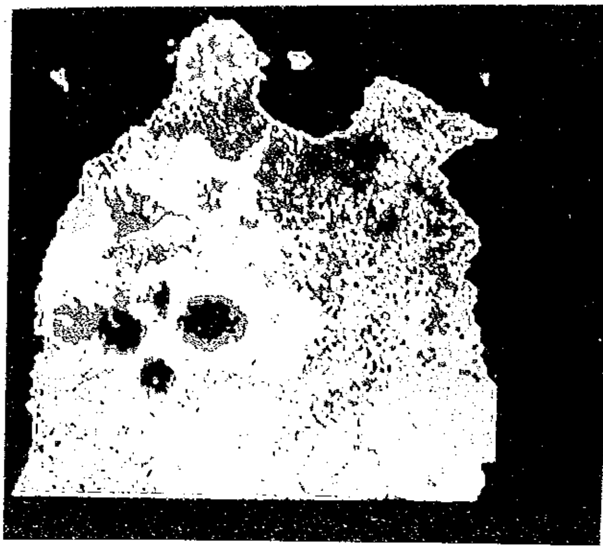
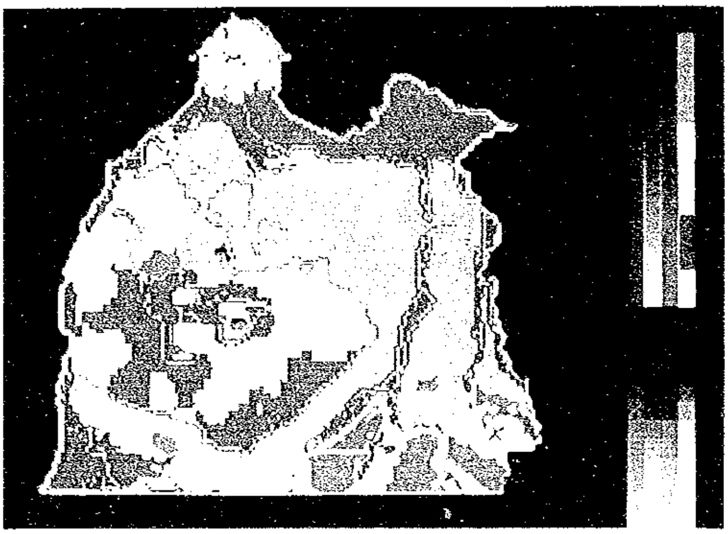


Land Condition (2nd Stage)

Water Resources (2 nd Stage

Black : Undefined

1. Very Poor Conditioned
2. Poor Conditioned
3. Moderate Good
4. Good Conditioned
5. Very Good Conditioned



Land Classification

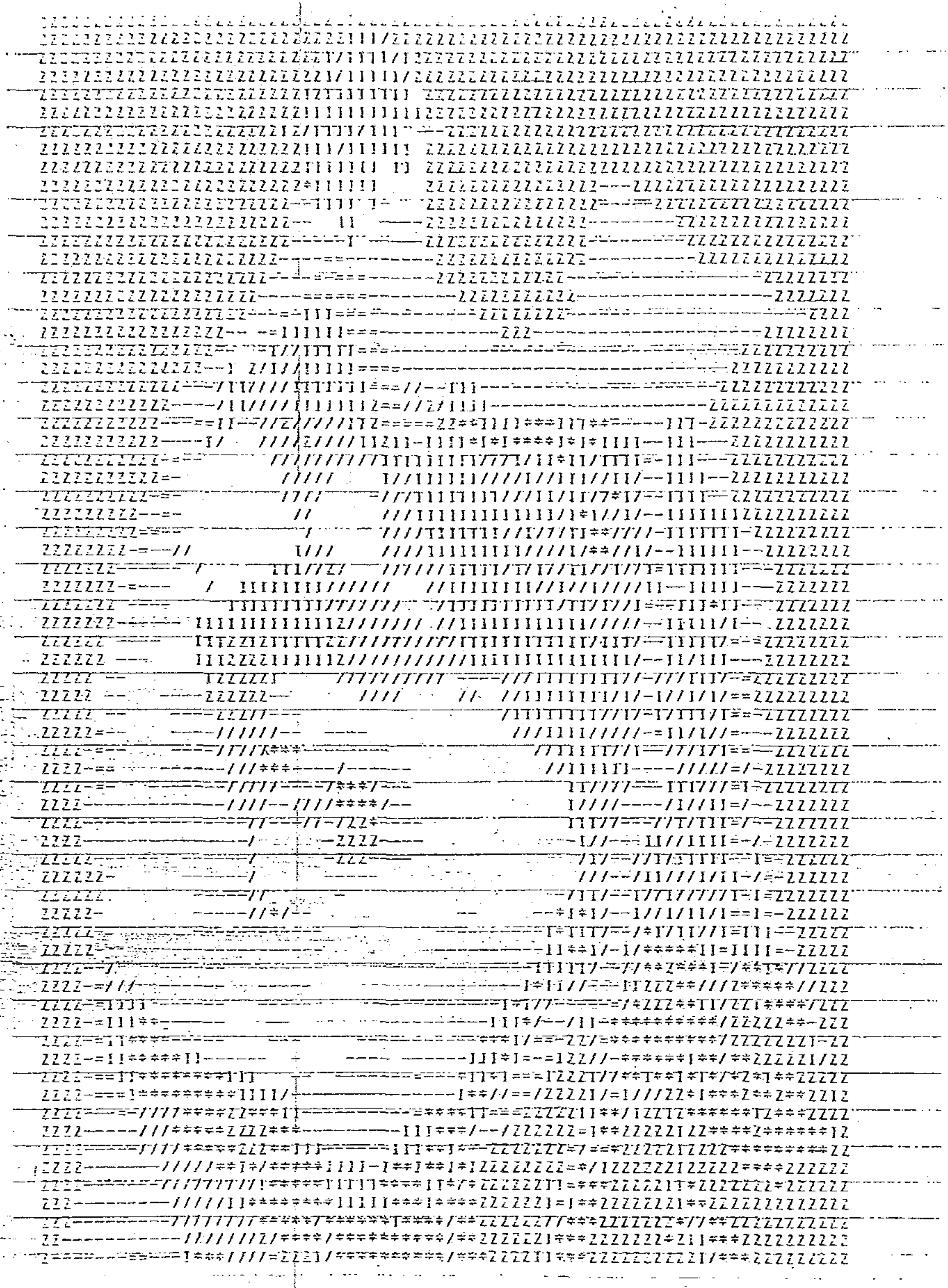
Fig. 5.7: Second Stage Evaluation Maps.

Fig. 5.8. Water Resources of North Banten.

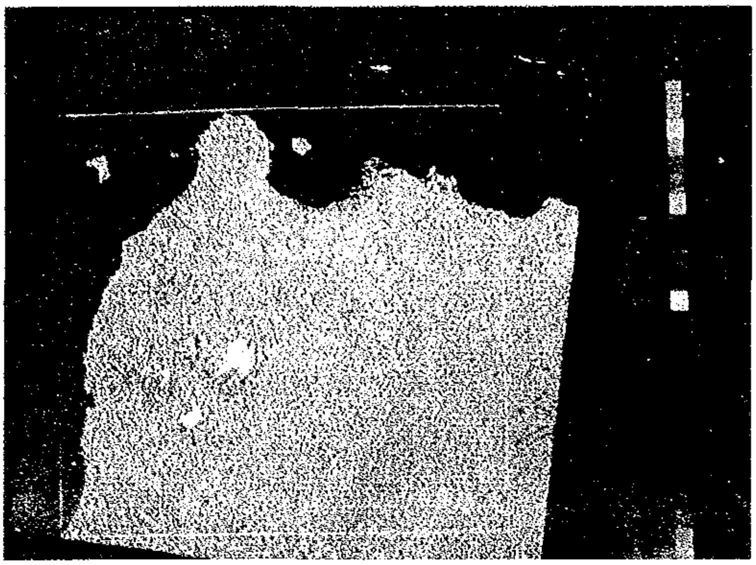
Fig. 5.9: Land Condition of North Banten.

45.

FIG. 5.10. Land Classification of North Banten.



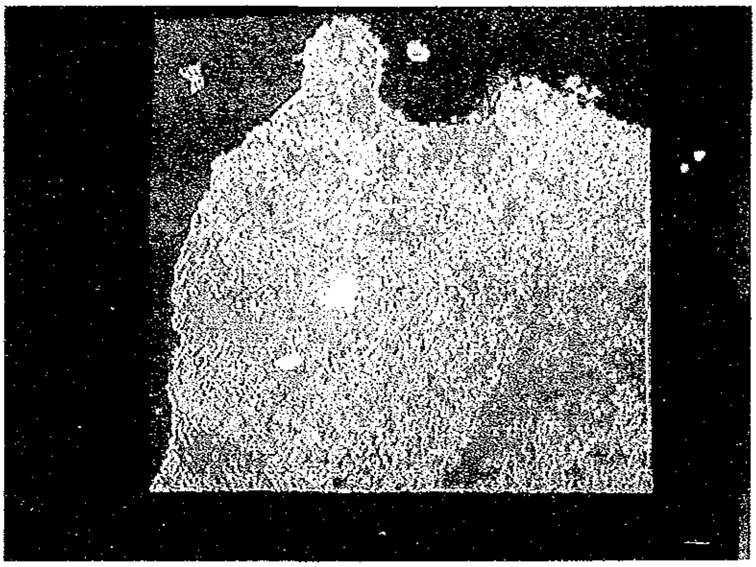
46



GEOMTRICAL CORRECTION OF BANTEN LAND COVER
(SOURCE - LANDSAT CLASSIFICATION).

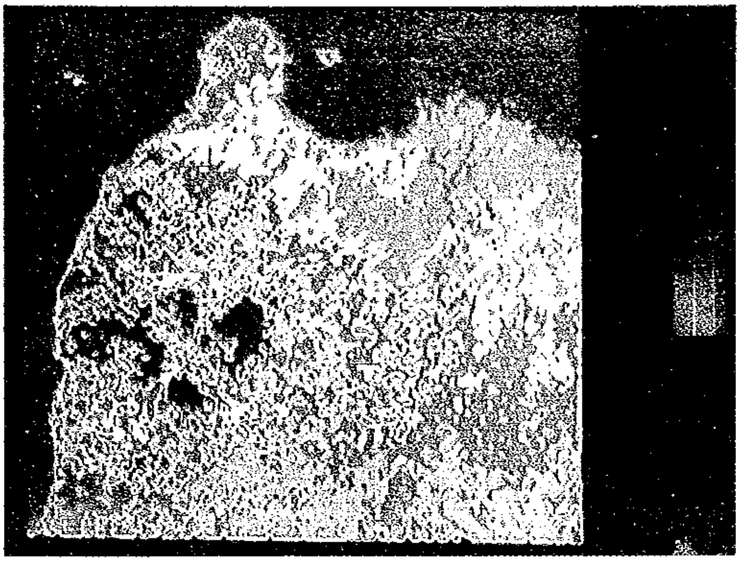
LEGEND :

1. Sea.
2. Sea Poluted.
3. Swamp/Fishpond.
4. Paddy B
5. Paddy Y.
6. Dryfield.
7. Grass.
8. Bush.
9. Rural 1.
10. Rural 2.
11. Low den Forest.
12. High den Forest
13. Urban 1
14. Urban 2.
15. Concrete & Baresoil.
16. Noise.



TRIMMING OF BANTEN LAND COVER FOR 70
BY 74 KM SQUARE

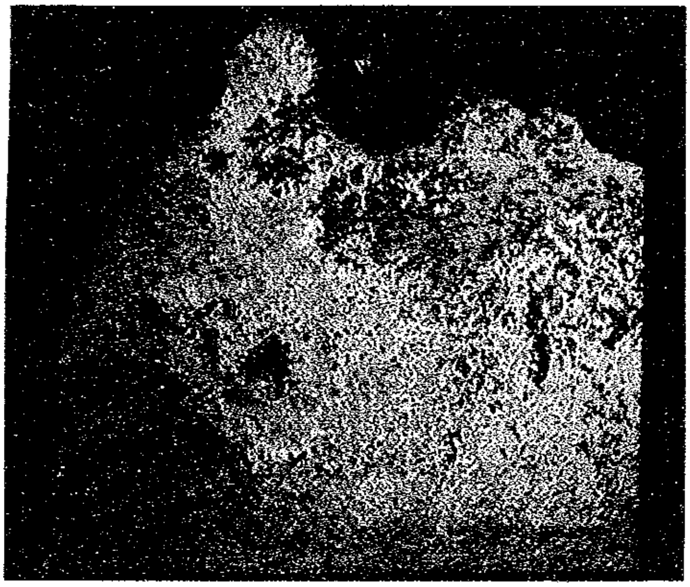
FIG : 5 11 a FIRST STAGE THEMATIC DATA



Minimum value of Biomass estimation
(By. Landsat Data (Grid size
500 M square).

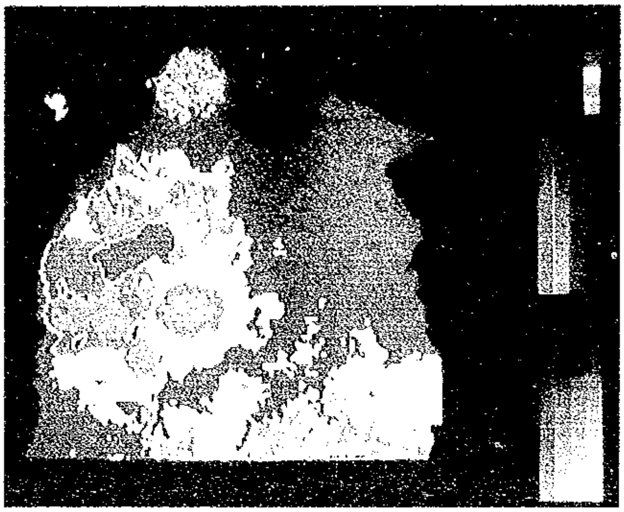
<u>LEGEND</u> :

1. Undefine .
2. 0 - 1 Kg / m2.
3. 1 - 2 Kg/M2.
4. 2 - 5 Kg/M2.
5. 5 - 9 Kg/M2.
6. 9 Kg/M2.



Mean Value of Biomass Estimation
By Landsat Data Grid size 500 m Square

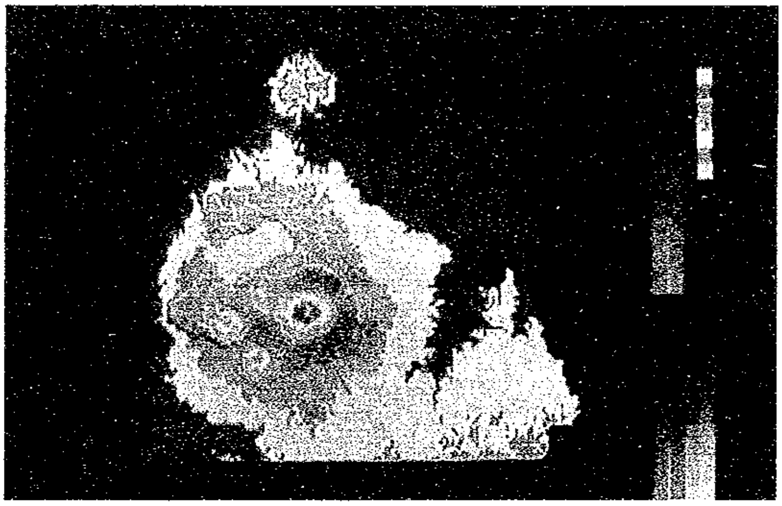
Fig : 5.11 B First Stage Thematic Data



LEGEND.

1. < 2 %
2. > 40 %
3. 2 - 15 %
4. 15 - 40 %

Slop - Thematic Map North Banten
Grid Size : 500 m Square.



LEGEND.

1. 0 - 25 m
2. 25 - 100 m
3. 100 - 200 m
4. 200 - 500 m
5. 500 - 700 m
6. 700 - 1000 m
7. 1000 - 1500 m
8. > 1500 m

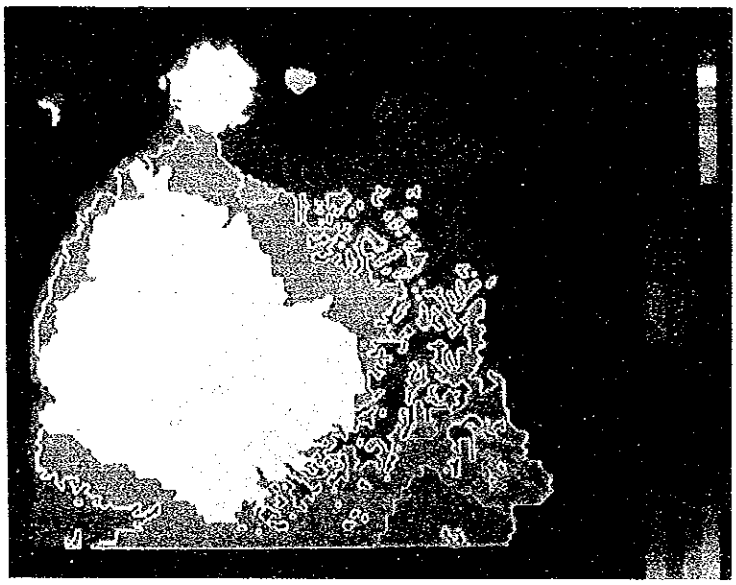
Elevation - Thematic Map North Banten
Grid Size : 500 m Square.

Fig : 5.11c. First Stage Thematic Data.

LEGEND :

1. Annual Rain Fall $<$ 1500 mm
2. 1500 - 2000 mm/Year
3. 2000 - 3000 mm/Year
4. 3000 - 4000 mm/Year
5. $>$ 4000 mm/Year

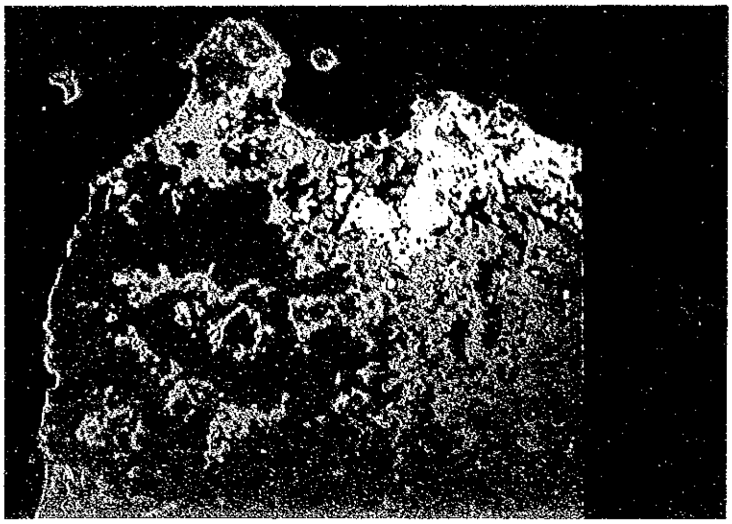
Precipitation - Thematic Map North Banten
Grid Size : 500 m Square.



LEGEND :

1. Alluvium
2. Un. Volcanic Produc
3. Pliocene Sedimentary
4. Miocene Sedimentary
5. Miocene Limestone
6. Andesite Basalt Diabase

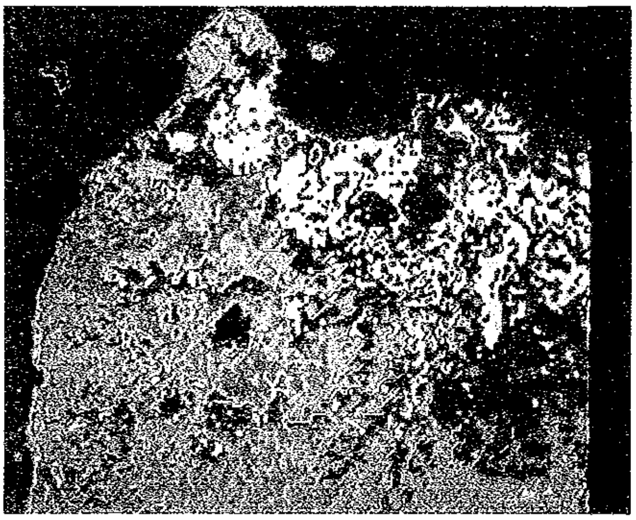
Geology: Thematic Map North Banten
Grid Size : 500 m Square
Fig : 5 . 11 D : First Stage Thematic Data.



Grid Biomass of Total Mode
(Souce - LANDSAT Biomass Estimation)

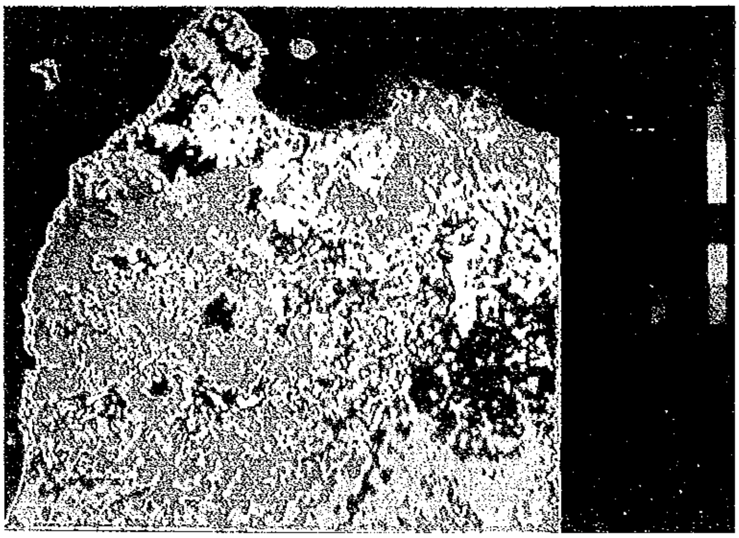
<u>LEGEND</u> :

1. Undefine.
2. a - 1 Kg/M2.
3. 1 - 2 Kg/M2.
4. 2 - 5 Kg/M2.
5. 5 - 9 Kg/M2.
6. 9 Kg/M2.

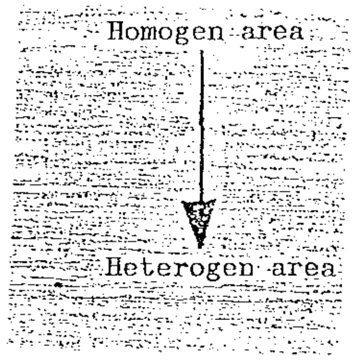


Grid Biomass of Majority Mode
(Source - Landsat Biomass Estimation).

