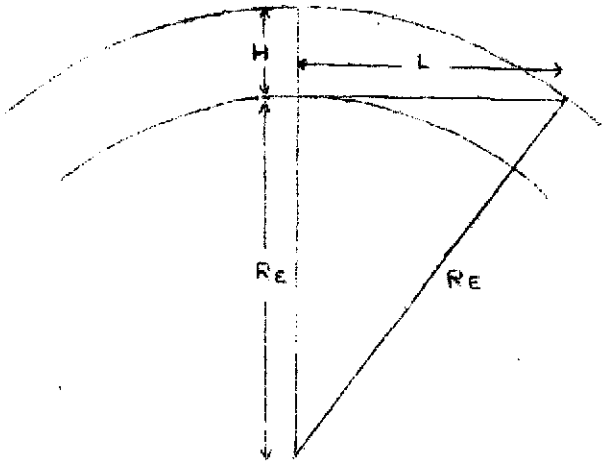
3. Line of Sight Limit, Bangkok to ERTS Orbit and Receiving Station in Bangkok.

(Calculated by SomSak Supornrutana, ASRCT)

Topic: Line of sight limit, Bangkok to ERTS orbit

To determine the "service area" for an ERTS receiving station located in Bangkok.



Let. H = ERTS-1 orbit altitude, about 914 km.

R = Mean value of earth radius, about 6,371 km.

= Line of sight radius to be determined

From Fig. shown, and by geometrycal of triangler; we obtain

$$(R_E + H)^2 = R_E^2 + L^2$$

$$R_E^2 + 2R_E H + H^2 = R_E^2 + L^2$$

Therefore,

$$L^2 = 2R_E H + H^2$$

$$** \quad L = (H\ (2R_E + H)\ )^{\frac{1}{2}} \ **$$

By substitution the given values above for H and R_E

$$L = (914\ (2 \times 6371 + 914)\ )^{\frac{1}{2}}$$

$$= (12,48,15,84)^{\frac{1}{2}}$$

$$= 3530 \text{ km.}$$

The line of sight radius is about 3530 km.

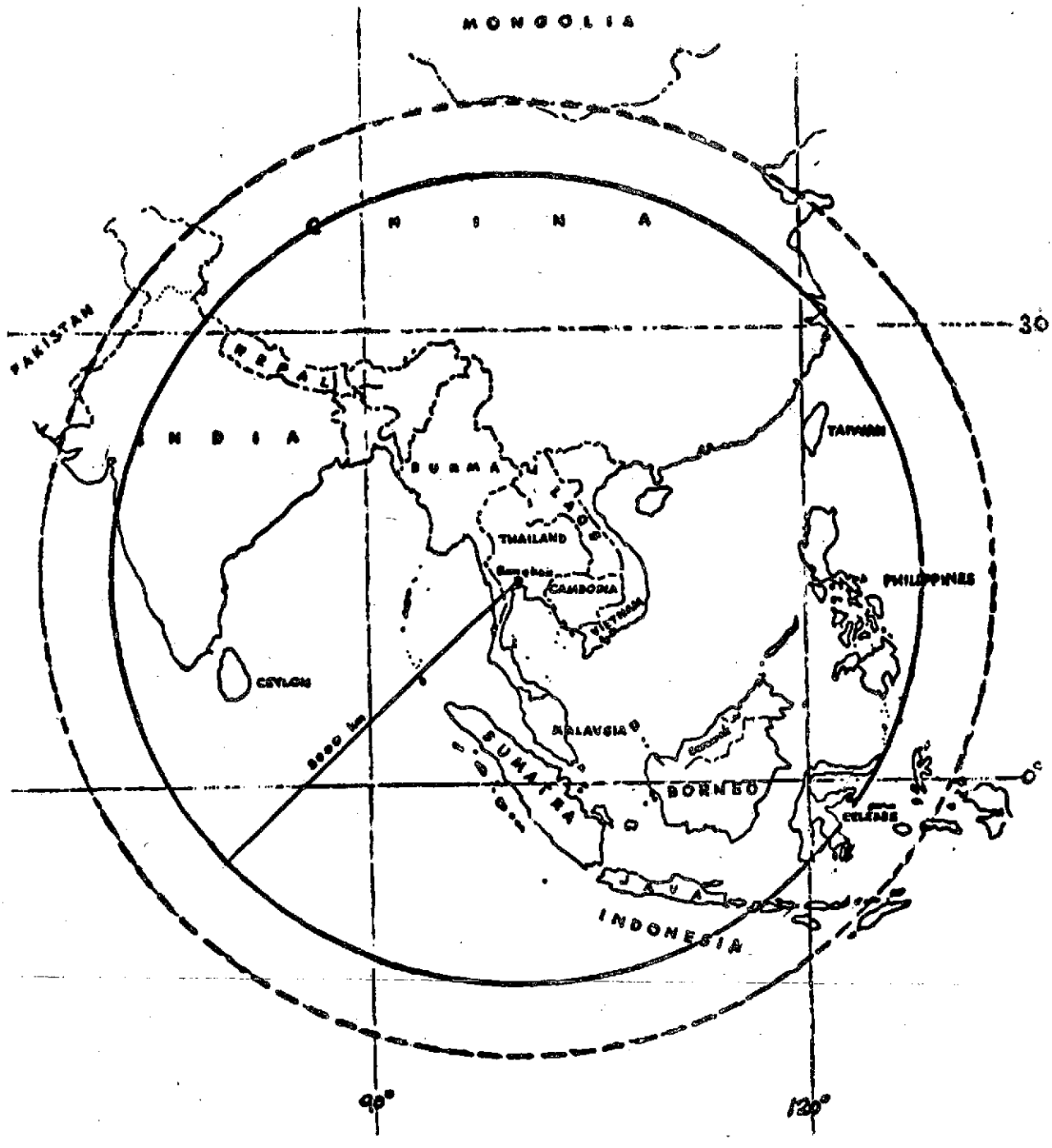
A reception and data processing station, similar to those in Canada and Brazil, could be erected in Bangkok and could supply ERTS data to Thailand and surrounding countries. The station would be capable of receiving image data in real-time when the satellite passes over areas within a circle with approximately a 3,000 kilometer radium centered on Bangkok. Processing facilities would be required for production of magnetic tapes, conversion of tapes to photographic images, and reproduction and dissemination of the images.

In addition, a reception station in Bangkok would allow use of the Data Collection System (DCS) on ERTS. The DCS is a satellite relay system which can receive data from ground monitoring stations such as stream gages and relay it to the central receiving station for processing and dissemination to users. For example, the series of stream gages along the Mekong River could be equipped with relatively inexpensive data transmitters sending data to the satellite and then to Bangkok. The data could be available to water users, including Thailand agencies and the Mekong Secretariat, within hours after collection.

Surveys for a suitable site for the reception station would need to be conducted to locate a site free of radio interference and otherwise suitable. A reception station suitable for use with ERTS-1 and the forthcoming ERTS-B would require some modification to be suitable for use with a future operational satellite system. Although planning for the operational system is only in the preliminary stages at this time, it is quite certain that the transmission frequencies would be different from ERTS-1 frequencies and therefore modifications to antennas and electronic components would be required.

It is clearly evident, with the growing experience of the Royal Thai Government and the geographic location of Bangkok, that a reception station serving all of Southeast Asia and surrounding countries (see attached map) could effectively be operated at Bangkok.

Attachment Map



Service area for an ERTS data receiving station located at Bangkok. The inner circle indicates a conservative 3000 Km radius, within which reception would be reliable. The outer circle (broken line) represents the distance to the horizon, about 3500 km, from the ERTS-1 satellite.