The 16th Congress of International Society for Photogrammetry and Remote sensing, Kyoto, Japan, 1988. Commission VII
Working Group 4

Introduction of the Remote Sensing System in the Tropical Rain Forest Research Institute, Indonesia

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Abstract:

This paper gives a review of the remote sensing activities at the Tropical Rain Forest Research Institute (PUSREHUT), Samarinda, Indonesia, which was conducted through cooperative research together with the Indonesian Ministry of Culture and Education and the Japan International Cooperation Agency.

The main purpose of the project is to research reforestation and rehabilitation of the tropical rain forest which had declined due to overlogging and forest fires.

The remote sensing system was installed and used for education and research on land-use in PUSREHUT. The system was designed by the Laboratory of Remote Sensing, Forest & Forest Products Research Institute, Tsukuba, Japan. Two Japanese reseachers were sent to the PUSREHUT and two Indonesian lecturers were sent to the Laboratory of Remote Sensing. The project is on the first phase of installation of the system, and this report shows its outline and process.

Background of the Project:

Indonesia is the largest archpelago in the world and consists of more than 13,000 islands. Remote sensing from satellites is very useful for such a large country as Indonesia, where the accesability is limited and rapid changes are being undergone in forest land-use. All of Indonesia will be covered by the 300 scenes of LANDSAT data. We should use remote sensing technology to watch the current condition of forests, and to make sure of their appropriate management, because it can form the basis for a forest management system in a comparatively short time, and at a low cost.

The Indonesian National Institute of Aeronautics and Space opened the ground receiving facility (LAPAN) in June, 1984, and carried out the following activities; data acquisition and recording, data processing and data products.

We can obtain the image data from the LAPAN as a computer compatible tape. The LAPAN also has data processing equipment to make a data correction for radiometric and geometric points and can provide outputs by the format of analogue imagery. Then, we obtained the outputs of CCT and images covering East Kalimantan.

The Remote Sensing Engineering Project for Development of Agricultural Infrastructure (DPU) was started in April, 1980, with the coorporation of JICA and the Productive Remote Sensing System (PRESS) was established, which is assisted by an IBM 4341 computer. They can analyze land-cover, biomass estimation, soil classification and land-evaluation. And then, they made a land-use map for agricultural development assisted by computer. These outputs from the Center were available to us. We could utilize them as material for education and research. From the consideration of this technological background, our remote sensing facility should play a role in the training of an Indonesian researcher in PUSREHUT. Our conception of our remote sensing system is as follows:

1. Low cost and simple manipulation
2. Less trouble and easy maintenance
3. Principal function is display of the LANDSAT data
4. Available to input not only CCT, but also aerial photographs
5. Software should be reformable according to the development of the Indonessian staff

From this conception, we made a muster plan of the system as in Figure 1.