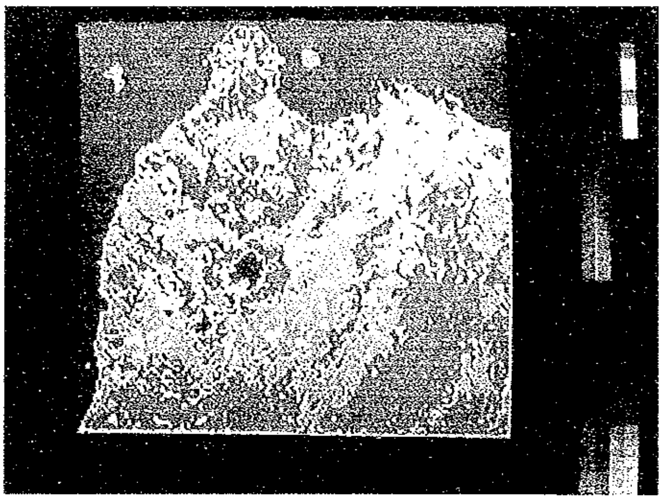
Fig 5.11 e .First Stage Thematic Data.



LEGEND :



Standard dev. Of Biomass Estimation By Landsat Data (Grid size : 500 M Square)



LEGEND :

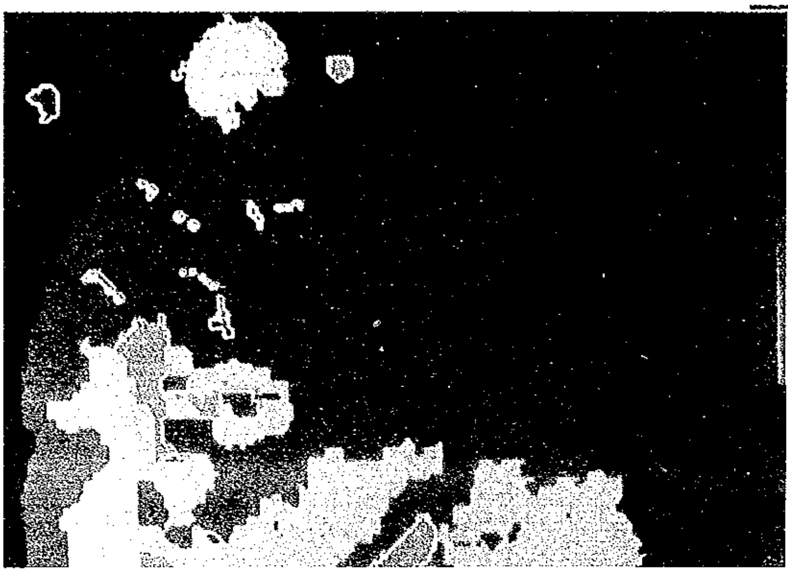
1. UNDEFINE.
2. VERY DRY.
3. DRY.
4. MEDIUM.
5. WET.
6. VERY WET.

Average soil Moisture From Landsat Class (Grid Size : 500 m Square)

Fig 5.11.First stage Thematic Data

LEGEND :

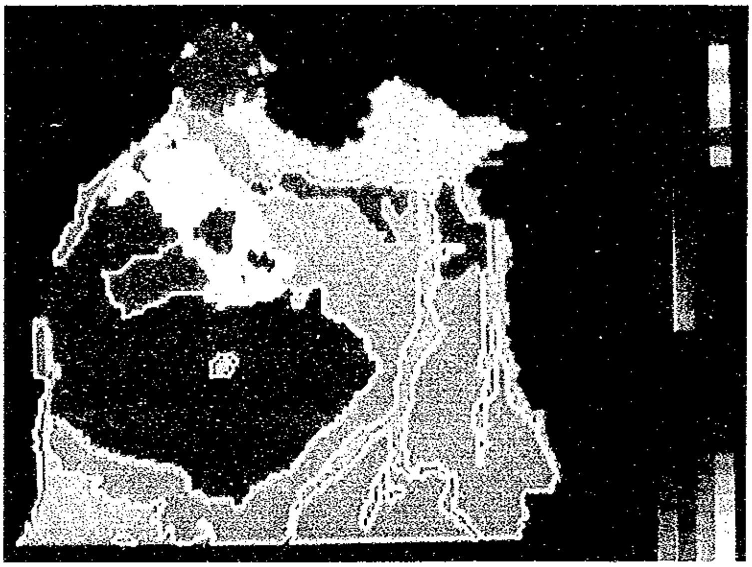
1. > 90 Cm.
2. 60 - 90 Cm.
3. 30 - 60 Cm.
4. < 30 Cm.
5. Pebble & Rock.



Soil Depth - Thematic Map - North Banten.

LEGEND :

1. Latosol.
2. Alluvial.
3. Regosol.
4. Komplex Renzina
5. Padsolik.
6. Asosiasi Glei Humus.
7. Asosiasi Grumusol Grey Yellow.



Soil type - Thematic map - North Banten.

Fig 5.11 g . First Stage Thematic Data

6. Summary

A spatial data analysis system utilizing a landscape model has been designed and developed for evaluation mapping of the land for the agriculture infrastructure development. The landscape model developed can accept multiple variable thematic data in the form of grid cell sampling structure. Four computer softwares which generate header label, Pack geo-coded thematic data as well as Landsat productions for data base construction evaluate the landscape model data for specified purpose by PATTERN method have been written by PL/I language. The developed system has been tested using thematic data of the North Banten Training Area, and satisfactory result has been obtained in the test. Due to the lock of appropriate basic data for evaluation, the assigned weights and PATTERN analysis tree structure could not be well refired. Further investigation of the weighting system and accumulation of basic data for the evaluation assessment should be continued in the Remote Sensing Project.

The benefits of the spatial data analysis system utilizing the landscape model are to be well exploited through practical application of the remote sensing for agricultural infrastructure development.

デ ー タ 処 理

(Data Processing)

農林水産省草地試験場

斉 藤 元 也

(Genya SAITO)

目 次

Ⅰ はじめに

インドネシア農業開発リモートセンシングプロジェクトにおいて，データ処理の指導の任期を終了することになりましたので，指導した業務内容を報告いたします。

Ⅱ 指導の課題と概要

指導の課題と概要は以下の通りです。詳細については，インドネシア側カウンターパートとともに作成したレポートを参照してください。

(1) ランドサットデータから土壌表面の色の合成

ランドサットデータは，土壌表面の反射特性と植生等の地表を覆う物体の反射特性の加重平均値が得られている。このランドサットデータから，植生の影響を取り除いた。さらに，ランドサットデータでは，観測されていない青の波長帯については，赤と緑の波長帯のデータより，土壌のスペクトル特性のモデルにより，この青の波長帯の値を算出し，土壌表面のカラー合成を行った。

(2) ランドサットデータから土壌水分変化の抽出

土壌表面の色は，土壌の有機物含量，鉄分などによって決まる土壌固有の色と水分状態による色の変化がある。土壌固有の色は，数年では，ほとんど変化しないので，植生を除去した土壌の色の変化は，土壌水分の変化と考えられる。

異なる年次のランドサットデータを使用し，土壌水分変化を抽した。

(3) 北バンテン地区における土地利用と土壌型および標高との関連について

土壌型および標高と土地利用との関連と農業開発の進んだ北バンテン地区で明らかにすることは，今後の開発計画のための指針になりうると考え，この解析をおこなった。

Ⅲ 所　　感

インドネシアリモートセンシングデータ処理の任期期間が終了しましたが，2ケ月間は非常に短かく，当初計画の半分程度しか指導できなかったように思われる。

本プロジェクトのリモートセンシングによる主題図作成は順調に進められており，私は，土壌表面の色の主題図と土壌水分の変化の主題図を指導し，良く理解された。

本来のメインテーマである農業適地選定の作業は＊1 PATTERN法のためのプログラムが開発され，さらに，これと異なる手法の主成分分析法による＊2 農村計画の検討がなされ，開始段階となった。

前者のPATTERN法は，プログラムにデータをいれれば農業適地評価図は出来あがる。しかしながら現実に使用価値のある評価図であるかどうかは，使用データの種類，精度，使用データの重み付け等によってきまる。このため，評価図を作成する人には農業に関する正しい知識が要求される。このことに関係して土地利用の決定要因の解析の例として土壌型および標高と

土地利用の関係の解析について指導した。時間不足と目的の理解が十分でなく，十分な成果が得られたとはいいがたいが，一応の成果を取りまとめられた。

無事任期を終えられたのは日本側及びインドネシア側関係者の御努力によるものであり，深く感謝いたします。

*[1] 各主題図の重み付け評価法

*[2] 適地評価手法開発の作業

V. A kind of data processing for soil information.
Development of agricultural infrastructure.
The Ministry of Public Works,
Indonesia.

26 March 1983 by Genya Saito
JICA Expert for
data processing

(I) PREFACE

I worked at the Remote Sensing Project in Indonesia during two months, and I would like to submit a brief report of my activities at the project.

(II) OUTLINE OF ACTIVITIES

Outlines of my activities are as follows, please refer to the individual report made by counterparts and me.

1. Extraction of soil color information of Landsat data.

   Landsat MSS data contained soil spectral information and soil covering material information. So we attempt extraction of soil color information by data processing, and making soil color image.

2. Extract of soil water contents by multi-times Landsat data.

   We extract of soil color information each time's Landsat data. We made soil brightness on averaging and then balanced these brightness. This result indicates soil water changing.

3. Relationship between ground-use and soil type etc. at North Banten.

It is very useful information for development of agricultural infrastructure that relationship between ground-use and soil type in the agricultural developed area. If we know this relationship, we can plant suitable crop on suitable land.

(III) WORK SCHEDULE

Jan. 28, 1983	Arrival to Jakarta
Jan. 29, 1983 – Feb. 10, 1983	Planning
Feb. 11, 1983 – Feb. 27, 1983	Extraction of soil color information
Feb. 28, 1983	Ground Truth (North Banten 1st time)
Mar. 1, 1983 – Mar. 7, 1983	Extraction of soil water change
Mar. 8, 1983 – Mar. 10, 1983	Ground Truth (North Banten 2nd time)
Mar. 11, 1983 – Mar. 20, 1983	Analysis of determination of ground-use
Mar. 21, 1983 – Mar. 25, 1983	Making Report

(IV) IMPRESSION

My work of data processing of Indonesia remote sensing project is over now. I feel that two months is very short and I thought I could teach Indonesia side very little.

I feeled that production of thematic map in this project is good condition. I taught extraction of soil color information and soil water change at this subject and I think Indonesia counterparts understood well.

Production of evaluation map for infrastucture of agriculture is main subject of this project and this work will be started in short time. The computer program of PATTARN method is already developed. But it needs the knowledge and sence about agriculture to operate this program, otherwise this evaluation map is not useful.

In this subject I taught study of relationship among soil type, elevation and ground-use. I'm afraid that counterparts can understand well or not because of short time and not clear object, but anyway we made up the report of this study.

I say for all the men and women of this project thank you very much for your kindness.

V. EXTRACTION OF SOIL COLOR INFORMATION OF LANDSAT MSS DATA IN NORTH BANTEN AND CJC AREA

GENYA SAITO
NANIK SITI MURJIATI
SRI YUMADIATI NINDYOPAWOKO

(I.) INTRODUCTION

LANDSAT MSS data contained soil spectral information and soil covering material spectral information mainly vegetation spectral information. At the temperate zone in early spring time, there are small vegetation, so in this time we can directly gather many soil spectral information. But Indonesia in tropical zone there are no season of the small vegetation.

We need to extract soil spectral information by treatment of calculation in the vegetation area.

In our remote sensing project, Fukuhara model is used for getting soil spectral information and also determining soil brightness as it were and this soil brightness is depend on both proper soil color and soil water content. Fukuhara suggest this model available to extent soil spectral information, but it cannot directly indicate soil color and our previous work indicate mainly depending on soil water conditions.
We want to have soil color information in order to recognise soil condition and soil mapping. Therefore, we attempt to extract soil color spectral information by using development Fukuhara's model and new conception of soil spectral reflectance.

We wish this report will be useful in the framework of Agriculture infrastructure project especially for soil scientist in order to get optimum result.

(II.) USING DATA AND SYSTEM

1. Area

   Banten area is indicated at Fig. 1.
   It locates in North western part of Java island.

2. Landsat data

   Landsat MSS image was taken at 21st August 1973.
   This image data was preprocessing by format conversion image noise reduction and triming of using area.

3. Using System

   Digital image processing system consist of IBM 4341 computer, magnetic taps units, disk memory, line printer, terminal display, and additive color viewer, and so on.

4. Ground truth

   We surveyed at North Banten and CJC area on 28th Feb. and 8th - 10th March in 1983. This route is indicated in Fig. 1.

5. Measurement of soil spectral reflectance soil sampling points are indicated at Fig. 7. We used handhold radio spectral meter to measure the spectral reflectance of soil and white board (MhO). We calculate as follow:

   $$f(\lambda) = 10^{(a\lambda - aw\lambda)}$$

   $a\lambda$ = meter value at soil
   $aw\lambda$ = meter value at white board

(III) DATA PROCESSING PROCEDURE AND CONCEPT

1. Flow chart

   Outline of data processing procedure is indicated at Fig. 2.
   We explain these concepts of data processings according to flow chart in later section.

2. Sampling of useful pixels.

   At Landsat MSS data, 1 pixels is corresponded to 80 m x 80 m on the ground. When we cast upon color display in this area, we need to skip all of data. Necessary data for the color display are only 1-5%.

   High vegetation covered area is unsuitable to get soil information. Therefore we pick up most useful pixel from 9 pixels (3 x 3). If vegetation cover is large, IR reflectance shows large value and IR reflectance of the area filled up by water is very low. So, we choosed the lowest pixel from band 7 of land area, and we choose the pixels from band 4 and band 5 some location of band 7.

3. Determination of Vegetation covering Ratio (VCR)

   At the same soil condition, we think that biomass and IR reflectance show direct liner correlative relationship as Fig. 3(1). So two dimensional graph of VCR and IR reflectance is given in Fig. 3(2). Therefore two dimensional graph of VCR and logarithms of IR is direct liner as Fig. 3(3).
   One member of us proved this concept by measuring of spectral reflectance in crop field.

   Fukuhara model is using two dimensional graph of IR and R, but in this case we use log IR instead of IR to get two dimensional graph as Fig. 4.
   High vegetation point, which is same as plants leaves, located at one point which have large IR value and small R value. Base soil point are on the line.

This soil line express as follows:

SIR = aSr + b

a ; slope of this line (constant value)

b ; the y value at cross point of y (IR) axis (constant value)

SIR ; logarithms of soil reflectance of IR

SR ; soil reflectance of R

Observed point A of mixed soil and vegetation, growth index k is defined as follows:

k = AIR - a AR - b

AIR ; logarithms of A point reflectance of IR

AR ; A point reflectance of R

Highest value of k named l which is determined as follows.

l = PIR - a PR - b

P = all vegetation point

VCR is defined as follows

$$VCR = \frac{k}{l} = \frac{AIR - aAR - b}{l}$$

So l, a, b value defined and then VCR is automatically calculated.

Note: Reflectance value use CCT count 0 - 255.
logarithsm value use 100 x log CCT count.

4. Determination of soil color.
Observed value of point A is average of soil reflectance and plant reflectance.
Two dimensional graph of VCR and reflectance is indicated at Fig. 5.

We can use formula as follows:

$AR = CPR + (1 - C)\ SR$

$AG = CPG + (1 - C)\ SG$

A = CCT count of observed

P = CCT count of all vegetation point

S = CCT count of soil

= R or G band

C = Vegetation covering ratio.

And then soil reflectance values are defined as follows.

$$SP = \frac{AR - CPR}{1-C}$$

$$SG = \frac{AG - CPG}{1-C}$$

SP, SG are determined by calculation. But Landsat MSS doesn't measure Blue band. We consider soil reflectance model as Fig. 6.

Normal soil show straight line at all wave length. and high humid soil are decreased the reflectance at all the wave length. But high contents of Fe^{+++} soil, as it were Latosol, is characteristic low value of Blue and Green. Reflectance graph will show character S centering around green value.

So we assume as follow:

$$SB = SG - (SR - SG)$$
$$= 2\ SG - SR$$

SB, SG and SR values are determined above and these value can be displayed at digital color viewer.

(IV) RESULT

1. Two dimensional graph of IR and R.

Two dimensional graph of IR and R is indicated at Fig. 7 and Log IR and R is indicated at Fig. 8. These sampling area is indicated at Fig. 9.

Fig. 7 is agreed with Fukuhara model, but high vegetation samples distributed along IR axis. Used model is shown in Fig. 8, and this is more suitable because high vegetation samples located in a circle.
Using Fig. 8 we decided a, b, 1 PR as follows:

a = 104
b = 98
1 = 92
PR = 32

in order to determined PG, we get two dimensional graph at high vegetation area, and it is indicated at Fig. 10 and using this result we determined PG as follows:

PG = 34 (CCT counts)

2. Sampling of useful pixels.

We indicated the effect of this treatment at Fig. 11 - 13. Fig. 11 shows that mean value of IR after sampling was sifted lower. Fig. 12 show that mean valve of R after sampling was sifted appear.
Fig. 13 show that mean values of CT before sampling and after sampling were not change.

3. Soil spectral reflectance.

Soil spectral reflectance measurement is indicated in Fig. 14. These three types of soil is characteristical one that are distributed large part of this area.
This result well agreed our concept and we can understand that reflectance change between IR band and R band is more affected by soil water contents than the color soil color.

So our previous work, soil brightness from Fukuhara model shows mainly soil water.

4. Vegetation covering ratio (VCR)
We calculate VCR using a, b, 1 constant that are determined two dimensional graph. This result is indicated at Photo1. This photo showed logarithsm of biomass omitted influence of soil reflectance above. Lower is the result by using useful sampling data. We can realize that data sampling is lower VCR.

5. Soil color image.
We get soil color image using VCR. PR, PG, and soil reflectance concept. This result is indicated at Phot 2 and restablished soil map at Photo3. These are well suitable with existing soil map. Existing soil map has rather rough boundary. So using this photo, soil map can be modified.
Dark part in upper of image is irrigated area or wetting area. We can understand that soil brightness is depent upon mainly soil water content.

ACKNOWLEDGEMENT

We would like to express our greatful thanks to all the members of Remote Sensing Project of Indonesia who suggest and extended us. We would like to express our thanks especially Miss Dessy Sjarif for computer processing work and Suhadi for photo processing.

At last, but at the most, we are grateful to Mr. S. Sakai and Mr. H. Yamamoto for development software and hardware.

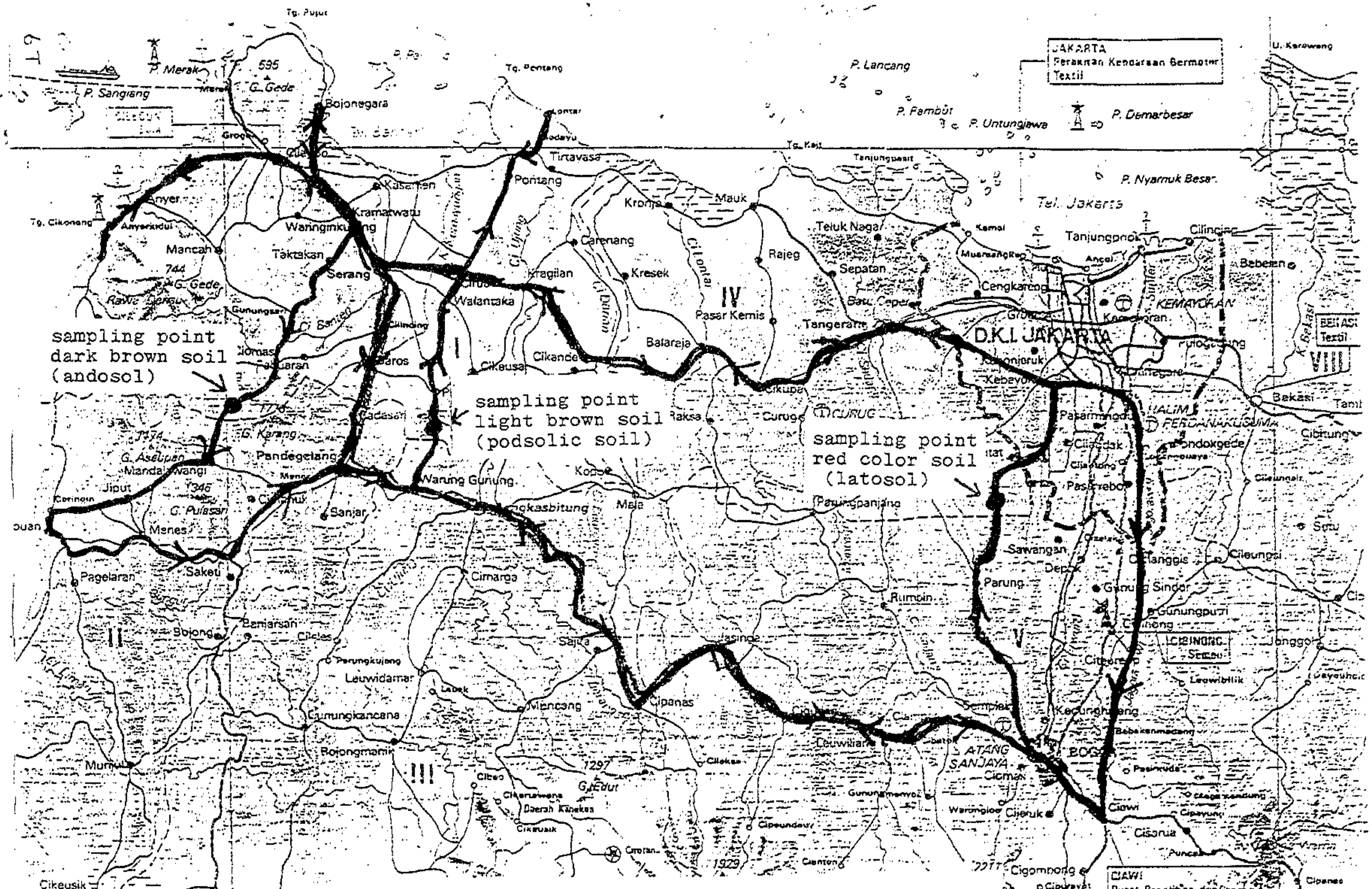


Figure 1. Banten CJC area and ground truth route.

REFERENCE

1) Fukuhara, M., Hayashi, S., etc (1979); Extraction of soil information from Vegetated Area. IBM TSC Report G318-1506-0.

2) Saito, G., and Fukuhara, M., (1982); Spectral Reflectance Factor in Sugar Beet Growth and Yield Estimation. Res. Bull Hokkaicho Natl. Agric. Exp., Sin., B4 39-54.

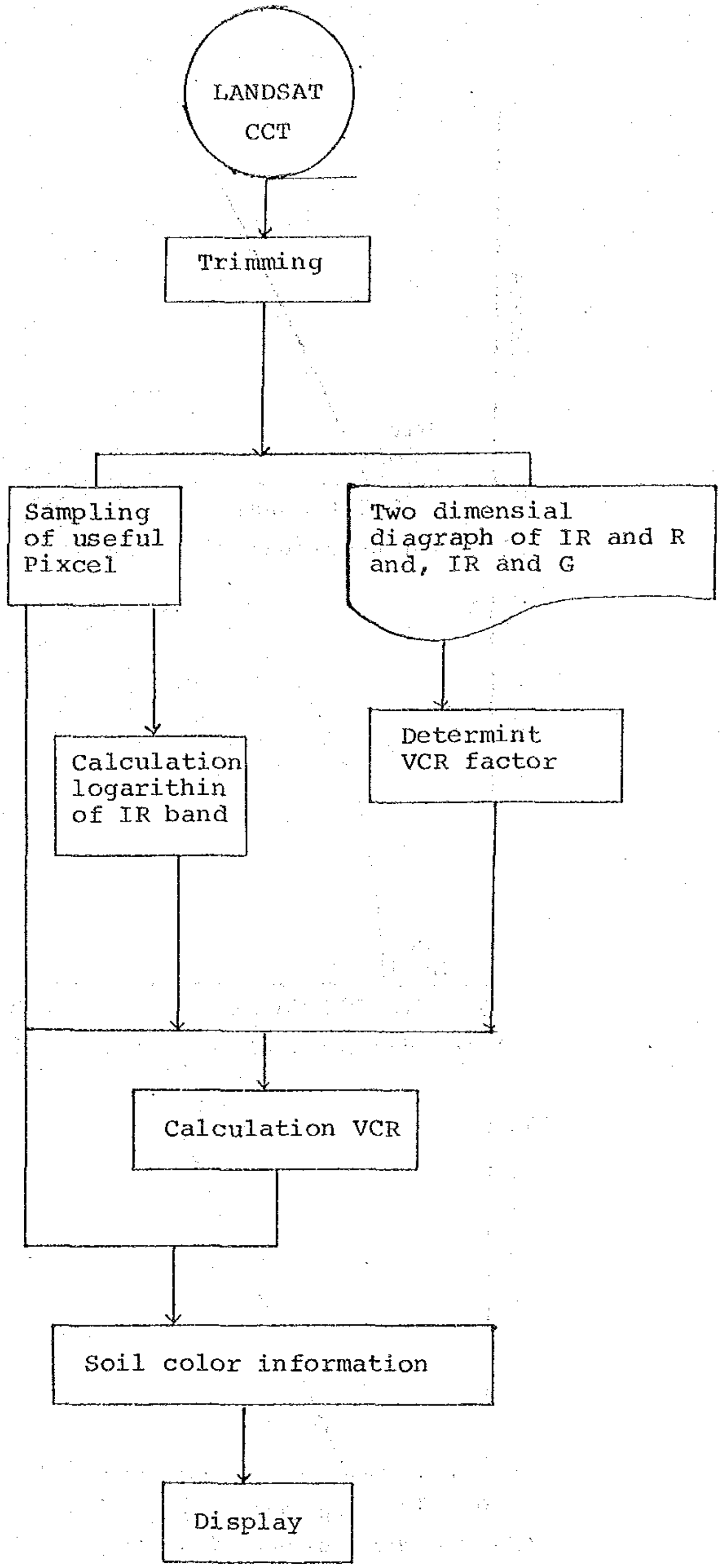
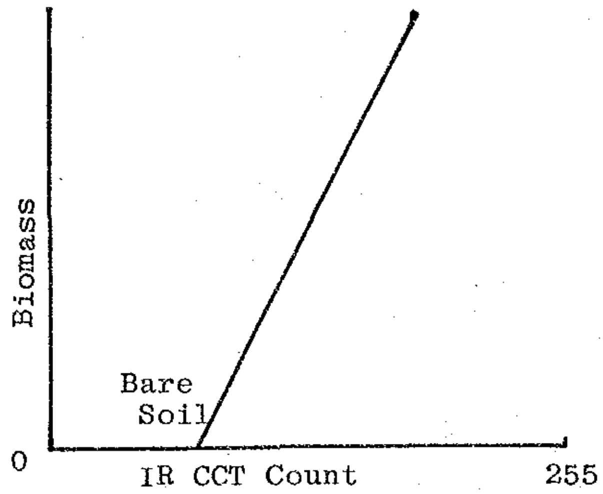
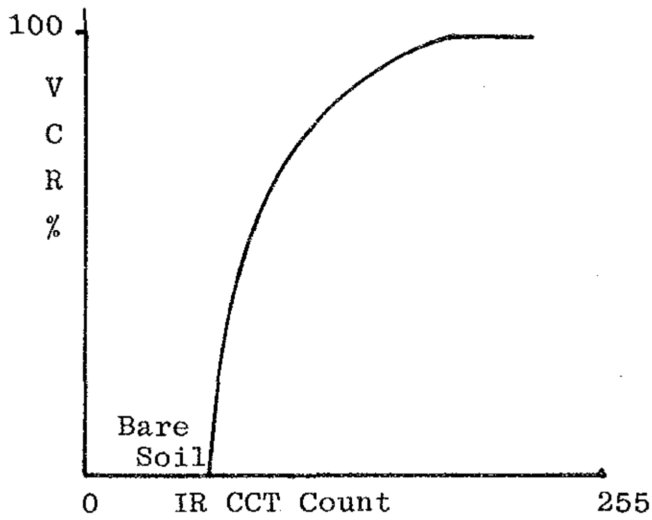


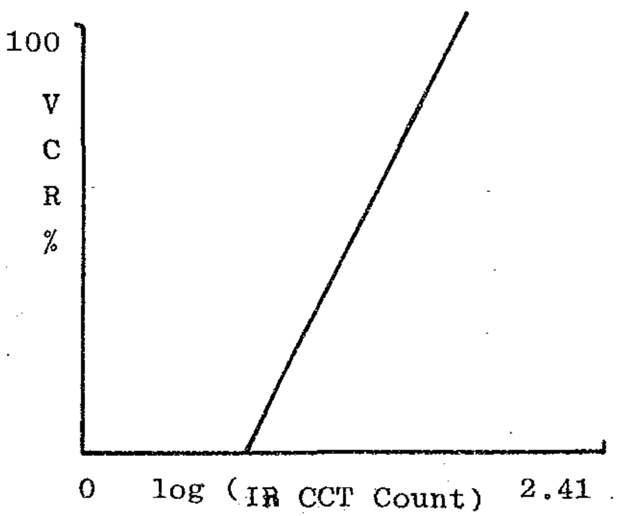
Fig. 2 Flowchart of data processing procedure



(1) Two dimensional diagraph of Biomass and IR



(2) Two dimensional diagraph of VCR and IR



(3) Two dimensional diagraph of VCR and log IR

Figure 3. Concept relationship VCR and spectral reflectance.

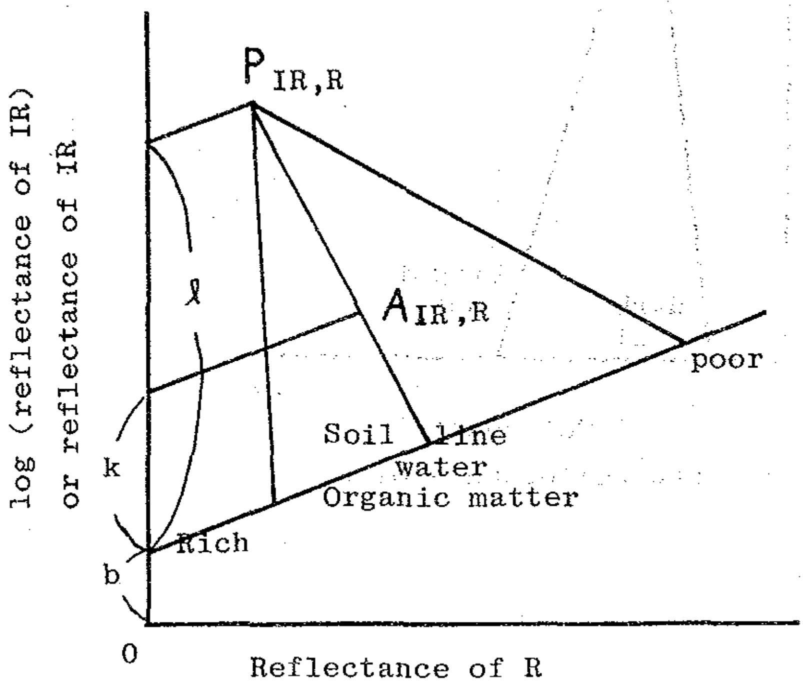
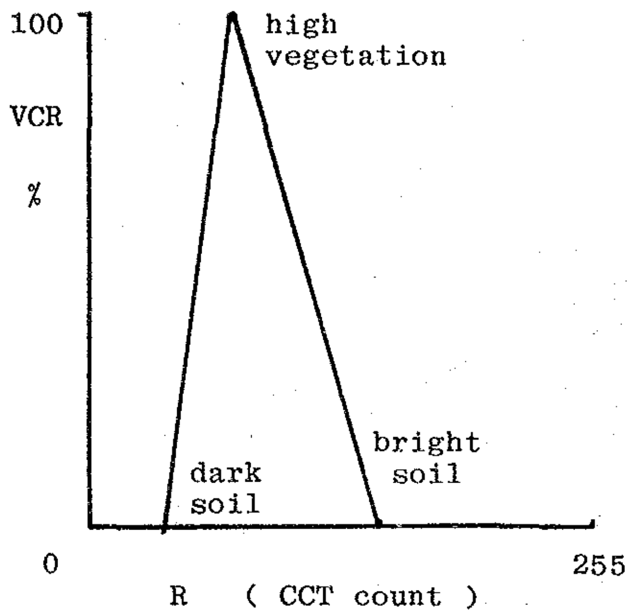
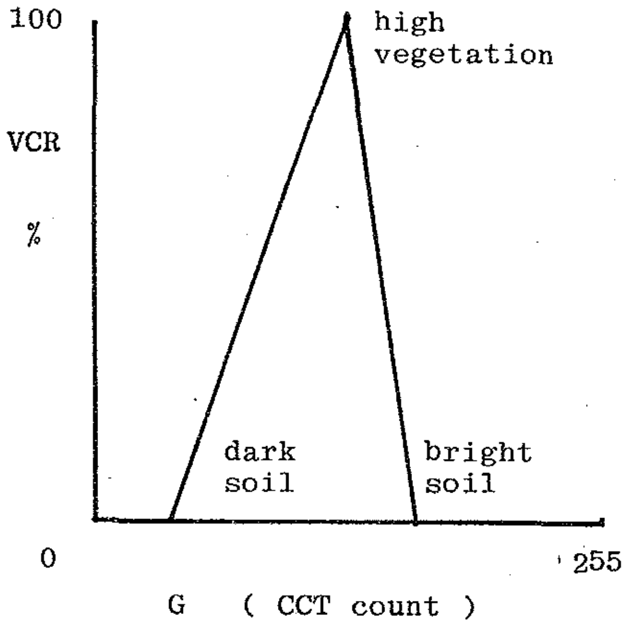


Figure 4. Concept of relationship between VCR and IR reflectance.



(1) VCR and Reflectance of R



(2) VCR and Reflectance of G

Fig. 5 Two dimentional graph of VCR (vegetation covering ratio) and reflectance of R and G.

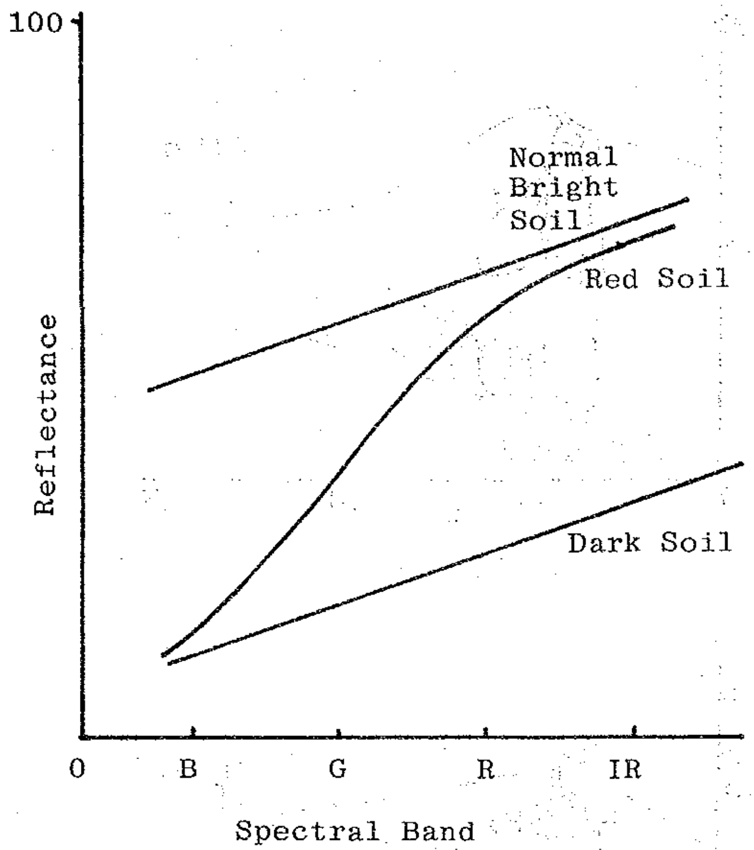


Fig. 6. Concept of Soil Spectral reflectance.

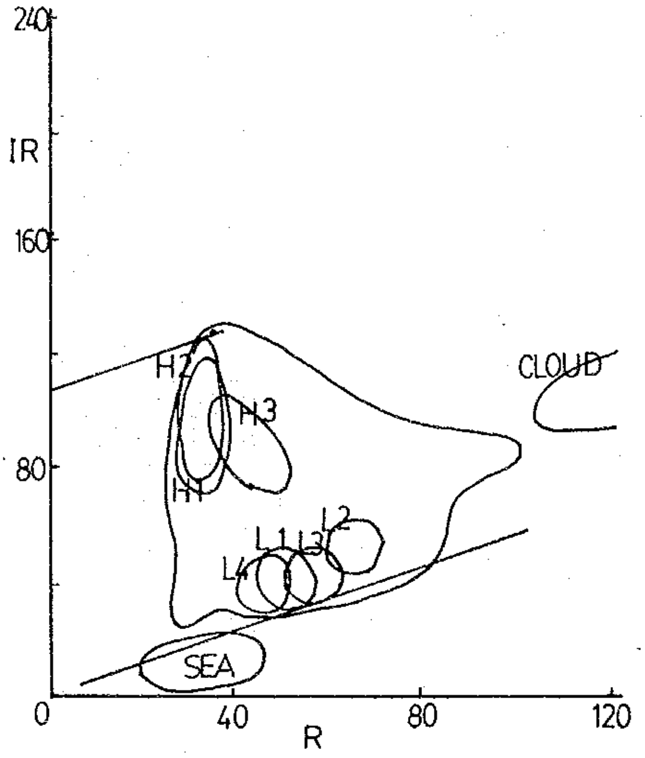


Figure 7. Two dimensional diagraph of IR and R.

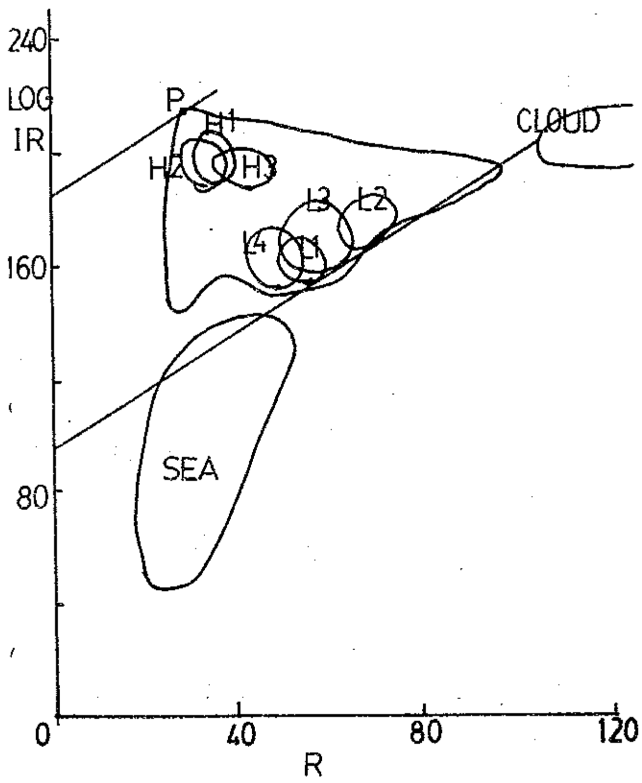
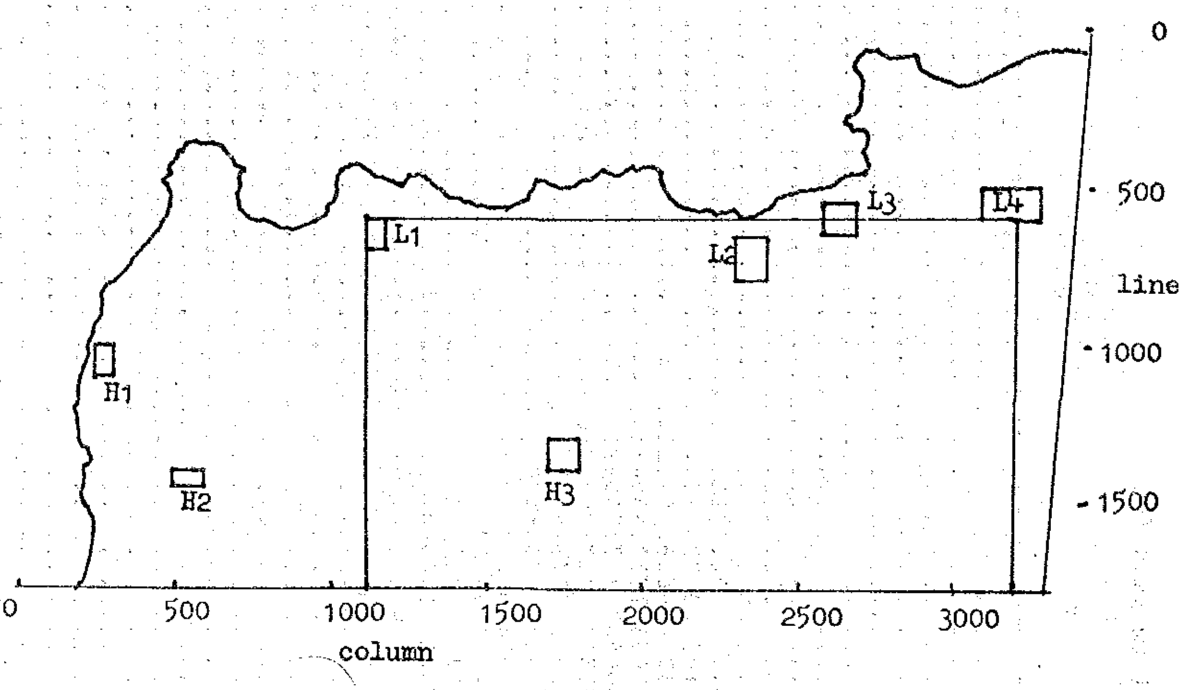


Figure 8. Two dimensional diagraph of log IR and IR.