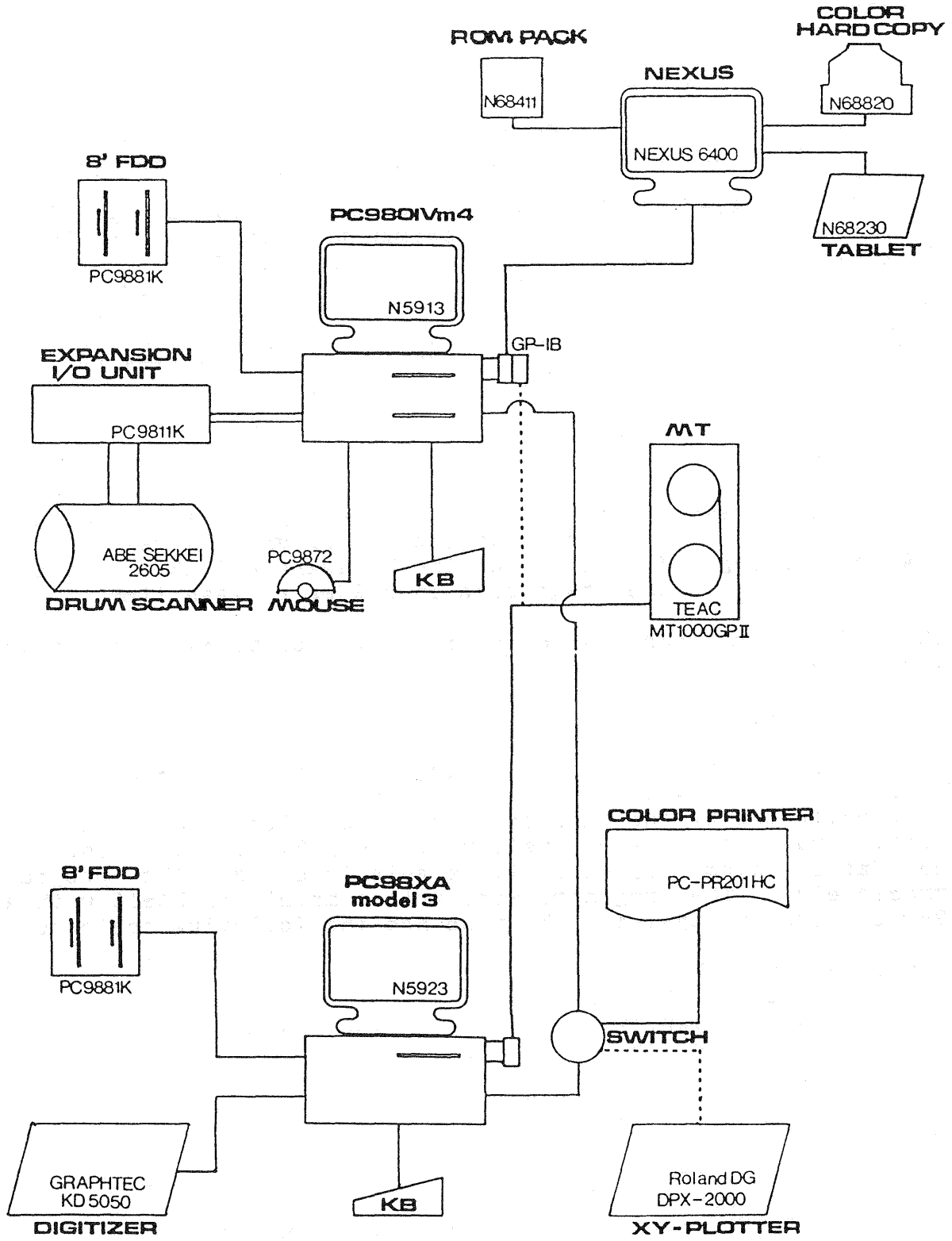


Fig. 1 Hardware System of the PIPS

Hardware Development:

The system consists of two micro-computers, PC-9801 VM4 (640KB memory, a 20KB hard disk, four 1MB floppy disk drives) which are connected by a drumscanner and an image processor, and PC-XA (1024KB memory, a 20MB hard disk, three 1MB floppy disk drives) which are connected by a magnet-tape drive and an X-Y plotter.

The X-Y plotter (DPX-2000) is connected by a parallel centronics interface and has a maximum plotting area of 594mm (X-axis) and 432mm (Y-axis) with a 15KB data buffer.

The drumscanner model 2605 can be controlled by micro-computer. The maximum measuring range is 300mm (X-axis) and 400mm (Y-axis), and the sampling rate is fram 25 m to 1000 m.

The real time image processor NEXUS 6400 is connected by GP-IB interface and has the following functions;

Resolution: 512 X 480 dots
Image memory: 512 X 512 X 8bit X 4set
Zoom function: 1, 2, 4, 8 times
Image enhancement: level slice, displaying the same radiance area, changing the brightness rate
Area counting: fitting it on the hardware and able to count the image area in a 33ms reflash time

The NEXUS has many kinds of its own commands for image processing.