H; high vegetation area
L; low vegetation area

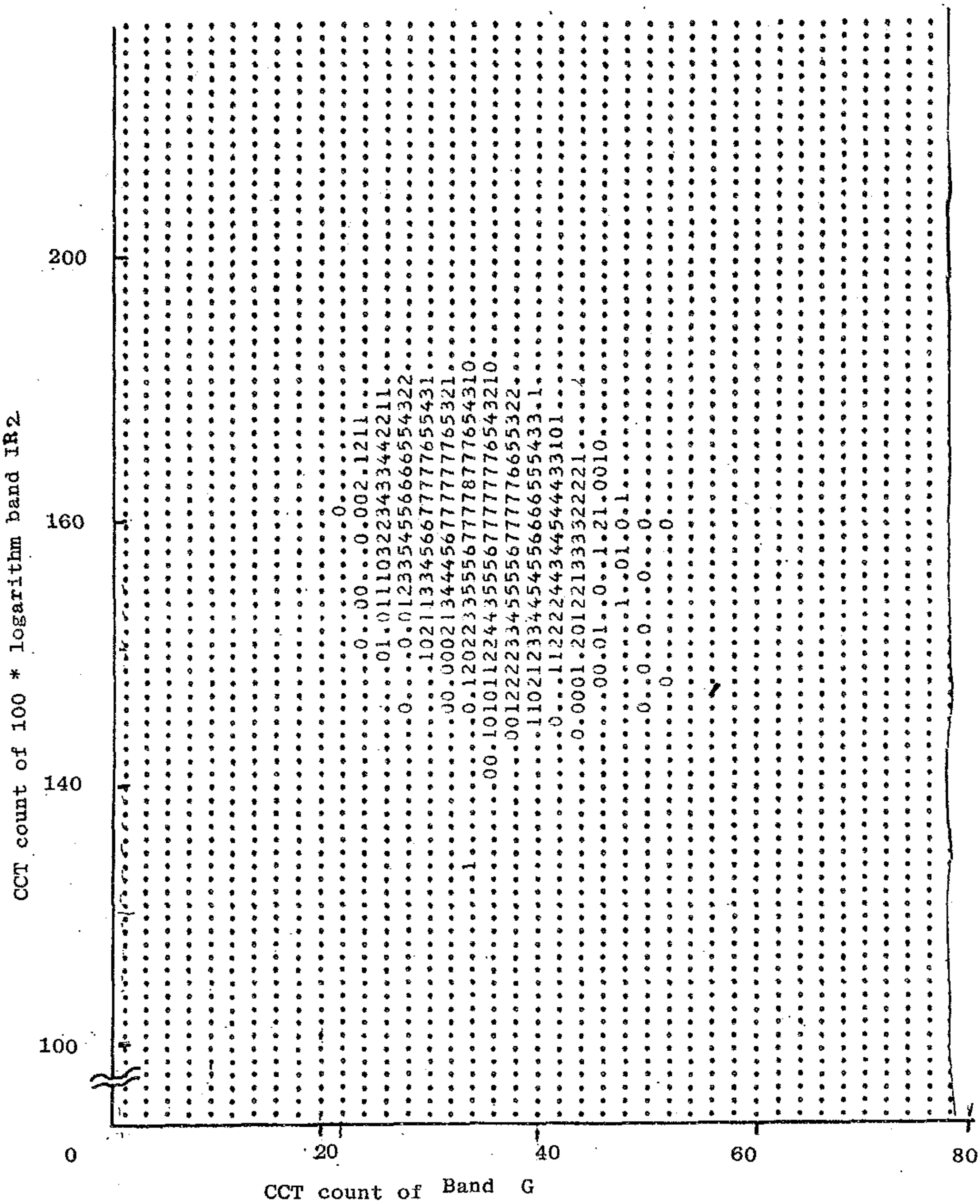
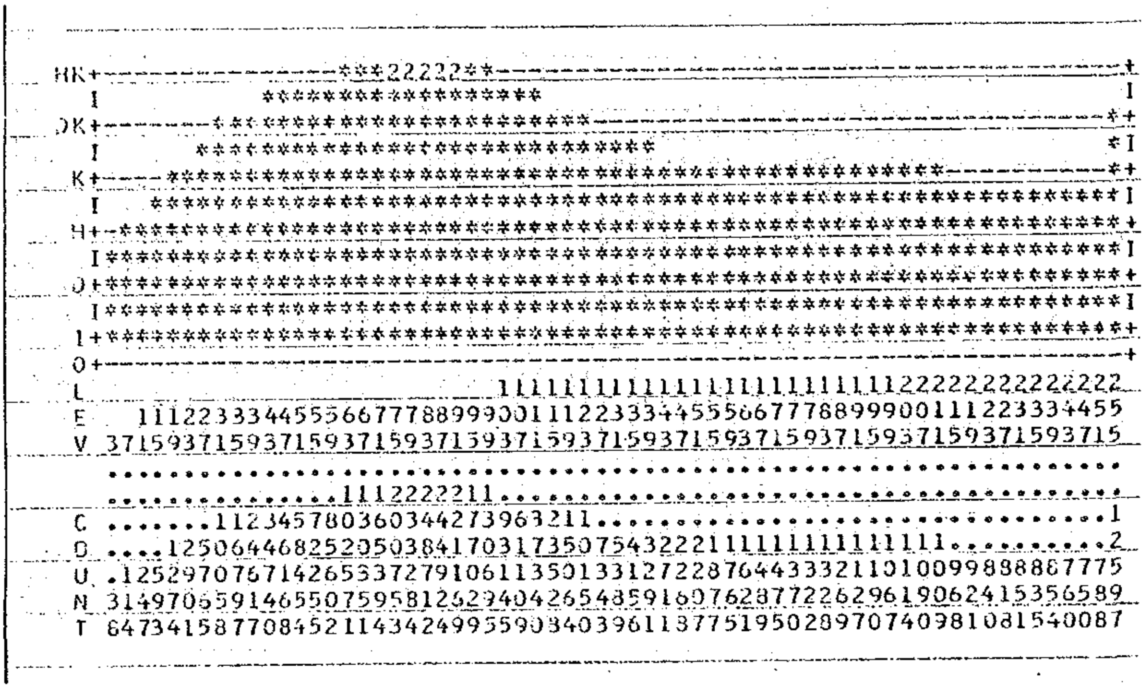
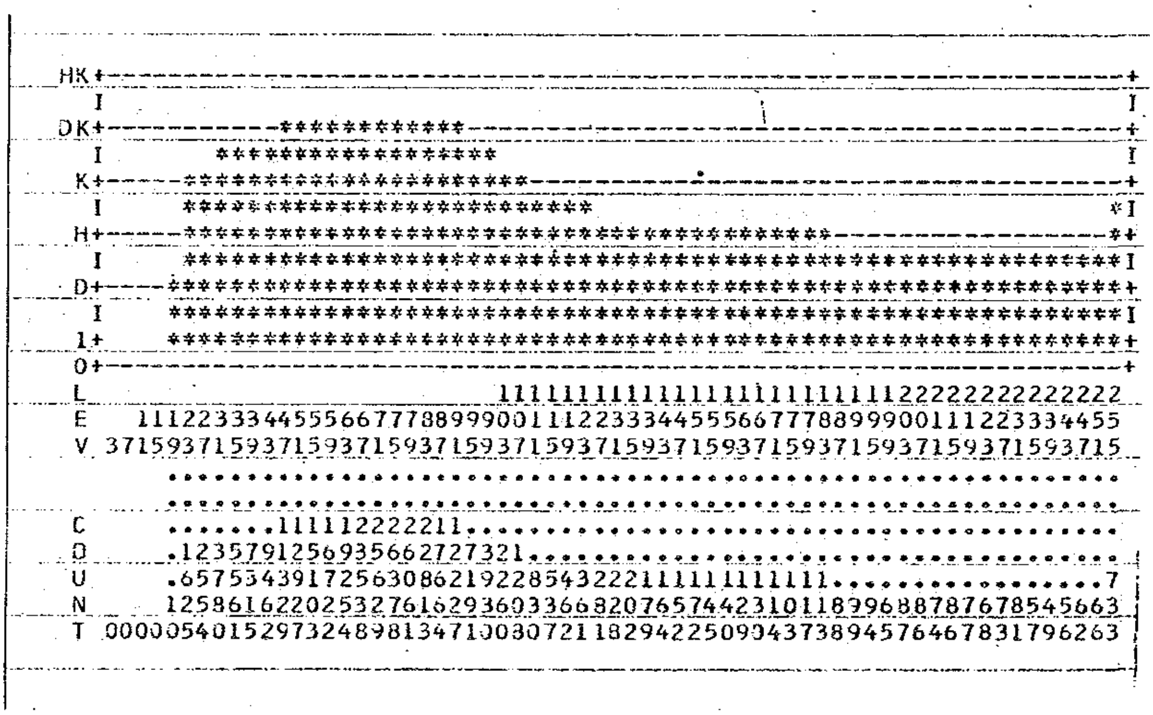


Fig. 10 . Computer output two dimentional graph of G and IR

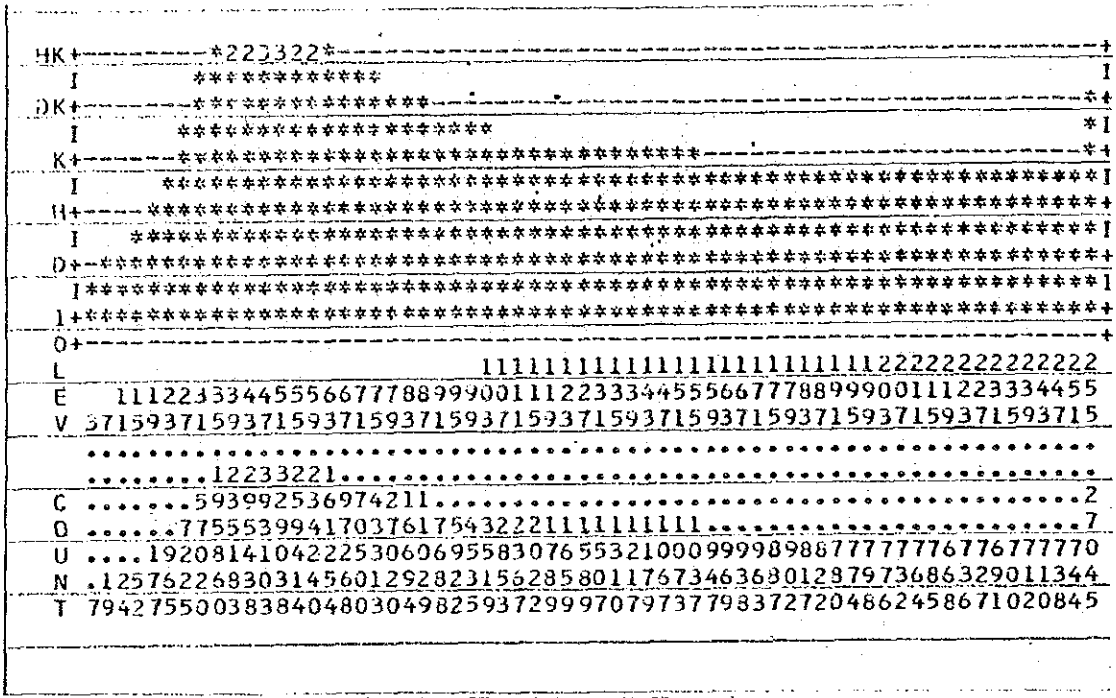


(1) Before sampling

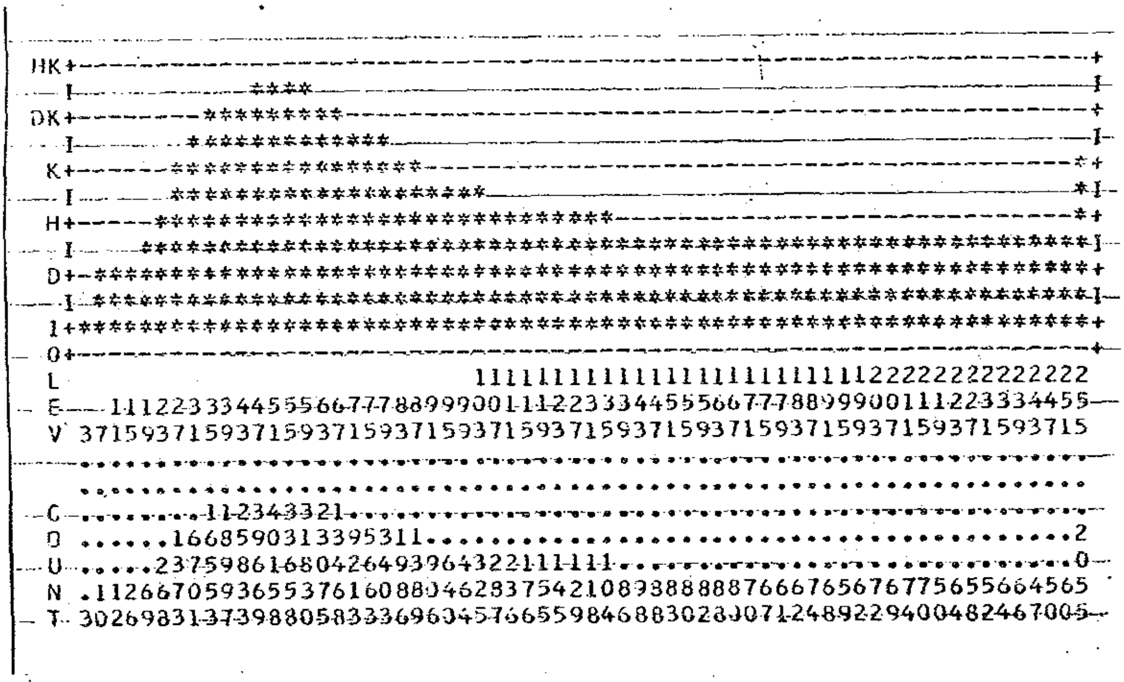


(2) After sampling

Fig. 11 Histgraph of IR band

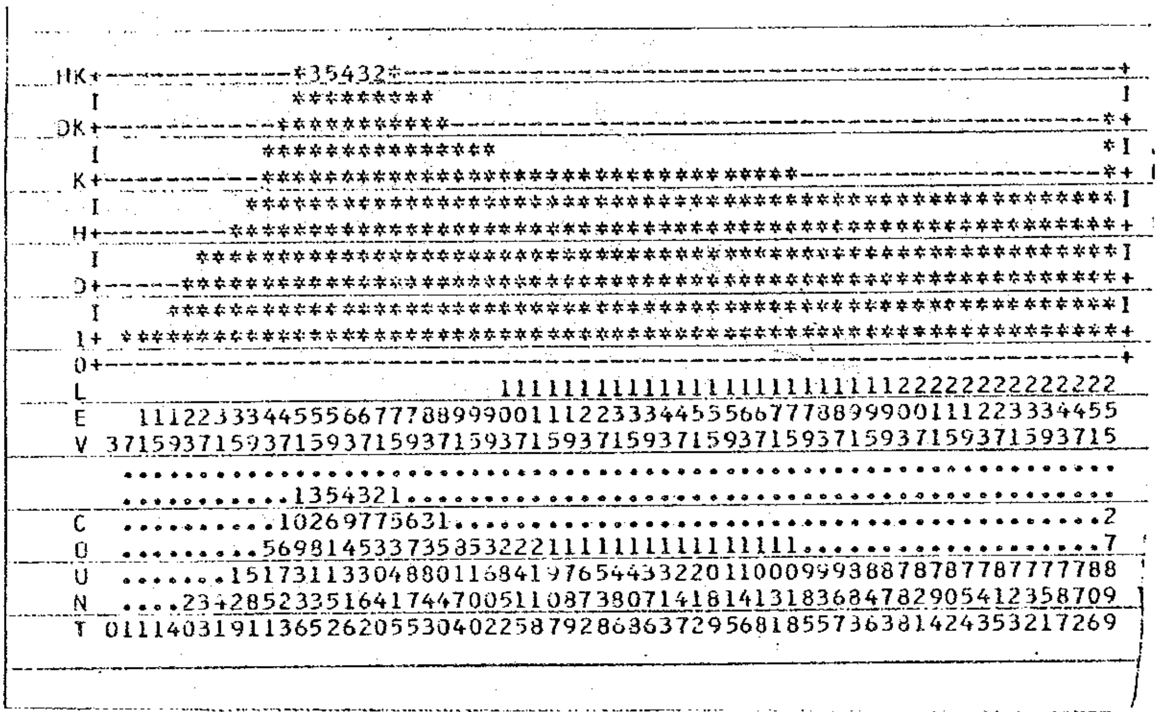


(1) Before sampling

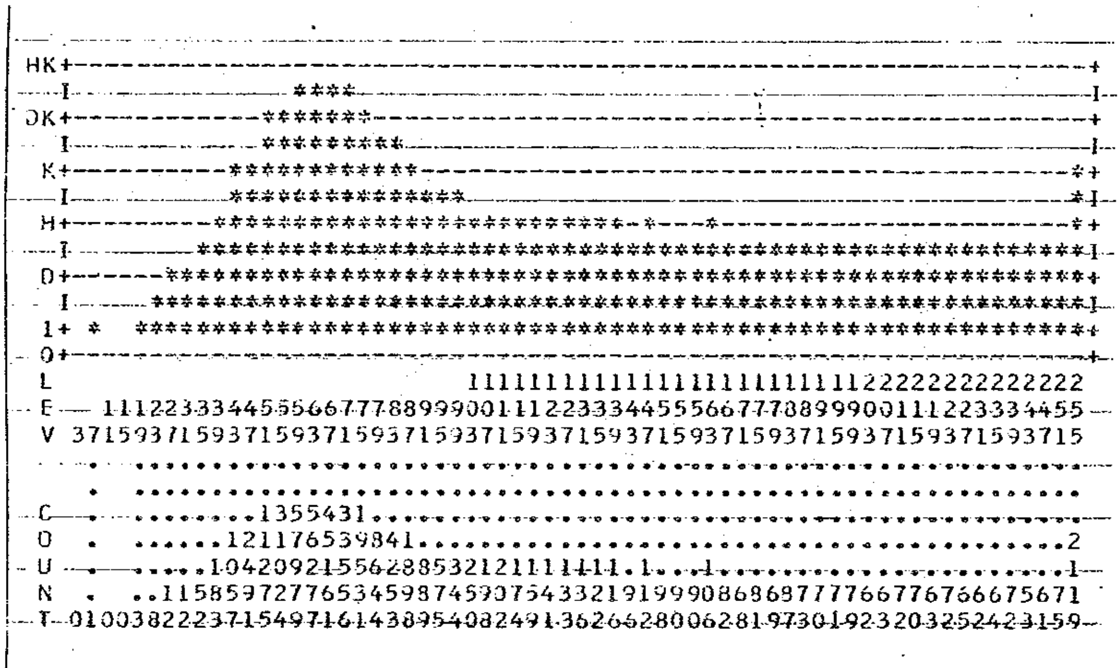


(2) After sampling

Fig. 12 Histgraph of R band

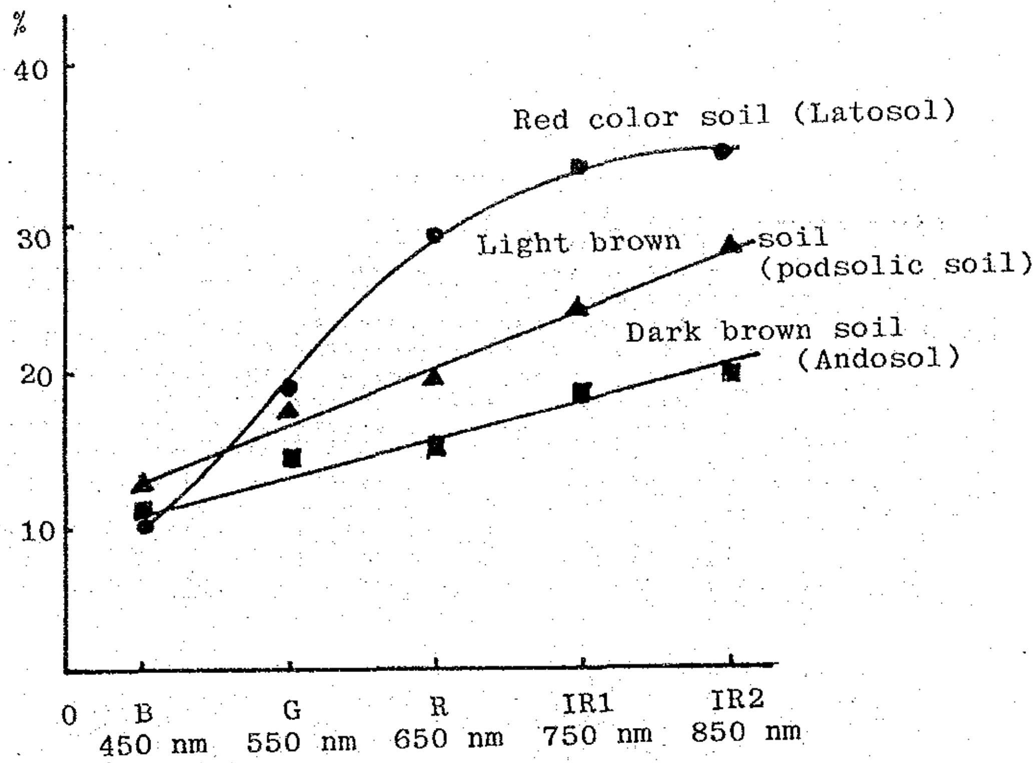


(1) Before sampling

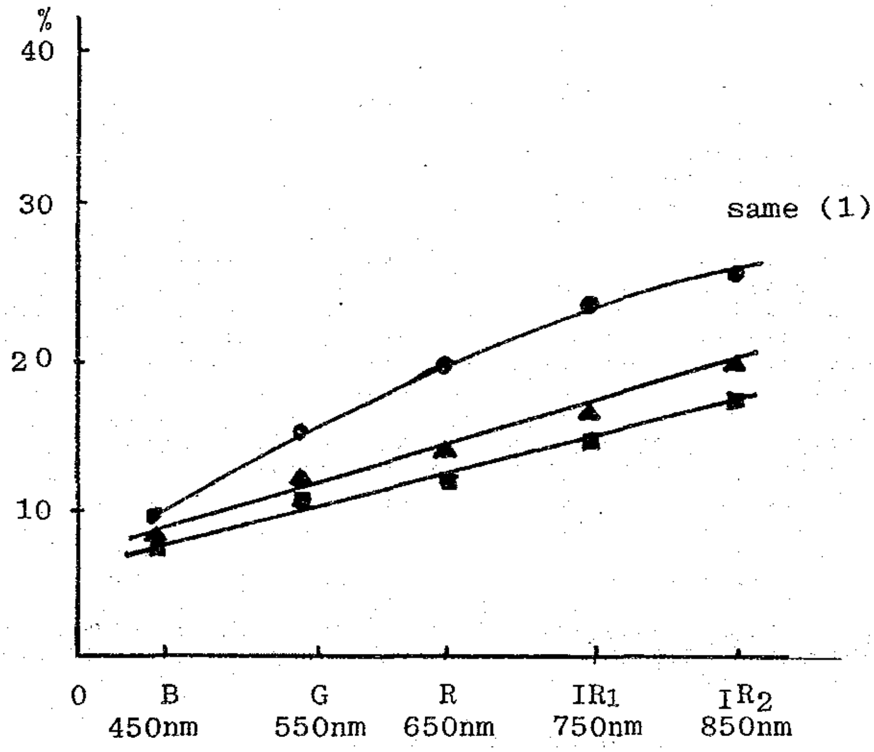


(2) After sampling

Fig. 13 Histgraph of G band

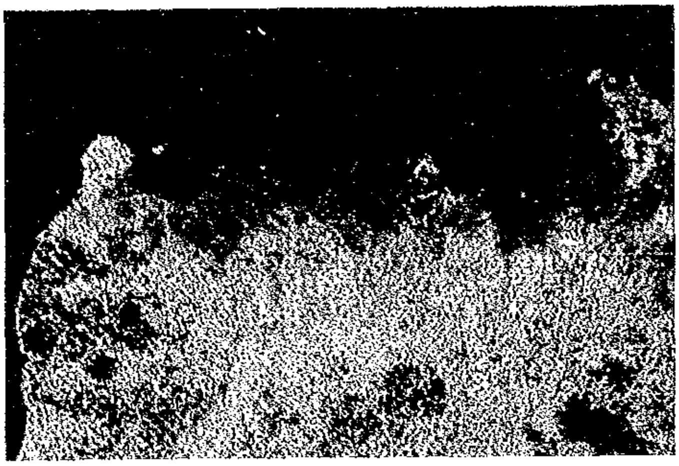


(1) Soil spectral reflectance semi-dry condition.



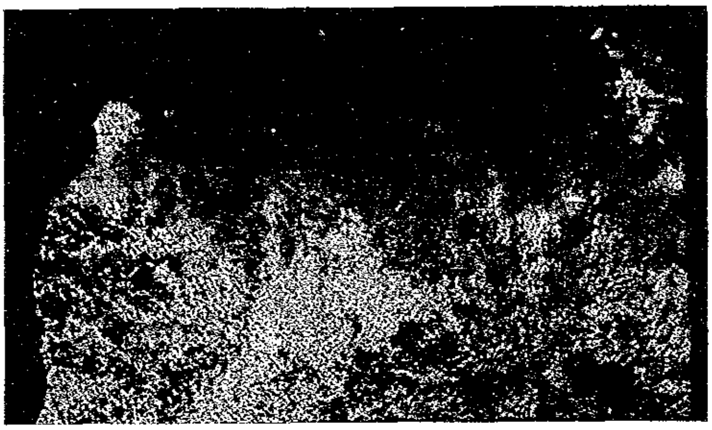
(2) Soil spectral reflectance wet condition.

Figure 14. Spectral reflectance of soil.



Black	0 - 6
Blue	6 - 25
Light blue	25 - 44
Yellow	44 - 69
Red	69 -100

(1) Ordinar Data.



SAME (1)

(2) Result of useful data sampling.

Photo 1. Vegetation covering ratio.

Photo 2. Soil color image.

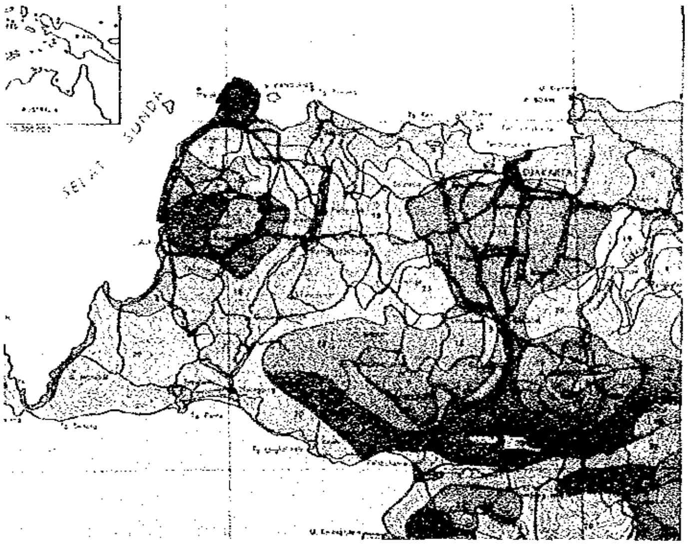


Photo 3. Existing soil map.

Ⅵ. EXTRACTION OF SOIL WATER CONTENT CHANGE BY MULTI-TIMES LANDSAT DATA

GENYA SAITO
NANIK SITI MURJIATI
SRI YUMADIATI NINDYOPAWOKO

I. INTRODUCTION

It is a very important thing to know soil water condition for development infrastructure of agriculture. This is an index of irrigation and draining at the land of using agriculture.

Spectral reflectance of soil depends on soil surface moisture and proper soil color. The value of spectral reflectance from G to IR of soil become down as water content become high.

Proper soil color, which was expected influence water, is same in long time. Therefore change of soil spectral reflectance at same area between two-stage is depend on change of soil water content. Fukuhara [1)] group worked this subject and suggest usefulness for understanding of soil condition.

But this work use change of soil index. The relationship between this soil index change and soil water content changing is not clearly explained.
We attempt the method of extracting soil water content changed by multi stage Landsat data that is well explained.

In our project achieved the map of beomass changes at multistage. Why did biomass change at multistage at tropical area.?
We want to think one answer is changing of soil water conditions. So we attempted Extracting Soil Water.

II. CONCEPT

1. Outline of this procedure is shown in Fig. 1.
   It is necessary to make geometric correction for overlay two image.
   But not necessary to fit UTM system.
   Overlay process is mentioned at the Chapter of Result.
   The concept of determination of soil spectral reflectance was already mentioned before of this report.
   We know soil brightness as it were, using G and R band.
   Therefore we compare result of 76 and that of 73.

2. Water content and soil spectral reflectance.
   The concept of soil spectral reflectance at high water content and low water content are indicated in Fig. 2.

   We can say that wet soil spectral reflectance is parallelly decrease dried soil spectral reflectance.
   This is the basic concept of this study.

III. USING DATA AND GROUND TRUTH, AND SO ON.

1. Using data

   1) 1973 Aug. 21st LANDSAT 1
   2) 1976 June 21st LANDSAT 2

   Path : 131 Row 64

2. Using system
   We mentioned before in the section of extraction of soil color LANDSAT data at north Banten and CJC area.

3. Ground truth
   We mentioned before.

4. Sampling of soil
   We mentioned before.

IV. RESULT AND DISCUSSION

1. Geometrical correction.

We used the program for geometric correction that is package program in our project. The purpose of this program is to fit the image to UTM. We don't like to rotation of image, so we used not true data of ground control point. We used data taken in 1973 as a map. We defined that one pixcel is corresponding to one second, so 60 pixcel is one minute.

As 360° is 40.000 km on earth so that 1 second is 30.9 m. So the parameter of sample size is 30.9 m. Rotation volume and sample number change is very small in this treatment. After triming, these two Image fit together.

2. Image of soil water content.

The difference of soil brightness that is average of G and R reflectance between 73' and 76' is displayed. We assume that fish pond area, where is observed water and pathway, is same reflectance at '73 and '76.

This area is standard point that is not change water condition, therefore we colored this area is yellow. Higher water content area is 1976 than in 1973 is colored blue and light blue. Blue is higher level change than light blue. Higher water content area in 1973 than in 1976 is colored red. This image was indicated at Photo 1 and Photo.

In these photos we feel light blue area is very large. This reason is the seasonal changed of dry and wet.

'76 years data were observed at June just after wet season, therefore paddy field is high water content.

But 73 year's data were observed at August long after wet season, therefore the paddy, where is not irrigated, is dried.

Fig. 3 indicates rainfall data of total three months before LANDSAT Data Collection. Rainfall amount is very different at two place near each. We cannot understand soil water condition by observation of rainfall at some spot and we can realize usefullness of this method.

Photo 3 is changing of vegetation cover which is made up previous in our project.

By Photo 2 and Photo 3, we can realize as follows.

1. Blue area in paddy is indicated A on Photo 2 is thick vegetation cover Aug 73 and thin vegetation cover June '76. We think this area is not irrigated so this area operated one time cultivation and rice is small in June and rice is big in August.

2. Yellow area in paddy is indicated B in Photo 2 is thick vegetation in June 76 and thin vegetation in August 73. We think that this area is irrigated, so two times cultivation operated and rice is middle because of early time planting, and there are no rice in August for plowing in order to second time cultivation.

ACKNOWLEDGEMENT

We would like to express our greatful thanks to all the members of Remote Sensing Project of Indonesia who suggest and extended us.
We would like to express our thanks especially Miss Dessy Sjarif for computer processing work and Suhadi for photo processing.
At last, but the most, we are grateful to Mr. S. Sakai and Mr. H. Yamamoto for development software and hardware.

REFERENCE

Fukuhara, M., Hayashi, S., etc. (1980) :

Soil moisture analysis for soil mapping, Proc. of Symp. on Machine Processing of Remotely Scene Data Purdue Univ.

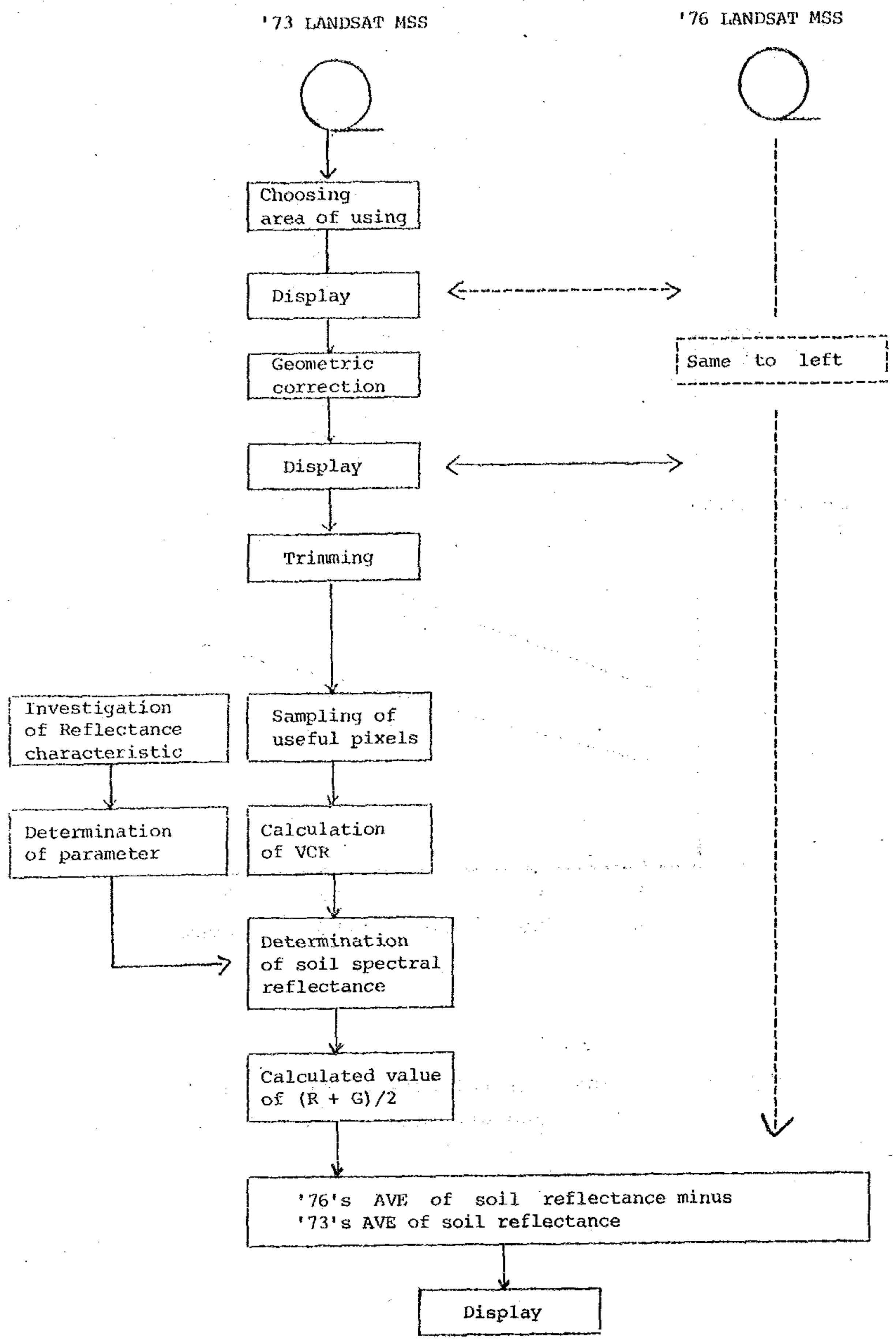


Fig. 1 - Flow Chart of Procedure

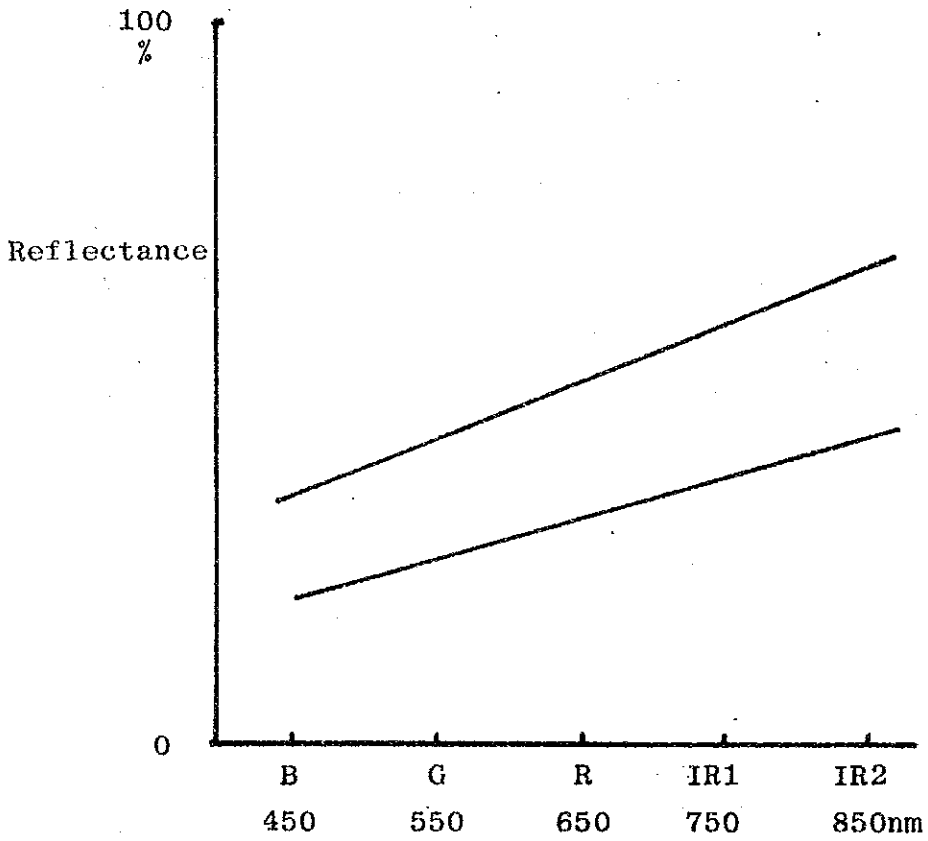
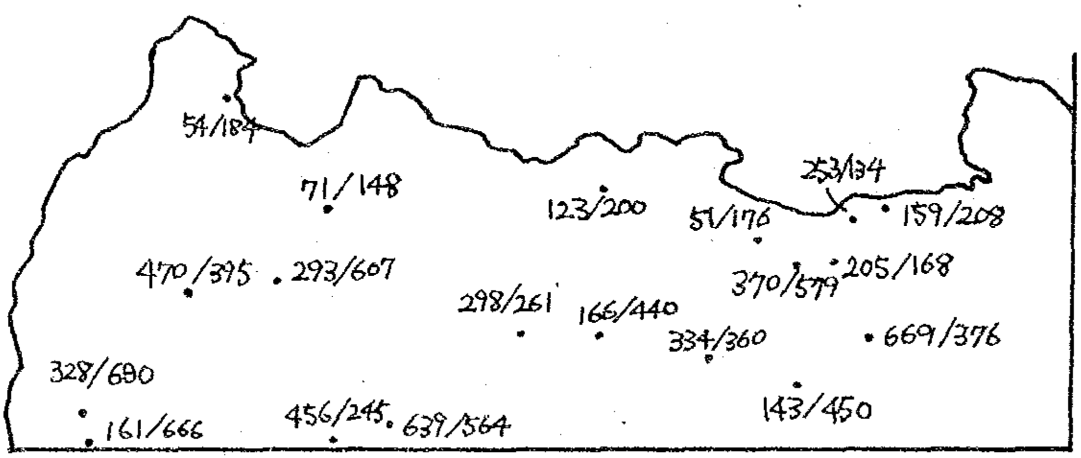


Fig. 2 Spectral reflectance of dry soil and wet soil.



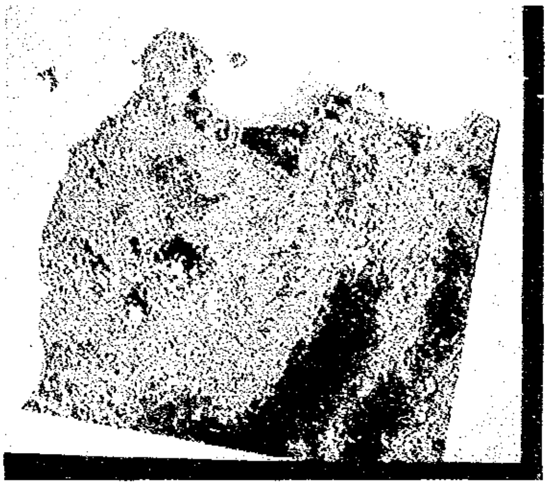
Total rainfall of the three months before LANDSAT observation.

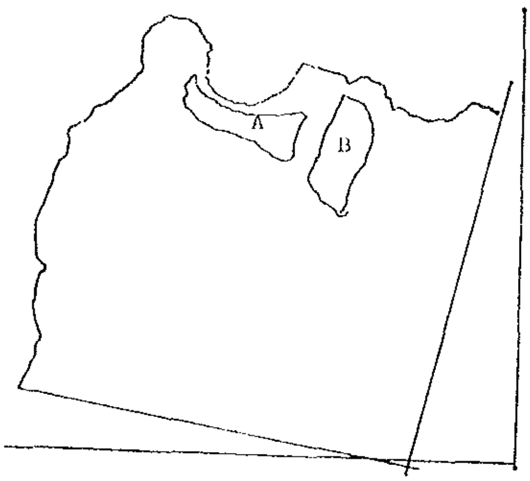
'76/'73

'76 April, May, June
'73 June, July. August

Figure 3. Rainfall observation on earth.

Photo 1. Soil water change between Jun.73 and Aug.76
at North Banten and CJC area.





(This Result was used with Ordinary Geometrical Correction)

Photo 2. Soil water change between Jun.73 and Aug.76
at North Banten area.

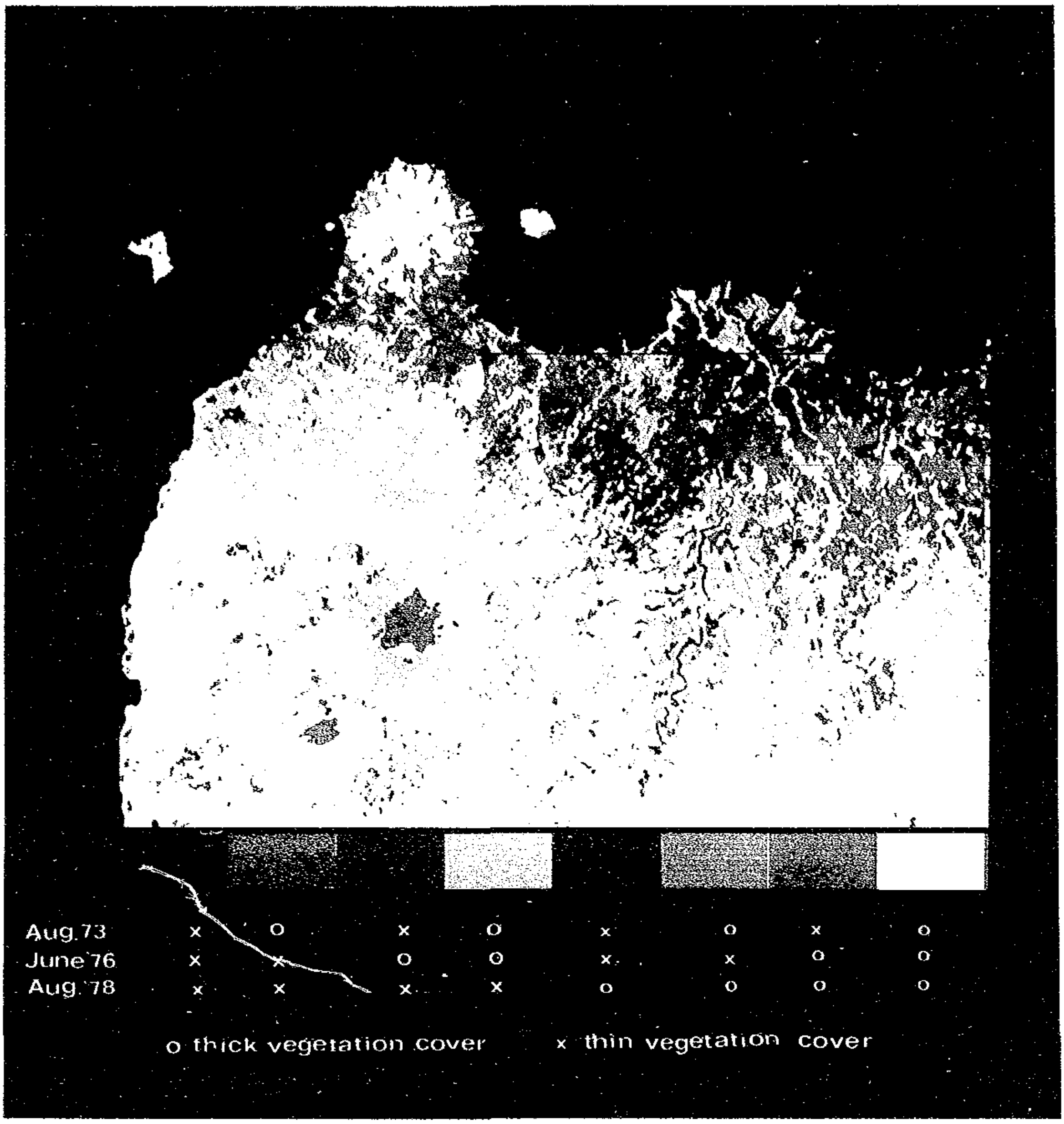


Photo 3. Change of vegetation cover
(Previous work of our project).