Software Development:

The FREDAM (Forest Remote Sensing Data Analysis System for Micro-Computer) is an packaged image processing software which was constructed by the Laboratory of Remote Sensing, Forest & Forest Products Research Institute. (Fig 2) It makes use of the "menu system," by which it is able to select the program immediately. The programms were writen mainly in BASIC with a MS-DOS operating system. The menu has the following contents:

Execute the NEXUS handler
Execute the FREDAM-CIPS
  Function 1: Display image data on the NEXUS
    1) False color display
    2) Pseudo color display
  Function 2: Print out image data
    1) Print out gray map
    2) Print out image data with number
  Function 3: Statistics calcilation and classification
    1) Count histogram
    2) Field statistics and classification

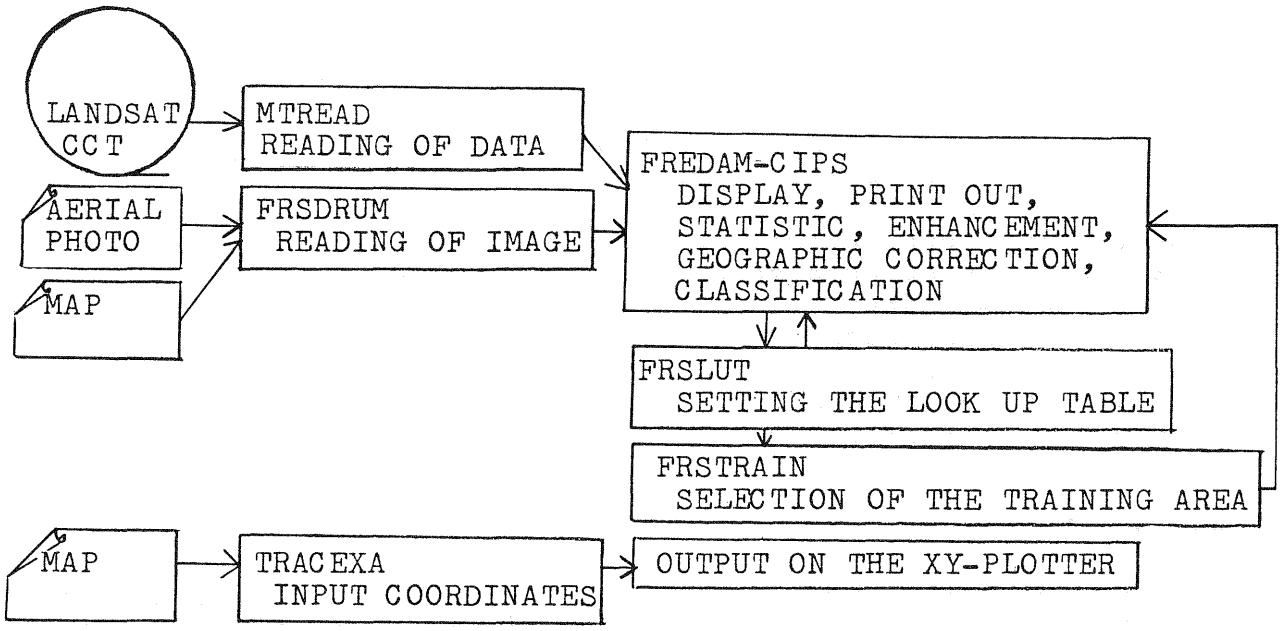


Fig 2 Flow of the image processing by FREDAM

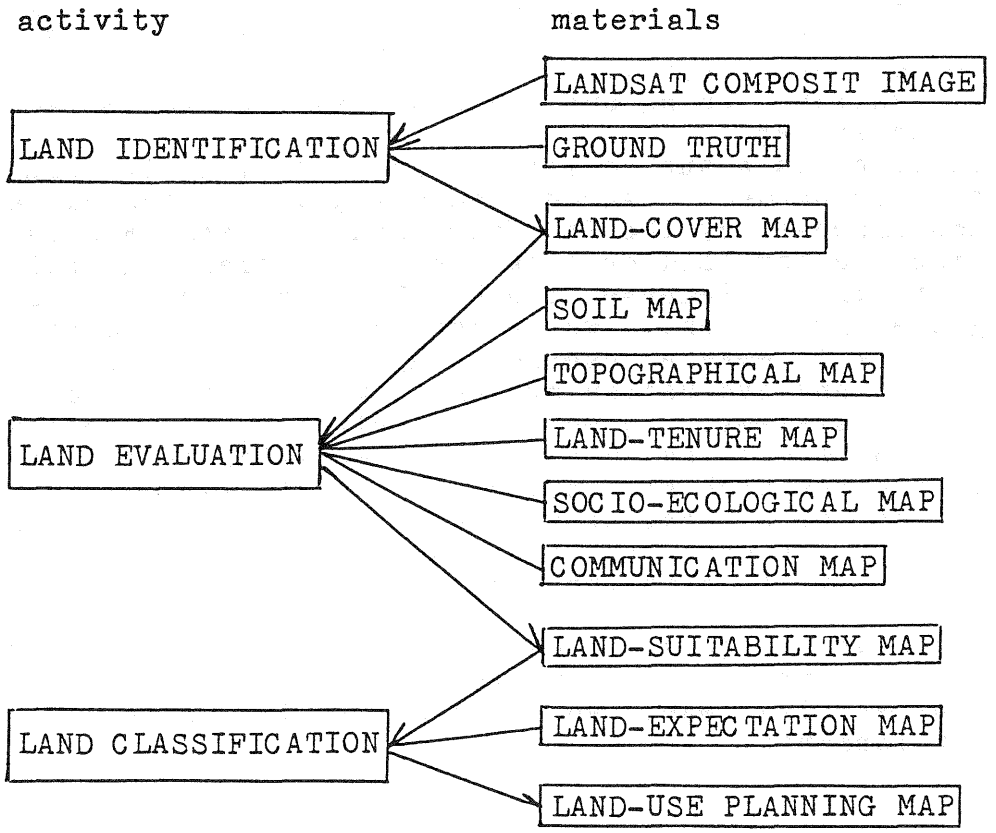


Fig 3 Procedure for landuse planning

Function 4: Handling image data
1) Stretch the image data
2) Calculate the interchannel ratio
3) 3 X 3 matrix filtering
4) Interpolation by sinc function
Function 5: Geometric correction
1) Affin
Execute the look up table handler
Execute training area selection
Execute drumscanner
Save the NEXUS image
Execute file conversion
Execute the MT read
Execute the digitizer handler

Land-use Planning:

Land-use planning has to be taken into account in regard to adjustment with other land-use. In our research project, the main purpose of land-use planning is to establish a permanent forestry in a tropical rain forest. Therefore, land-use planning has to depend on the natural conditions concerning forest productivity and conservation. Information on land-cover, geography and soil condition are just a few of the things that can be obtained quickly and efficiently by remote sensing in this country. There is no basic terrain map in this area, and poor information about vegetation and soils as still prevails. Data would be collected through the use of remote sensing techniques combined with ground survey. (Fig 3) LANDSAT images are important as a fundamental material for land-identification. Using our image processing system, we can make a land-cover map.

Land-evaluation is a such difficult job that much information concerning it is needed. An outline was given of the concepts and methods proposed by the FAO Framework for Land Evaluation and the Guideline for land evalluation for rainfed agriculture and for forestry. Because the FAO Framework was aimed at conserving the environment, we recognized its value to be very high, and we will make a research program with attention on it. But the land evaluation system is very complicated and needs many sub-systems, so we cannot introduce it directly in our system. We are going to follow a simplified method of it, and our future research will establish a small system for the land-evaluation of a local area. After the results of land-evaluation, the land-suitability map for forestry will be issued, which will describe an ecological stability for forestland.

If farmers have a request to develop an agricultural field in a forestland, the map of the expected site will be overlayed on the land-suitability map. We can classify the area by the criteria for land-use.