VII. RELATIONSHIP BETWEEN SOIL TYPE, ELEVATION AND GROUNDUSE

GENYA SAITO
SRI YUMADIATI NINDYOPAWOKO
NANIK SITI MURJIATI

I. INTRODUCTION

The knowledge of determination factors about ground-use of developed agricultural area in Indonesia, is very useful for agriculture infrastructure.

In Indonesia, we consider that ground-use for agriculture are; paddy field, upland farming field, estate form, grassland, forest, etc.

Ground-use was determined either by natural condition or human activities. We can consider that natural conditions are soil condition, water transportations, elevation, human activities, area road consuming cities, population density and government policy.

In this case, we limited on one natural condition and we used soil type as soil condition. Afterwards, we made overlay among of the elevation, soil map, and ground-use map, respectively.

Therefore, we studied the relationship among of the soil type, elevation, and ground-use map.

Elevation and soil type map are used as established map, and ground-use map made by Remote Sensing project, using remotely sensed data. Then, we examined this ground-use map which was made by remote sensing project using established land use map and ground

II. METHOD

1. Using data

In this case we used ground cover data, soil type data, elevation data and land use data from study area. Those data were made geo-coding data at 1 Km x 1 Km grid cells for input data.

1) Ground cover map

This map made from remote sensing in our project previously. Classification from Landsat data have been 14 classes were expert water as follows

1. Swamp and fishpond
2. Paddy B (Paddy growing period)
3. Paddy Y (Paddy nature)
4. Dry field (Paddy)
5. Grass
6. Bush
7. Rural 1 (rural area with high density housing)
8. Rural 2 (rural area with low density housing)
9. Low density forest
10. High density forest
11. Urban 1 (is centre of city
12. Urban 2 (is outside from city centre)
13. Bare soil
14. Noise

2) Soil type data.

Soil type data was got from soil map. There are 7 types of soil :

1. Latosol
2. Alluvial
3. Regosol
4. Renzina
5. Podsolik
6. Grey hidromorphic soil
7. Grumosol

3) Elevation data

Elevation data was got from elevation map. There are 8 classes :

1. 0 - 25 meters
2. 25 - 100 meters
3. 100 - 200 meters
4. 200 - 500 meters
5. 500 - 700 meters
6. 700 -1000 meters
7. 1000 -1500 meters
8. > 1500 meters

In this case, elevation 0 - 100 meters covered in large area. In highest area on > 1500 meters we can found in small area only.

4) Established land use map

This data was got from land use map. Land use data from study area can be devided to 10 classes, there are:

1. Paddy two times product for one year
2. Paddy one times product for one year
3. Mix garden (garden with multi perennial vegetation for example coconut, bamboo, fruit trees etc.)
4. Cultivated area (upland farm)
5. Plantation
6. Bush
7. Homogenus forest
8. High density forest
9. Grass
10. Swamp
11. Fish pond

B. Ground Truht

We have surveyed for two times.

- First time on February 28th, 1983 we went to north Banten for general orientation.
- Second time on March 8th - 10th, 1983 we went to check on this study area and we compared between land cover data and landscape.

3) Flow Chart

The procedure of flow chart was indicated at Fig. 1. Firstly, we examined the ground cover map and then using this ground use map data we studied the relationship between soil type, elevation and ground use.

III. Result and Discussion

1. Evaluation of ground cover map made by remote sensing data.

We thought this ground cover map is suitable with real ground use according to our ground truth. For example, even if a small paddy this ground cover map can indicate correctly.

But in this map there are some unfamiliar class such as rural and urban we could under and. Rural is upland farm including fruit trees and urban is an unusing area of agriculture according to ground truth.

We could get to established map of land use, therefore we compare ground cover map made by remote sensing with established land use map. This result was indicated Table 1. These two thematic maps were made in different times when the area was observed and they were made by different methods. It is very difficult to determine main ground cover and land use in 1 Km x 1 Km unit area, because the unit size is so large and actual land use is so complicated.

In this view point, ground cover map made by remote sensing data is very suitable. We thought that bush, rural area and forest are linked each other, so it is difficult to divided. But class of grass is very different of these two maps and we could not find grass land at ground truth, therefore we don't use grass data latter study.

Remote sensing data of making ground cover map, include thin cloud at mountain area. Therefore we indicated table 2 that is almost same with the table 1 but omitted unsuitable area. We thought that table 2 is partly more clear than table 1.

2. Relationship between ground cover and elevation.

The relationship between ground cover and elevation is indicated at Table 3, and illustrated on Fig. 2 for easy understanding.

Under 25 m elevation area is mainly paddy area, and fish pond, urban area is located in this elevation.

Over 25 m under 100 m elevation area is mainly Rural area and Bush.

Over 100 m under 200 m elevation area is mainly Rural area and Forest.

Over 200 m under 500 m elevation area is mainly Rural area and Forest.

Over 500 m elevation area is only Forest.

We thought that clearly relationship exists between elevation and ground cover.

3. Relationship between ground cover and soil types.

We indicated outline of soil types at table 4. We refer at Dudal's work for making this table.

The relationship between ground cover and soil types are indicated at table 5 and table 6.

We can understand as follows

1) Alluvial and Glei Humus is used almost paddy.
2) Latosol is widely used but mainly rural area and forest.
3) Regosol is used paddy.
4) Renzina is used rural area.
5) Podsolic soil is used paddy.
6) Grumosol is used only forest.

4. Relationship between soil type and elevation.

The relationship between soil type and elevation is indicated at table 7.

We can understand as follows :

1) Latosol and Renzina is widely spreaded in low and high elevation.

2) Alluvial, Regosol, grey hidromorphic soil and Podsolic soil are located in low elevation.

3) Grumosol is located only in high elevation.

5. Conclusion.

We can understand that ground cover, soil type and elevation have high correlation one another.

We can say that alluvial soil and Grey hidromorphic soil is good for paddy.

Grumosol is not used for paddy, this reason is that grumosol is located only very high area in this case.

Therefore we think that all of these soil type, we can make rice if there are water.

We thought that ranking soil class for rice is as follows;

1) good suitable class; Alluvial soil, grey hidromorphic soil.

2) suitable class; Latosol, Regosol, Renzina podsolic soil.

3) unsuitable class, nothing

4) no comment, grumosol.

ACKNOWLEDGEMENT

We would like to express our grateful thanks to all the members of Remote Sensing Project of Indonesia who suggested and extended us.

Reference

DUDAL, R. and SOEPRATOHARDJO, M., (1957);
Soil Classification in Indonesia.
Contr. Gen. Agr. Res. St., No. 148 Bogor.

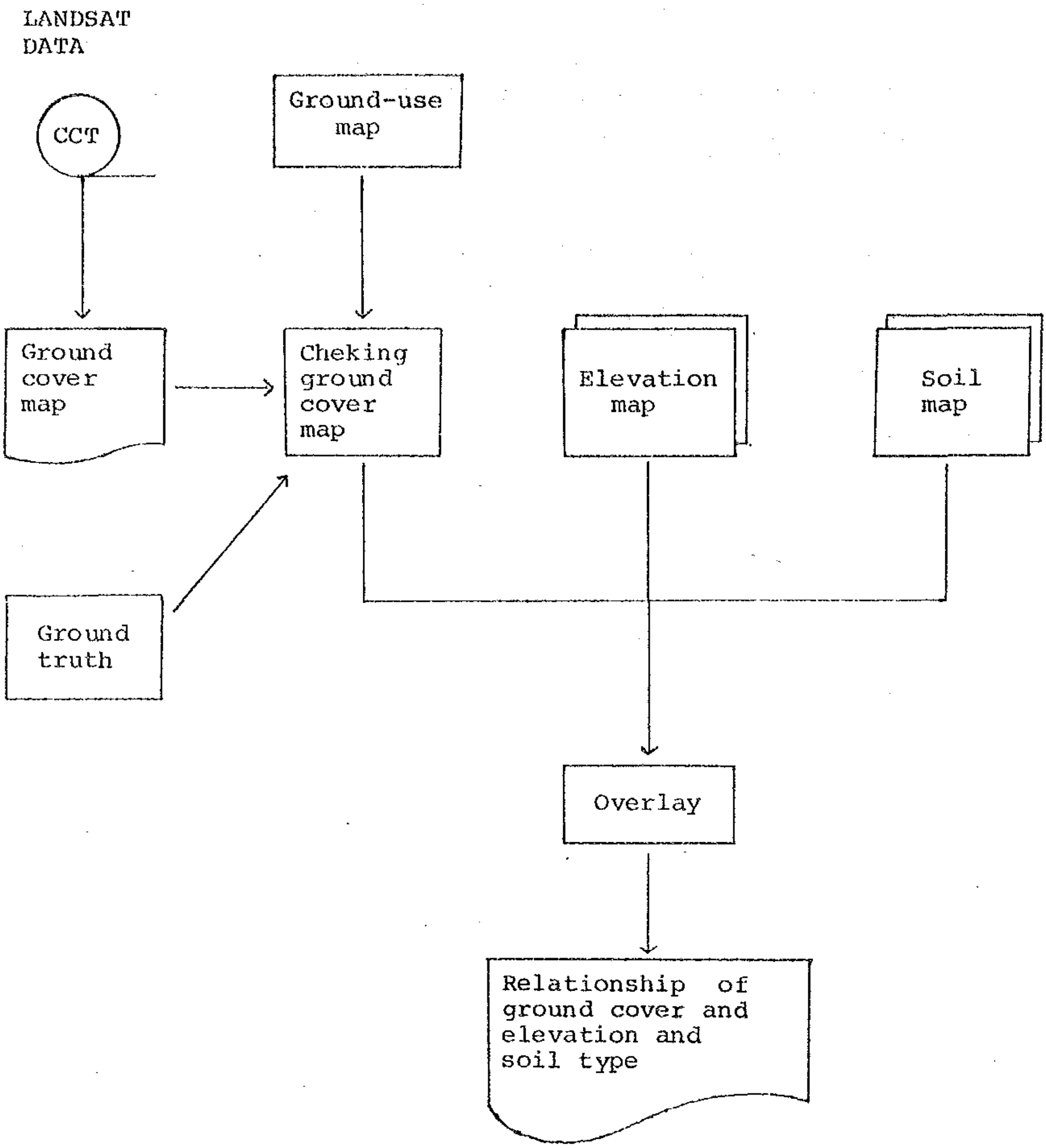
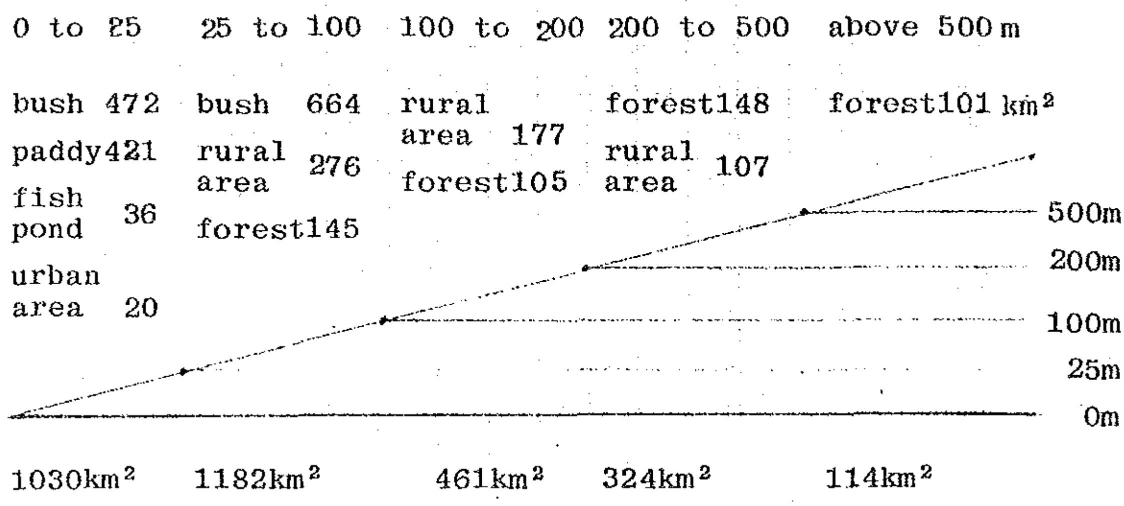


Fig. 1. Flowchart of procedure of this study.



(grass and noise omitted)

Fig. 2 The relationship between elevation and grounuse

Table 1. The relationship between ground cover map made by remote sensing and established Landuse map (all of north Banten area)

	Fish pond swamp	Paddy B	Paddy Y	Paddy Dry	Grass	Bush	Rural area 1	Rural area 2	Forest 1	Forest 2	Urban area 1	Urban area 2	Bare Soil	Noise
Paddy 2 times/yr	2	15	45	137	61	119	9	54	11	20	5	8	0	2
Paddy 1 time /yr	6	12	34	200	70	305	8	29	12	4	1	4	1	0
Mix garden	0	3	21	60	123	555	28	430	111	120	0	0	0	24
Upland form	0	1	5	26	20	132	0	10	5	11	0	1	0	3
Plantation	0	0	2	9	16	104	2	13	25	4	0	0	0	0
Bush	0	1	2	4	5	79	3	14	27	3	0	0	0	0
Forest Homogen	0	0	0	0	2	16	1	11	21	120	0	0	0	7
Forest High density	0	0	0	0	0	0	0	0	3	10	0	0	0	5
Grass	0	0	0	0	0	0	0	0	0	4	0	0	0	0
Swamp	0	0	0	0	0	0	0	8	1	4	0	0	0	0
Fish pond	31	6	1	19	3	4	1	1	0	0	0	1	0	0

(unit : Km2)

Table 2. The relationship between ground cover map made by remote sensing and established Landuse map (only suitable area at north Banten)

	Fish pond swamp	Paddy			Grass	Bush	Rural area		Forest		Urban area		Bare soil	Noise
		B	Y	Dry			1	2	1	2	1	2		
Paddy 2 times/yr	2	11	20	123	34	64	3	21	7	15	3	7	0	1
Paddy 1 time /yr	6	11	23	137	50	133	3	11	5	4	1	3	1	0
Mix garden	0	1	10	51	90	200	16	225	44	94	0	0	0	23
Upland form	0	1	5	22	18	102	0	10	3	10	0	1	0	3
Plantation	0	0	1	8	16	35	0	1	4	1	0	0	0	0
Bush	0	0	0	0	0	1	0	0	3	3	0	0	0	0
Forest Homogen	0	0	0	0	2	1	1	11	21	120	0	0	0	7
Forest High density	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grass	0	0	0	0	0	0	0	0	0	4	0	0	0	0
Swamp	0	0	0	0	0	0	0	8	1	4	0	0	0	0
Fish pond	28	5	1	13	1	3	0	1	0	0	0	1	0	0

(unit : Km^2)

Table 3. The relationship between ground cover and elevation (All of north Banten area)

	Fish pond Swamp	Paddy			Grass	Bush	Rural area		Forest		Urban area		Bare Soil	Noise
		B	Y	Dry			1	2	1	2	1	2		
0 - 25 m	36	28	39	354	102	472	6	58	10	7	6	13	1	0
25 - 100	0	3	29	64	130	664	21	255	108	37	0	1	0	1
100 - 200	0	5	32	19	47	123	21	156	45	60	0	0	0	1
200 - 500	0	2	10	17	20	50	4	93	46	102	0	0	0	21
500 - 700	0	0	0	1	0	4	0	8	6	48	0	0	0	10
700 -1000	0	0	0	0	0	0	0	0	1	31	0	0	0	6
1000 -1500	0	0	0	0	0	0	0	0	0	14	0	0	0	2
> 1500	0	0	0	0	0	0	0	0	0	1	0	0	0	0

(unit : Km^2)

Soil type	Parent Material	Condition	Character	Distribution	Surface Color	PH	Tentative structure	Permea-bility	Fertilizer			
									Org.M.	Base Sm	Nutrient	Comment
Latosol	Volcanic material (Basic medium)	Wet tropical	Deeply weathered strongly leached	all in Indonesia	brown - red	4.5 - 5.5	A fiable consist-ence		Rela-tively low	Rela-tively less	Low	
Andosols	Volcanic ash (basic)	Relatively cool climate high rain-fall		Mountain	black-dark brown	4.5 - 6.0	Medium		Rich	Rich	fairly low	High P2O5 absorb-ance
Red-Yellow Podsolic soils	Volcanic material (acid)	Wet tropical	Highly leached	30% of Ind. mainly East Sumatra, West Java, Kali-mantan	light grey yellowish bluer red yellow	4.2 - 4.8	Relatively heavy blocky low degree of stable aggregation	Low	Low	Less	No good	
Grumusol (vertisol)	Marls Calcareous shales argilaceous limestone old alluvial deposit	Wet tropical to subtropical lowland	Vertisol	Central & East Java, Madura, but small area	Dark grey - black	Neutral - alkaline acid soils also occur	hard (dry) sticky (wet)		Low	rela-tively rich	Rich - low	Suitable paddy use
Grey Hydromor-phic soil		Poorly drained high influence of water	Sunken place at plateau	Association with red - yellow podsolic soils	light	acid	heavy					Only paddy use
Renzine (Calcisols)	Marls limestone	In plateau		Association with calcerous lithosols or ragosols not in Java	dark grey - black	Neutral - Alkaline	Heavy granular (good development)		many	many	good	
Litosol	Limestone uplifted (oval reef)			Central & East Java, Madura, Sumatra etc.								No use for agriculture
Alluvial Soils	Transported material	Transported by river							less		good	

Table 5. The relationship between ground cover and soil type
(All of north Banten area)

	Fish pond Swamp	Paddy			Grass	Bush	Rural		Forest		Urban area		Bare soil	Noise
		B	Y	Dry			1	2	LD	HD	1	2		
Latosol	0	7	43	53	85	203	27	312	91	255	0	0	0	40
Alluvial soil	41	25	20	174	45	316	5	31	13	4	5	8	0	0
Regosol	1	0	4	20	30	32	2	19	2	3	0	0	0	0
Renzina soil	0	0	2	7	32	69	5	58	15	10	0	0	0	1
Podsolic soil	0	5	28	116	80	656	13	137	87	5	0	4	1	0
Grey Hidromorphic soil	0	2	13	83	28	39	1	13	8	14	1	2	0	0
Grumosol	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(unit : Km^2)

Table 6. The relationship between ground cover soil type
(Only suitable area at north Banten)

	Fish pond swamp	Paddy			Grass	Bush	Rural area		Forest		Urban area		Bare Soil	Noise
		B	Y	Dry			1	2	LD	HD	1	2		
Latosol	0	2	13	34	48	144	13	180	63	216	0	0	0	33
Alluvial soil	32	22	14	137	25	74	0	13	0	3	3	6	0	0
Regosol	1	0	2	20	28	26	1	16	2	3	0	0	0	0
Renzina	0	0	2	7	32	69	5	58	15	10	0	0	0	1
Podsolic soil	0	3	17	88	52	197	3	8	0	0	0	4	1	0
Grey Hidromorphic soil	0	2	12	66	26	29	1	13	8	14	1	2	0	0
Grumosol	0	0	0	0	0	0	0	0	0	9	0	0	0	0

(unit : Km^2)

Table 7. The relationship between soil type and elevation (All of north Banten area)

	0-25m	25-100	100-200	200-500	500-700	700-1000	1000-1500	1500
Latosol	53	246	357	337	77	36	10	0
Alluvial Soil	560	113	3	1	0	0	0	0
Regosol	100	11	0	0	0	0	0	0
Renzina	12	80	83	24	0	0	0	0
Podzolic Soil	277	798	57	0	0	0	0	0
Grey Hidromorphic soil	127	65	9	3	0	0	0	0
Grumosol	0	0	0	0	0	2	6	1

農　村　計　画

(Agrarian Forming)

農林水産省北陸農政局
土地改良技術事務所　石　川　　守
(Mamoru ISHIKAWA)

目　　　次

Ⅰ はじめに

インドネシア農業開発リモートセンシングプロジェクトにおいて農業適地選定評価手法の開発とその指導の任期を終了することになりましたので，ここに業務内容を報告いたします。

Ⅱ 指導の課題と概要

指導の課題と概要は以下の通りです。詳細には，報告書を取りまとめたのでそれを参照して下さい。

1　主成分分析手法による解析

主成分分析手法を用いた農業適地の選定評価手法は数学的な解析により，多量のデータを理解しやすくするものであり，今回の開発は北パンランおよびＣＪＬエリアのランドサットデータ並びにマップデータをデータとして解析したものである。

算出結果は現地の実情とマッチするものであり，良い結果が得られた。

2　ＸＹプロッタープログラムの開発

主成分分析により得られた得点を２軸平面上にプロットするプログラムを開発した。

これにより，グループ分け作業の効率が向上した。

3　選定評価の概算式の開発

生データから手計算により得点を計算できる計算式を導出した。

4　農業適地の基準の設定

上記作業の結果，農業適地の持つ各種生データに対する基準が設定できた。

Ⅲ 所　　感

インドネシアリモートセンシング農業適地選定評価手法の開発の任期期間が終了しましたが初期の目的を果すことができました。

今後，当チームに希望したいのは，この手法を用い更に農業適地の選定作業を高度化してもらいたい。このためには，基準データの整備を行う必要があり，特にランドサットデータの解析技術を高め基礎データとして分類整理が必要であると思われる。

最後に，無事任期を終えられたのは，日本側及びインドネシア側関係者の御努力によるものものであり深く感謝いたします。

Ⅳ. Making model to select the suitable area for the development of agricultural infrastructure. Center for Data Processing and Statistics The Ministry of Public Works, I N D O N E S I A.

by Mamoru ISHIKAWA
JICA Expert

(I) P R E F A C E.

I worked at the Remote Sensing Project in Indoensia during one month, and I would like to submit a brief report of my activities at the project.

(II) Outline of Activities.

Outline of my activities are as follow, please refer to the individual report made by me.

1. Analysis by Principal Component Analysis.

   I analyzed a mathematical analysis of North Banten and CJC AREA's Landsat DATA and MAP DATA. The results obtained are very much in agreement with ground truth.

2. Development of XYPLOTTER program.

   I make XYPLOTTER program, this program has the function of drawing component score.

3. Development of the estimated expression.

   I develop estimated expression to select the suitable area for the development of agricultural infrastructure.

4. Making standard of Agricultural suitable land.

   I make standard of suitable area for the development of agricultural infrastructure.

(III) Work Schedule.

Mar. 11, 1983.	------------	Arrival to Jakarta.
Mar. 12, 1983. – Mar. 18, 1983.	------------	Planning.
Mar. 19, 1983. – Mar. 25, 1983.	------------	execution of Principal Component Analysis.
Mar. 6, 1983. – Apr. 1, 1983.	------------	Analusis of calculated values (include execution of XYPLOTTER Program)
Apr. 2, 1983. – Apr. 9, 1983.	------------	Making report.

(IV) Impression.

My work of making model to select the suitable area for the development of agricultural infrastructure of Indonesia remote sensing project is over now. It was progressing with my work in accordance with the present program.

I hope the members of this project will expanded my work. This project need to establise the basis DATA and also need to make up the basis data from LANDSAT DATA.

I say for all the men and women of this project thank you very much for your kindness.

V. Making model to select the suitable area for the development of agricultural infrastructure

- Principal Component Analysis -

Mamoru Ishikawa

JICA Expert of Remote Sensing Project for
Development of Agricultural Infrastructure,
Center for Data Processing and Statistics,
Ministry of Public Works, Indonesia.

(I) INTRODUCTION

Principal Component Analysis is an Analytical Method of Multivariate Technique. Multivariate Analysis were described by F. Galton, K. Pearson, D.A. Fisher, P.C. Mahalanobis, C.R. Rao, C. Spearman and H. Hotalling (top of the 20th century) and have been examined by various authors from different points of view.

This Principal Component Analysis is analyzed a mathematical analysis of a great many DATA. This analysis is very good analysis. Say in other words, this analysis is Reduction of Dimensionality or parsimong of thinking. I used this analysis that making model to select the suitable area for the development of agriculture infrastructure.

In the present report I wish to propose a method which permits me to arrive at a solution of sufficient accuracy by means of a solution obtained through analytical theory.

(II) Using Data and System

1. Area

My work of making model to select the suitable area for the development of agricultural infrastructure have been carried out using the data of the North Banten Training Area.

North Banten Training Area locates in North Western part of Java Island.

It is the toropical zone and a good agricultural region.

The area is 74 Km wide and 70 Km long.

2. Data

Using Data are Landsat Data and Map Data.

These Data are as follows :

1. ALTITUDE
2. BIOMASS
3. SOIL DEPTH
4. GEOLOGY
5. RAINFALL
6. SLOPE
7. LAND COVER

Number of Data's point are 20,720 point that pick up 500m grid cell from this area. ($^{74km}/0.5km$ x $^{70km}/0.5km$)

There are 20,720 points in Landsat Data including sea's Data. It can be considered that there is no effect from sea's Data. So I get rid of sea's Data, it must give me sufficient results. Original Data are classified as following legend, Photo 1 - Photo 7 show these Data image. I need not classified Data but I need actual Data. Therefore I transformed classified Data into actual Data by picking up the medium value of each classified Data.
Conversion are as follows:

Original		Transformation
1)	ALTITUDE	
	1. 0 - 25 m	12.5 m
	2. 25-100 m	62.5 m
	3. 100-200 m	150.0 m
	4. 200-500 m	350.0 m
	5. 500-700 m	600.0 m
	6. 700-1000m	850.0 m
	7. 100-1500m	1250.0 m
	8 1500m	1750.0 m
2)	BIOMASS	
	1. 1 - 2 Kg/M^2	1.0 Kg/M^2
	2. 2 - 6 "	4.0 "
	3. 6 -14 "	10.0 "
	4. 14 -31 "	22.5 "
	5. 31 "	39.5 "

3) SOIL DEPTH

1.	90 cm	105.0 cm
2.	60 - 90 cm	75.0
3.	30 - 60 cm	45.0
4.	30 cm	15.0
5.	Pebble & rock	0.0

4) GEOLOGY

1.	ALLUVIUM	1.
2.	UNDIFFERNTIATED volcanic product	2.
3.	PLIOCENE SEDIMENTARY	3.
4.	MIOCENE SEDIMENTARY	4.
5.	MIOCEWE LIMESTONE	5.
6.	ANDESITE BASALT DIABASE	6.

5) RAIN FALL

1.	Annual Rainfall < 1500 MM/year	750	MM/year
2.	1,500-2,000 MM/year	1750	"
3.	2,000-3,000	2500	"
4.	3,000-4,000	3500	"
5.	> 4,000	4500	"

6) SLOPE

1.	< 2%	1.0%
2.	> 40%	52.5%
3.	2 - 15%	8.0%
4.	15 - 40%	27.5%

7) LAND COVER

1.	SEA WATER	1.
2.	SEA POLUTED	2.
3.	SWAMP/FISHPOND	3.
4.	PADDY ON GROWING PERIOD	4.
5.	PADDY MATURE	5.
6.	DRY FIELD	6.
7.	GRASS	7.
8.	BUSH	8.
9.	RURAL 1	9.
10.	RURAL 2	10.
11.	LOW DENSITY FOREST	11.
12.	HIGH DENSITY FOREST	12.
13.	URBAN 1	13.
14.	URBAN 2	14.
15.	CONCRETE & BARE SOIL	15.
16.	CLOUD & ITS SHADOW	16.

3. Using System

Digital image processing system is consisted of IBM 4341 computer, magnetic taps units, desk memory, line printer, terminal display, XY Plotter and additive color viewer, and so on.

Outline of making model to select the suitable area for the development of agricultural infrastructure procedure is indicated at Flowchart 1.

I explain these concepts of this data analysis according to flow chart as follows :

1) Trimming and drawing data of land

Get rid of sea's Data (20,720 points - 14,076 points) and making sequential file.

2) Data Analysis

Analyzing Data and making output Eigen vector, Factor Roading and Component Score and so on.

3) Construction

Plotting component score of first axis and of second axis by XY Plotter.

4) Classification

Two component axis area is classified in 6 classes.

1st	class	good agricultural
2nd	"	medial agricultural
3rd	"	farm (orchard)
4th	"	farm
5th	"	farm
6th	"	barren land

5) Transformation

Above classified result is transformed to Display File.

(III) Result

1. Result and Discussion

I have a try 4 cases of making model to select the suitable area for development of agricultural infrastructure. Each of the case was tried the process using Eigen Vector Component Score and the process using Factor Roading Component Score.

I carried on the research by basing one's progress on the merits and demetris of the results because I need to select a good Data element.

1) Case 1

I have shown the result of these calculations for output 1 (showing in appendix I). This case have 5 element of ALTITUDE, BIOMASS, SOIL DEPTH, RAIN FALL and SLOPE. Adding up 1st Eigen Value and 2nd Eigen Value of commulative contribution ratio is 56.4%, because I decided that we can classify all Data point by 1st axis and 2nd axis. I examined thoroughly about Eigen Vector and Factor Roading and the conclusion is that the physical meaning of the 1st axis is considered to be suited agriculture and the physical meaning of the 2nd axis is considered to be suited ALTITUDE and BIOMASS.

a. Eigen Vector Component Score

Figure 1 shows the result of these calculations which was arranged in the way XY Plotter program.

I get 6 classes by this Figure. The results which were obtained in the way described above are shown in Table 1.

Table 1

	$Z1$	Z_2
good agricultural	$Z \leqq -0.5$	-
medial agricultural	$-0.5 < Z_1 \leq 1.5$	$-1.0 < Z_2$
farm (orchard)	$-0.5 < Z_1 \leq 1.5$	$Z_2 < -1.0$
farm	$1.5 < Z_1$	$-1.0 < Z_2$
forestry	$1.5 < Z_1$	$-3.2 < Z_2 < -1.0$
barren land	$1.5 < Z_1$	$Z_2 < -3.2$

Photo 8 shows display image of these data and I can say this plot means agrarian farming image.

We can use this photo, to select the suitable area for the development of agricultural infrastructure in future.

b. Factor Roading

Process of Factor Roading is same as (a) and result is shown in Figure 2 and Photo 9.

Table 2

	Z_1	Z_2
good agricultural	$Z_1 < -1.2$	-
medial agricultural	$-1.2 \leq Z_1 \leq 1.2$	$-1.2 \lesssim Z_2$
farm (orchard)	$-1.2 < Z_1 \leq 1.2$	$Z_2 < -1.2$
farm	$1.2 < Z_1$	$-1.6 \lesssim Z_2$
forestry	$1.2 < Z_1 < 4.8$	$Z_2 < -1.6$
barren land	$4.8 \leq Z_1$	$Z_2 \lesssim -1.6$

2) Case 2 (Adding Geology Element)

Case 2 is processed same as Case 1 but adding geology element and second commulative contribution is calculated as 51.6% from output 2.
The results are shown in Fig. 3 - Fig. 4 and Photo 10 - Photo 11.

a. Eigen Vector

Table 3

	Z_1	Z_2
good agricultural	$Z_1 \leq -1.0$	-
medial agricultural	$-1.0 < Z_1 \leq 0.3$	-
farm (orchard)	$0.3 < Z_1 \leq 2.00$	$-0.5 \leq Z_2$
farm	$2.00 < Z_1$	$-2.3 \leq Z_2$
forestry	$0.3 < Z_1 \leq 2.00$	$-0.5 > Z_2$
barren land	$2.00 < Z_1$	$-2.3 \geq Z_2$

b. Factor Roading

Table 4

	Z_1	Z_2
good agricultural	$Z_1 < -1.5$	-
medial agricultural	$-1.5 < Z_1 < 0.0$	-
farm (orchard)	$0.0 < Z_1 < 2.50$	$-1.2 < Z_2$
farm	$2.5 < Z_1$	$-2.00 < Z_2$
forestry	$0.0 < Z_1 < 2.5$	$-1.2 > Z_1$
barren land	$2.5 < Z_1$	$-2.00 \geq Z_2$

3) Case 3 (Adding Land cover element)

Case 3 is processed same as Case 1 but adding Land cover element.

Second commulative contribution is calculated as 53.6% from the output 3, but the 2nd axis means only ALTITUDE.

The results are shown in Fig. 5 - Fig. 6 and Photo 12 - Photo 13.

a. Eigen Vector

Table 5

	Z_1	Z_2
good agricultural	$Z_1 < -1$	-
medial agricultural	$-1.0 < Z_1 < 2.0$	$1.00 \geq Z_2$
farm (orchard)	$-1.0 < Z_1 < 2.0$	$Z_2 > 1.0$
farm	$2.0 < Z_1$	$Z_2 \leq 1.0$
forestry	$2.0 < Z_1$	$1.0 < Z_2 \leq 2.3$
barren land	$2.0 < Z_1$	$2.3 < Z_2$

b. Factor Roading

Table 6

	Z_1	Z_2
good agricultural	$Z_1 < -1.00$	-
medial agricultural	$-1.00 \leq Z_1 \leq 1.60$	$Z_2 \leq 1.8$
farm (orchard)	$-1.00 \leq Z_1 \leq 1.60$	$1.8 < Z_2$
farm	$1.60 < Z_1$	$Z_2 \leq 1.8$
forestry	$1.60 < Z_1 \leq 4.5$	$1.80 < Z_2$
barren land	$4.5 < Z_1$	$1.80 < Z_2$

4) Case 4 (Add Land cover and Geology)

Case 4 is processed same as Case 1 but adding Land cover and Geology element, and second commulative contribution is calculated as 53.6% from the output 4.

The results are shown in Fig. 7 - Fig. 8 and Photo 14 - Photo 15.

a. Eigen Vector

Table 7

	Z_1	Z_2
good agricultural	$Z_1 \leq -1.5$	-
medial agricultural	$-1.5 < Z_1 \leq 1.2$	$Z_2 \leq 1.1$
farm (orchard)	$-1.5 < Z_1 \leq 1.2$	$1.0 < Z_2$
farm	$1.2 < Z_1$	$Z_2 \leq 1.1$
forestry	$1.2 < Z_1$	$1.1 < Z_2 \leq 5.4$
barren land	$1.2 < Z_1$	$5.4 < Z_2$

b. Factor Roading

Table 8

	Z_1	Z_2
good agricultural	$Z_1 \leq -1.30$	-
medial agricultural	$-1.30 < Z_1 \leq 1.20$	$Z_2 \leq 1.5$
farm (orchard)	$-1.30 < Z_1 \leq 1.20$	$1.5 < Z_2$
farm	$1.20 < Z_1$	$Z_2 < 1.5$
forestry	$1.20 < Z_1$	$1.5 \leq Z_2 < 6.00$
barren land	$1.20 < Z_1$	$6.00 < Z_2$

11

From the facts described above, I may conclude that Case 1 - Factor Roading and Case 4 - Factor Roading are in approximate agreement with the present situation. As a matter of course, these results coincide with each other. North Banten Training Area is excellent agricultural area.
As a matter of interesting fact we can find potential area for development of agricultural infrastructure comparison between Photo 7 and Photo 9. This area located in the north-east part of North Banten area.

2. Development of the estimated expression

I developed estimated expression to select the suitable area for the Development of agriculture infrastructure. This estimated expression can be used for classification in another area by us. Of course another area should be agriculture zone some as North Banten Training Area. Estimated expression is given as follows :

a. Case 1 - Factor Roading

1st axis component score is given by following expression

$Z_1 = 0.004.X_1 + 0.029.X_2 - 0.021\ X_3 + 0.007.X_4 + 0.030.X_5 - 1.387$

2nd axis component score

$Z_2 = -0.003.X_1 + 0.053.X_2 + 0.006.X_3 + 0.0001.X_4 + 0.001.X_5 - 1.535$

X_1 = ALTITUDE X_4 = RAIN FALL
X_2 = BIOMASS X_5 = SLOPE
X_3 = SOIL DEPTH

Score Class	Z_1	Z_2
good agricultural	$Z_1 < -1.2$	-
medial agricultural	$-1.2 < Z_1 \leq 1.2$	$-1.2 \leq Z_2$
farm (orchard)	$1.2 < Z_1 \leq 1.2$	$Z_2 < -1.2$
farm	$1.2 < Z_1$	$-1.6 \leq Z_2$
forestry	$1.2 < Z_1 < 4.8$	$Z_2 < -1.6$
barren land	$4.8 \leq Z_1$	$Z_2 \leq -1.6$

b. Case 4 - Factor Roading

1st axis component score

$$Z_1 = 0.003.X_1 + 0.033.X_2 - 0.019.X_3 + 0.656.X_4 + 0.0007.X_5 + 0.055.X_7 - 3.272.$$

2nd axis component score

$$Z_2 = 0.004.X_1 - 0.026.X_2 - 0.008.X_3 - 0.294.X_4 + 0.0001.X_5 + 0.001.X_6 - 0247.X_7 + 2.954.$$

X_1 = ALTITTUDE

X_2 = BIOMASS

X_3 = SOIL DEPTH

X_4 = GEOLOGY

X_5 = RAINFALL

X_6 = SLOPE

X_7 = LAND COVER

Classes : refer to Table 8.

3. Making Standard

I get standard of good agricultural land and medial agricultural land. I try making standard of these two classes only because these classes are very important. Standard of Farm land are very complexity. If we want to make standard of Farm, we need to increase elements much more.

I decided standard as follows :

a. Case - 1 - Factor Roading

Table 10

	ALTITUDE	BIOMASS	SOIL DEPTH	RAINFALL	SLOPE
good Agricultural	0.0 ¦ 62.5	0 ¦ 22.5	more than 150	750 ¦ 2500	0.0 ¦ 8.50
Agricultural	12.3 ¦ 150.0	22.5 ¦ 39.5	15.0 ¦ 105.0	750 ¦ 2500	8.50 ¦ 27.5
	(m)	(Kg/M2)	(cm)	(mm/year)	(%)

b. Case 4 - Factor Roading

Table 11

	ALTITUDE	BIOMASS	SOIL DEPTH	GEOLOGY	RAIN-FALL	SLOPE	LAND COVER
good Agricultural	0 ¦ 62.5	0 ¦ 22.5	more than 150	1 ¦ 2	750 ¦ 2500	1.0 ¦ 8.5	5.0 ¦ 8.0
Agricultural	12.5 ¦ 150.0	0 ¦ 39.5	75.0 ¦ 105.0	2 ¦ 3	750 ¦ 2500	0.0 ¦ 27.5	7.0 ¦ 10.0
	(m)	(Kg/M2)	(cm)		(mm/year)	(%)	

14

(IV) Expansion

The results of my work obtained is almost agreed with my expectation.

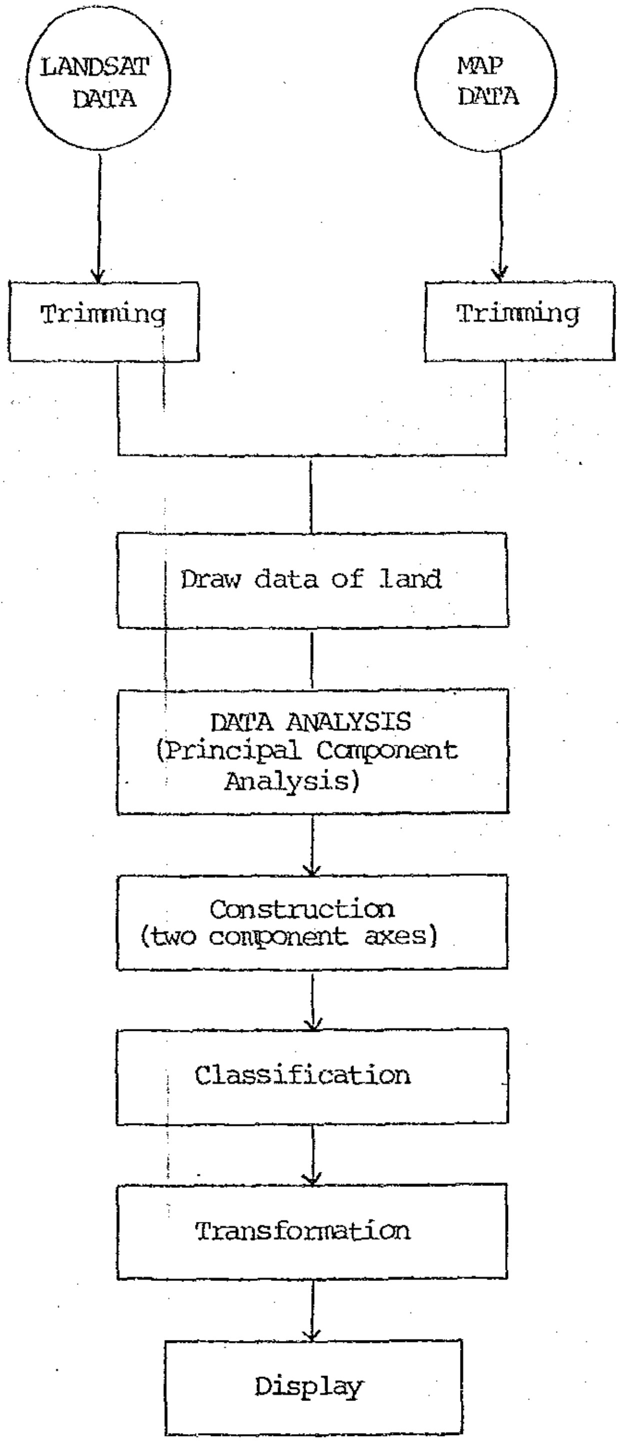
This project should expand this work.

We shall need precise data by actual measurements including LANDSAT Data in order to obtain a satisfactory result.

(V) Acknowledgement

We would like to express our greatful thanks to all the members of Remote Seasing Project of Indonesia who suggest and extended us. We would like to express our thanks especially Ir. Tubagus Haedar Ali and Drs. Suroso for special encouragement to the work.

At last, but at the most, we are grateful to Professor T. NAKAGAWA and Mr. S. Sakai and Mr. H. Yamamoto and Mr. K. Mima for support and encouragement and development software and hardware.