Research Topics:

The following topics were proposed by the Indonesian researchers in the Project:

1. Development of Remote Sensing Techniques for Forest Land-Use Classification

 1-1 Determination of the Spectrum Characteristics of Tropical Forest Vegetation Type by Remote Sensing Techniques

 1-2 The Study on the Synthetic Aperture Radar (SAR) and Multispectral Scanner (MSS) Synergism for the Detection of Tropical Rain Forest Changes due to Forest Fires

 1-3 Application of Remote Sensing Techniques for Detection of Productive and Non-Productive Forests

2. Forest Land-Use Planning

 2-1 The Use of Aerial Photographs for Evaluation of Vegetation conditions in the Bukit Suharto Protection Forest

Every material on the ground surface has its own electro-magnetic radiation. This is the principal theory on which remote sensing is based, and ground material thus can be detected. Although spectral characteristics are the basic data for the interpretation of images, there are few observations on a tropical area.
A spectro-photometer (model 2703) was introduced for measuring the spectrum reflectance of ground surface materials. Until now, the following materials were observed:

Tree --- Acacia mangium, A. auriculiformis, A. silva, Pinus merkusii, Albizia falcataria, Swietenia sp, Homalanthus populneus, Shorea leprosula, Piper sp
Grass --- Imperata cylindrica, Paspalum conjugatum
Shrub --- Mimoza sp
Non-vegetation --- river water, bare soils, concrete

It is very difficult to obtain data from a tall tree, so we have to improve the platform for data aquisition. A pilotless model plane was examined for putting on a spectrophotometer, but it has some weak points because a pilotless plane needs professional skills for operation, and also it has a limitation for confirming the coverage area or the observation- angle. Contrary to this, the kytoon method can be operated by an amateur, and the location for data collection and control for the observation angle can easily be set by the radio controller. We are going to introduce a kytoon system in PUSREHUT.

Concerning the topic 1-2, we cannot process the raw-data from SAR, which is too big a job for the micro-computer-based

system. The images from SAR will be used through the drumscanner. We know this is a rather inefficient method, but it is sufficient to extract an advantage for SAR, which can detect the data even through thick clouds.

Topic 1-3 has a very wide range from basic observation to data for applications in forest productivity. As far as application goes, forest companies desire the results of thes research. Untill now, we decided the test sites as follows:

Bukit Suharto protection forest
Lumpake Experimental Forest
Kutai National Park

These test sites are included in the LANDSAT data of Path 116, Row 60, 6 May, 1985.

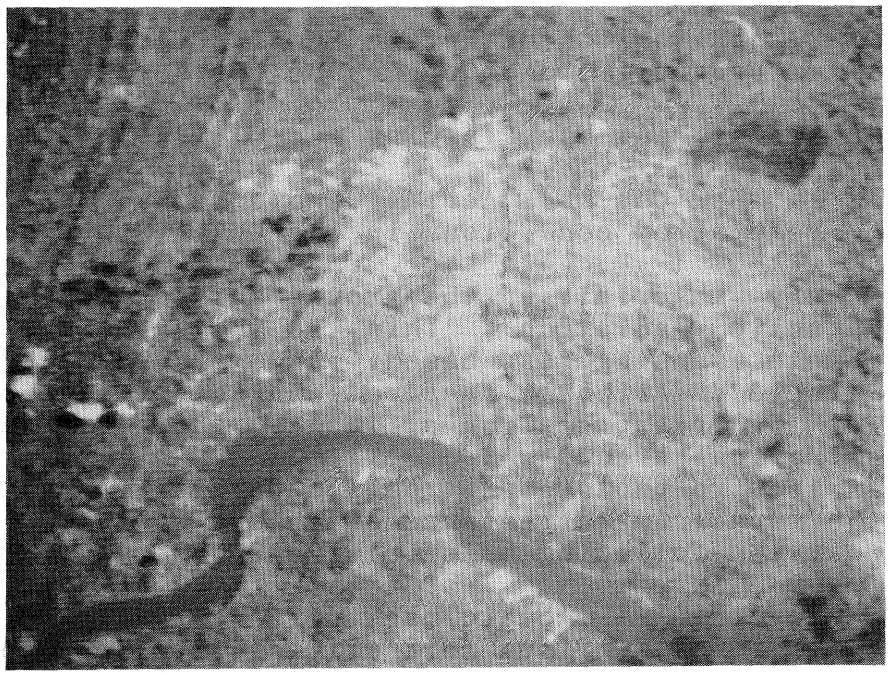


Photo 1 is a composit image of false color (Band 7 = red, Band 5 = green, Band 4 = blue), and it shows the city of Samarinda (the central), the Mahakam river (the bottom) and Lumpake Forest (the right top). The Lumpake Forest was slightly damaged by a forest fire in 1982-83, though it looks like a normal forest from this image. It has a clear boundary, and is surrounded by agricultural fields.

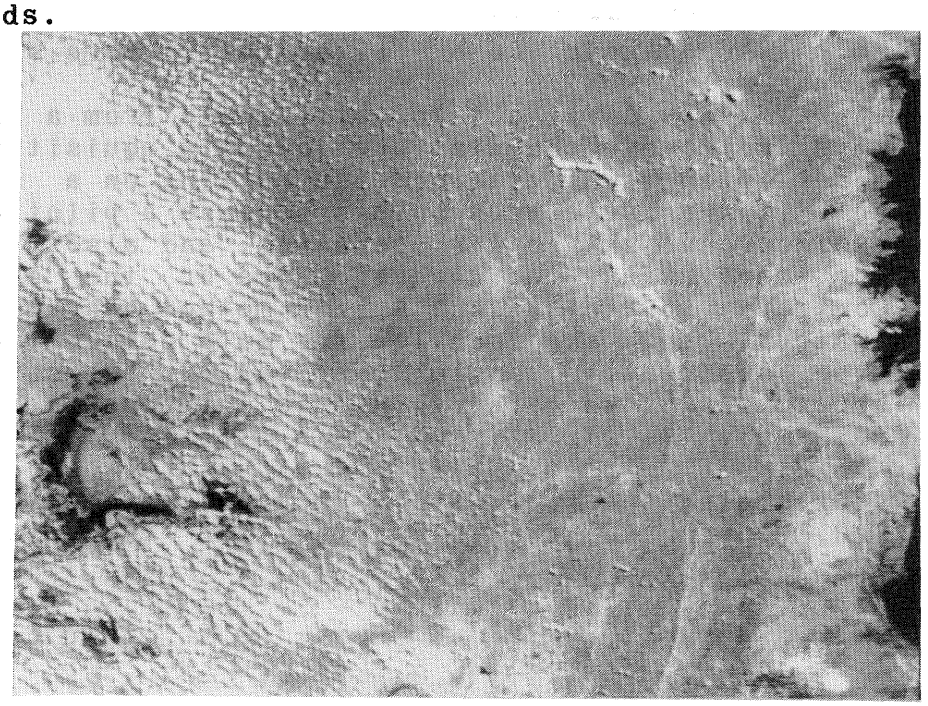
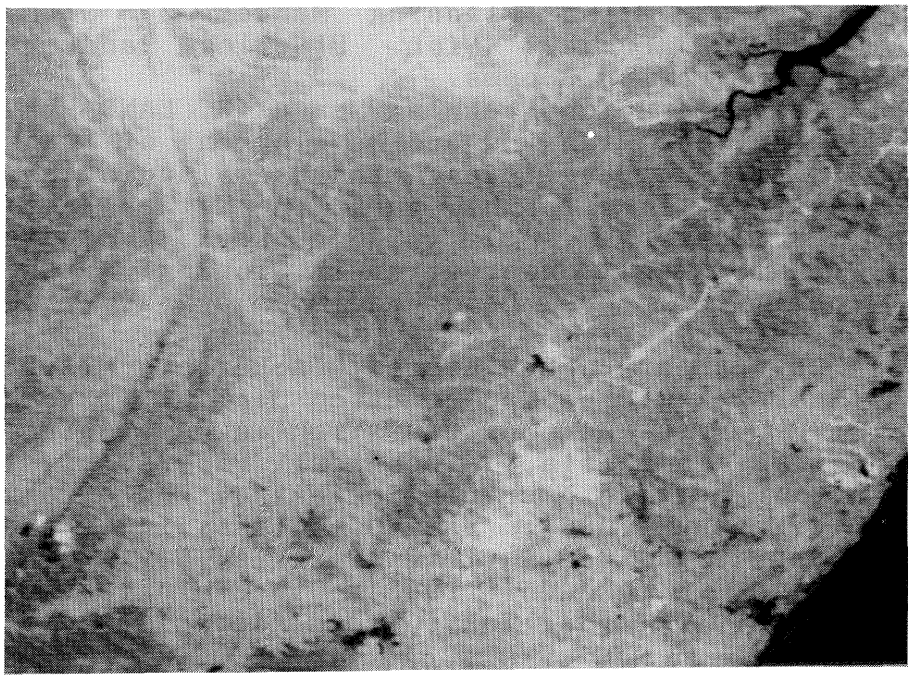


Photo 2, the Kutai National Park, the left side shows the swamp area with a blackish pattern, and at its the right hand the Kerangus area shows a light pattern, which is a peculiar sandy area and is covered by shrubs.

On the sea coast

on the right side, there is the city of Bongtang, which has been newly developed by an oil company.

Phot 3 shows the Bukit Suharto Experimental Forest. The central part is a natural forest, and is surrounded by an extensive agricultural area. The farmers cut down trees and burn them out, then, mainly plant rice, corn and kyassaba.



Conclusion:

In PUSREHUT, the research project for land-use classification and planning was started in 1985, and a remote sensing system was installed in September, 1986, with the coorporation of JICA. The investigation is still in progress, so we cannot yet give a view of the future results. The image processing system and the research activities have been introduced in this paper. The land-use classification should be done by an analytical process of LANDSAT data using our system. The methodology for land-use classification was established by FREDAM, so our research target should be how to apply it in the tropical rain forest area which has a complicated land-use, and most of them are peculiar to this area. We have to study some basic observabions to make progress in the application of remote sensing. Our research activities will be restricted to physical land-use planning, and the framework of it should be based on ecological geography. Although the socio-economic and cultural factors have an important nature, human land-use must submit to the roles of nature, which is the stand point of physical planning. Appropriate development of this area will succeed if based on this idea, and a suitable environment can be maintained by it. Understanding the geographical condition and linking it to the biological situation is the fundamental result of land-use planning, and remote sensing is the most important tool for this. We are confident that remote sensing will be useful for area-development, and that it will contribute to the future of Indonesia.

Litalature:

1) Transmigration Planning Manual 2, SITE IDENTIFICATION, UNDP/FAO Project for Planning and Development of Transmigration Schems.
2) Transmigration Planning Manual 3, LAND EVALUATION, UNDP/FAO Project for Planning and Development of Transmigration Schems.
3) D. T.Lindgren (1985); Land Use Planning and Remote Sensing, Marlinus Nijhoff Publishers (The Netherlands)
4) W.Siderius (ed.) (1986); Land Evaluaton for Land-Use Planning and Conservation in Sloping Areas, International Institute for Land Reclamation and Improvement (The Netherlands)
5) S.C.Ahearn, R.W.Kiefer, A.Rambe, M.A.Raimadoya (1984); IBM-PC/XT Microcomputer-Based Digital Image Processing System for Remote Sensing Education in Developing Countries Case Study: Indonesia, Technical Papers of the 50th Annual Meeting of the American Society of Photogrammetry
6) Y.Matsuo (1986); Land-Use Classification and Evaluation in Indonesia, J.Soc.Agric.Engineering,54,12
7) H.Ide, K.Takeuchi (1985); Gio-Ecological Land-Use Planning, The University of Tokyo Press (Japan)