Flowchart 1

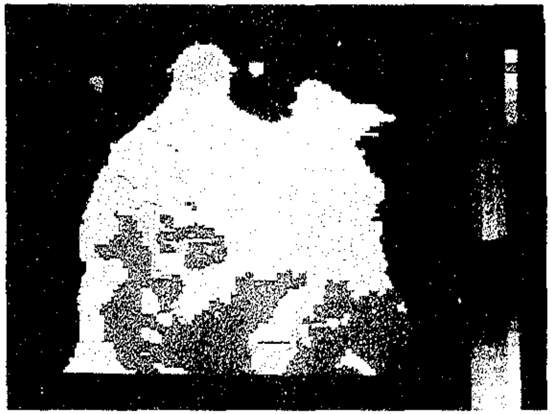
Flow chart of making model to select the suitable area for the development of agricultural infrastructure procedure.

17

LEGEND :

1. 0 - 25 m
2. 25 - 100 m
3. 100 - 200 m
4. 200 - 500 m
5. 500 - 700 m
6. 700 -1000 m
7. 1000 -1500 m
8. 1500 m

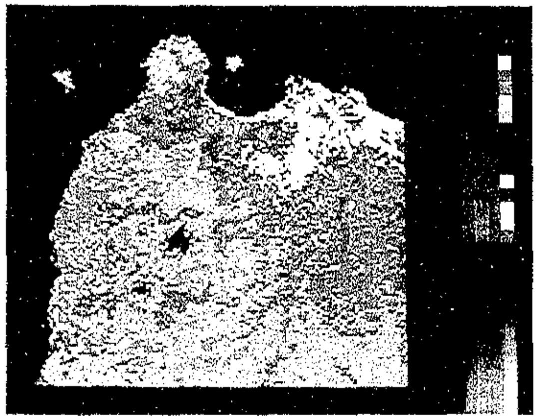
Photo 1. ALTITUDE



LEGEND :

1. 90 cm
2. 60 - 90 cm
3. 30 - 60 cm
4. 30 cm
5. Pebble & Rock

Photo 3. SOIL DEPTH



LEGEND :

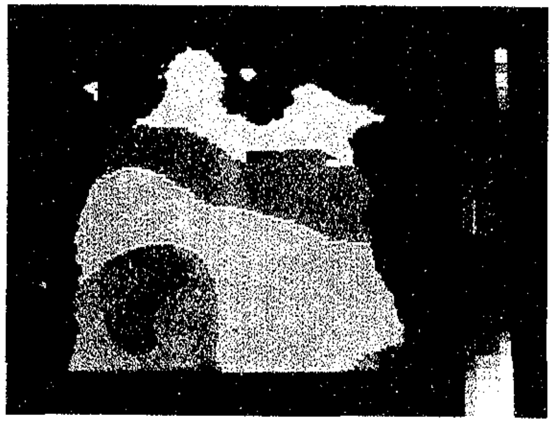
1. 1 - 2 Kg/M^2
2. 2 - 6 Kg/M^2
3. 6 -IX Kg/M^2
4. 14 -31 Kg/M^2
5. 31 Kg/M^2

Photo 2. BIOMASS

LEGEND :

1. ALLUVIUM
2. UNDIFFERENTIATED VOLCANIC PRODUCT
3. PLIOCENE SEDIMENTARY
4. MIOCENE SEDIMENTARY
5. MIOCENE SEDIMENTARY
6. ANDESITE BA SALT DIABASE

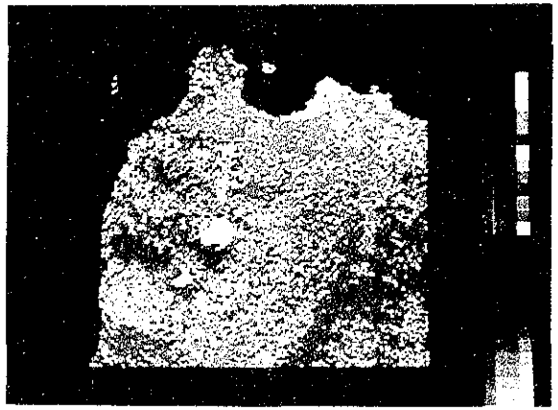
Photo 4. GEOLOGY



LEGEND :

1. ANNUAL RAINFALL
   1500 MM/Year
2. 1500 - 2000 MM/Year
3. 2000 - 3000 MM/Year
4. 3000 - 4000 MM/Year
5. 4000 MM/Year

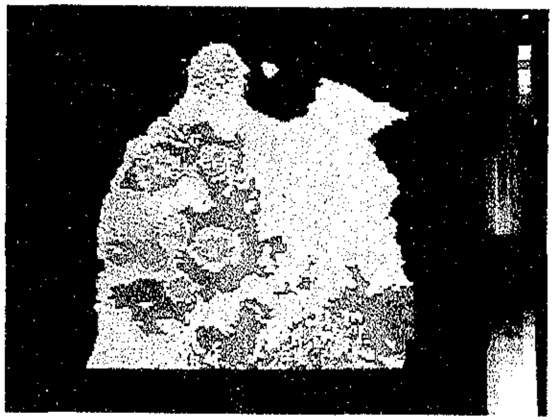
Photo 5. RAIN FALL



LEGENG :

1. Sea Water
2. Sea poluted
3. Swamp/Fishpond
4. Paddy B.
5. Paddy Y.
6. Dry field
7. Grass
8. Bush
9. Rural 1
10. Rural 2
11. Low den. Forest
12. High den. Forest
13. Urban 1
14. Urban 2
15. Concrete & Baresoil
16. Cloud & its shaddow

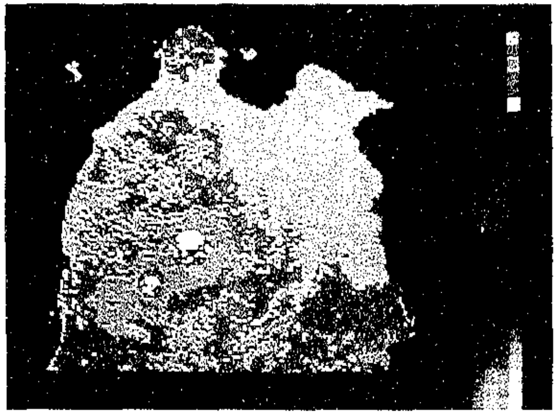
Photo 7. LAND COVER



LEGEND :

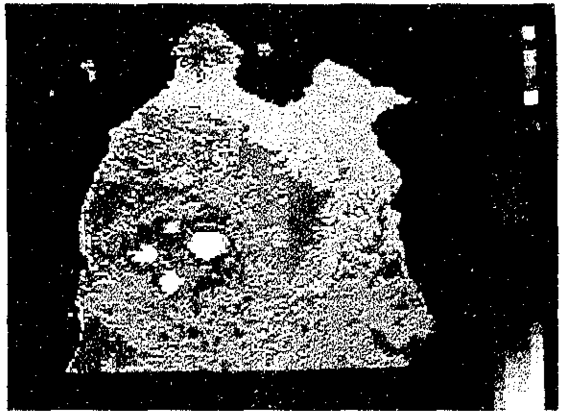
1. 2%
2. 40%
3. 2-15%
4. 15-40%

Photo 6. SLOPE



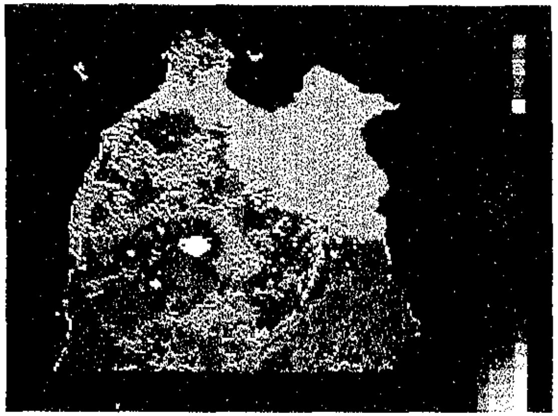
1st class good Agricultural
2nd " Agricultural
3rd " farm (orchard)
4th " farm
5th " forestry
6th " barren land

Photo 8. 5 ELEMENT (EIGEN)



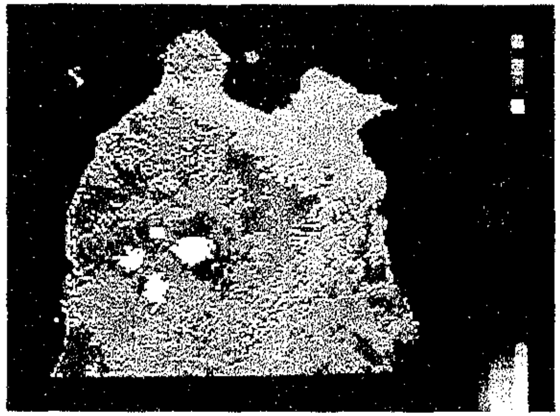
1st class good Agricultural
2nd " Agricultural
3rd " farm (orchard)
4th " farm
5th " forestry
6th " barren land

Photo 10. 6 ELEMENT (EIGEN & GEOLOGY)



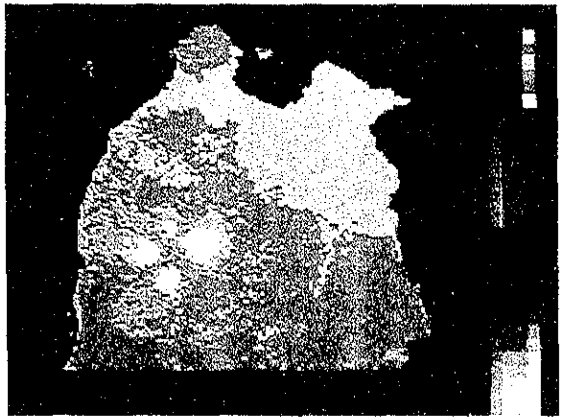
1st class good Agricultural
2nd " Agricultural
3rd " farm (orchard)
4th " farm
5th " forestry
6th " barren land

Photo 9. 5 ELEMENT (ROADING)



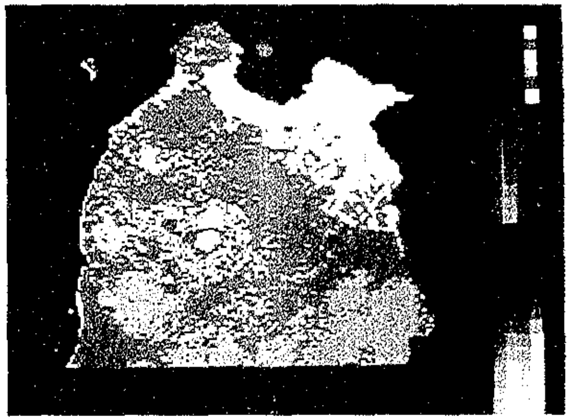
1st class good Argicultural
2nd " Agricultural
3rd " farm (orchard)
4th " farm
5th " forestry
6th " forestry

Photo 11. 6 ELEMENT (ROADING) (GEOLOGY)



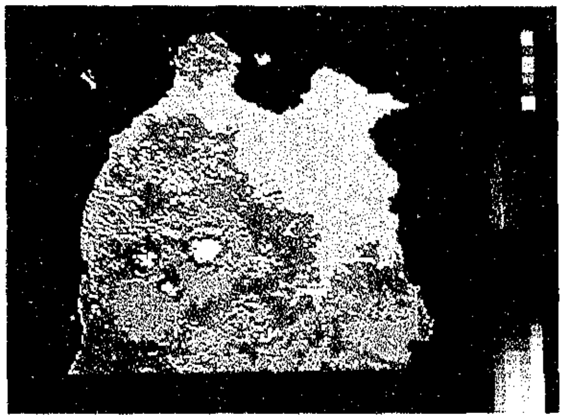
1st class good Agriculrural
2nd " Agricultural
3rd " farm (orchard)
4th " farm
5th " forestry
6th " barren land

Photo 12. 6 ELEMENT (EIGEN)
(+ LAND COVER)



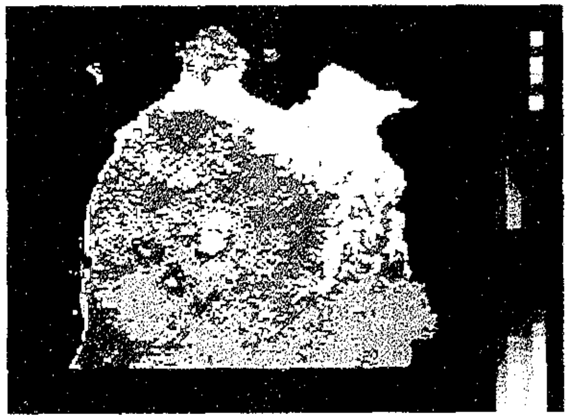
1st class good Agricultural
2nd " Agricultural
3rd " farm (orchard)
4th " farm
5th " forestry
6th " barren land

Photo 14. 7 ELEMENT (EIGEN)



1st class good Agricultural
2nd " Agricultural
3rd " farm (orchard)
4th " farm
5th " forestry
6th " barren land

Photo 13. 6 ELEMENT (ROADING)
(+ LAND COVER)



1st class good Agricultural
2nd ", Agricultural
3rd " farm (orchard)
4th " farm
5th " forestry
6th " barren land

Photo 15. 7 ELEMENT (ROADING)

F1 REMOTE

Output 1

****

PRINCIPAL COMPONENT ANALYSIS

****

0 ..... 1234567890123456789012345678901234567890123456789012345678901234 .....

0***** INPUT DATA

DATA NO.	ALTITUD	BIOMASS	SOILDEP	RAINFAL	SLOPE %
1	12.50	39.50	15.00	750.00	1.00
2	12.50	39.50	15.00	750.00	8.50
3	12.50	22.50	15.00	750.00	1.00
4	12.50	22.50	15.00	0.0	1.00
5	12.50	22.50	15.00	0.0	1.00
6	12.50	39.50	15.00	0.0	1.00
7	12.50	39.50	15.00	0.0	1.00
8	12.50	22.50	45.00	0.0	1.00
9	12.50	22.50	45.00	0.0	1.00
10	12.50	39.50	15.00	750.00	8.50
11	52.50	77.50	15.00	750.00	8.50
12	12.50	22.50	15.00	750.00	1.00
13	12.50	39.50	15.00	750.00	27.50
14	12.50	22.50	15.00	750.00	1.00
15	62.50	22.50	15.00	750.00	1.00
16	12.50	22.50	15.00	750.00	1.00
17	12.50	22.50	45.00	750.00	1.00
18	12.50	39.50	45.00	750.00	1.00
17	62.50	22.50	15.00	750.00	52.50
20	12.50	22.50	45.00	750.00	1.00
21	12.50	22.50	45.00	750.00	1.00
22	150.00	39.50	15.00	750.00	27.50
23	52.50	22.50	15.00	750.00	27.50
24	12.50	39.50	15.00	750.00	1.00
25	62.50	39.50	15.00	750.00	27.50
26	12.50	39.50	15.00	750.00	1.00
27	62.50	39.50	15.00	750.00	27.50
28	12.50	22.50	15.00	750.00	8.50
29	12.50	39.50	15.00	750.00	1.00
30	12.50	39.50	15.00	750.00	52.50
31	12.50	39.50	45.00	750.00	1.00
32	12.50	22.50	15.00	750.00	1.00
33	62.50	22.50	15.00	750.00	52.50
34	12.50	22.50	15.00	750.00	8.50
35	12.50	22.50	45.00	750.00	1.00
36	150.00	39.50	15.00	750.00	1.00
37	22.50	22.50	15.00	750.00	27.50
33	150.00	22.50	15.00	750.00	27.50
39	62.50	39.50	15.00	750.00	27.50
40	62.50	39.50	15.00	750.00	1.00
41	12.50	39.50	15.00	750.00	27.50

PRINCPL T-I VA/SP REL-1.1

	14067	62.50	39.50	105.00	3500.00	52.50
	14068	62.50	39.50	105.00	3500.00	52.50
	14069	150.00	22.50	105.00	3500.00	52.50
	14070	150.00	39.50	105.00	3500.00	52.50
	14071	150.00	39.50	105.00	3500.00	8.50
	14072	150.00	39.50	75.00	3500.00	8.50
	14073	150.00	39.50	75.00	3500.00	8.50
	14074	150.00	39.50	75.00	3500.00	8.50
	14075	150.00	39.50	75.00	3500.00	8.50
	14076	150.00	39.50	75.00	3500.00	8.50
0	TOTAL	1615725.000	297705.000	1256385.000	32338500.000	263732.500
0	MEAN	114.857	21.150	89.257	2297.421	18.736
0	ST.DEV.	157.725	15.260	24.342	991.777	22.488
0	C.V.	1.460	0.722	0.273	0.432	1.200

1

***** CORRELATION MATRIX

		ALTITUD 1	BIOMASS 2	SOILDEP 3	RAINFAL 4	SLOPE % 5
0 ALTITUD	1	1.000	-0.013	-0.230	0.316	0.254
0 BIOMASS	2	-0.013	1.000	-0.144	0.237	0.181
0 SOILDEP	3	-0.230	-0.144	1.000	-0.091	-0.192
0 RAINFAL	4	0.316	0.237	-0.091	1.000	0.311
0 SLOPE %	5	0.254	0.181	-0.192	0.311	1.000

***** VARIANCE CO-VARIANCE MATRIX

		ALTITUD 1	BIOMASS 2	SOILDEP 3	RAINFAL 4	SLOPE % 5
0 ALTITUD	1	0.281D+05	-0.462D+02	-0.938D+03	0.525D+05	0.959D+03
0 BIOMASS	2	-0.462D+02	0.233D+03	-0.535D+02	0.359D+04	0.620D+02
0 SOILDEP	3	-0.938D+03	-0.535D+02	0.593D+03	-0.221D+04	-0.105D+03
0 RAINFAL	4	0.525D+05	0.359D+04	-0.221D+04	0.984D+06	0.693D+04
0 SLOPE %	5	0.959D+03	0.620D+02	-0.105D+03	0.693D+04	0.506D+03

1

***** ORIGINAL MATRIX FOR P.C.A IS CORRELATION MATRIX . *****

0***** VARIABLE SELECTION

ALTITU, - BIOMASS - SOILDEP - RAINFAL - SLOPE %

0***** DIAGONAL MATRIX (CHECK MATRIX FOR EIGEN VALUE)

		1	2	3	4	5
0	1	0.551D+00	-0.232D-07	0.124D-09	0.545D-11	0.435D-08
0	2	-0.232D-07	0.102D+01	0.0	0.834D-11	-0.609D-09
0	3	0.124D-09	0.0	0.916D+00	0.183D-08	-0.193D-11
0	4	0.545D-11	0.834D-11	0.183D-08	0.180D+01	0.0
0	5	0.435D-08	-0.609D-09	-0.193D-11	0.0	0.711D+00

1

***** EIGEN VALUE AND ITS CONTRIBUTION

	EIGEN VALUE	CONTRIBUTION RATIO	CUMULATIVE CONTRIBUTION
1	1.803	0.36051	0.36051
2	1.021	0.20411	0.56462
3	0.916	0.18316	0.74778
4	0.711	0.14211	0.88989
5	0.551	0.11011	1.00000

0***** EIGEN VECTOR

COMP.NO.	1	2	3	4	5
0 ALTITUD 1	0.467	-0.573	0.111	-0.327	0.578
0 BIOMASS 2	0.326	0.799	-0.144	-0.233	0.425
0 SOILDEP 3	-0.375	0.151	0.847	0.082	0.336
0 RAINFAL 4	0.521	0.100	0.486	-0.337	-0.607
0 SLOPE % 5	0.513	0.023	0.115	0.848	0.066

1

***** FACTOR ROADING

COMP.NO.	1	2	3	4	5
0 ALTITUD 1	0.628	-0.579	0.106	-0.276	0.429
0 BIOMASS 2	0.438	0.807	-0.138	-0.196	0.315
0 SOILDEP 3	-0.503	0.153	0.810	0.069	0.249
0 RAINFAL 4	0.700	0.101	0.465	-0.284	-0.450
0 SLOPE % 5	0.689	0.024	0.110	0.715	0.049

0***** CUMULATIVE CONTRIBUTION OF K-COMPONENTS TO ORIGINAL VARIABLE

COMP.NO.	1	2	3	4	5
0 ALTITUD 1	0.394	0.729	0.740	0.816	1.000
0 BIOMASS 2	0.192	0.843	0.862	0.901	1.000
0 SOILDEP 3	0.253	0.276	0.933	0.938	1.000
0 RAINFAL 4	0.490	0.503	0.717	0.797	1.000
0 SLOPE % 5	0.474	0.475	0.487	0.998	1.000

1

***** COEFFICIENT OF ORIGINAL VARIABLE FOR COMPONENT SCORE

COMP.NO.	1	2	3	4	5
0 ALTITUD 1	0.003	-0.033	0.001	-0.002	0.003
0 BIOMASS 2	0.021	0.032	-0.009	-0.015	0.028
0 SOILDEP 3	-0.015	0.006	0.035	0.003	0.014
0 RAINFAL 4	0.001	0.000	0.000	-0.000	-0.001
0 SLOPE % 5	0.023	0.001	0.005	0.038	0.003
0CORRECTION CONSTANT					
	-1.035	-1.519	-4.203	0.321	-0.866

1

***** COMPONENT SCORE

COMP.NO. / DATA.NO.	1	2	3	4	5
1	0.03	0.68	-3.67	-0.47	0.03
2	0.20	0.68	-3.64	-0.19	0.05
3	-0.33	-0.21	-3.51	-0.21	-0.45
4	-0.73	-0.29	-3.88	0.04	0.01
5	-0.73	-0.29	-3.88	0.04	0.01
6	-0.36	0.60	-4.04	-0.22	0.49
7	-0.36	0.60	-4.04	-0.22	0.49
8	-1.19	-0.10	-2.84	0.14	0.43
9	-1.19	-0.10	-2.84	0.14	0.43
10	0.20	0.68	-3.64	-0.19	0.05
11	-0.02	-0.39	-3.44	-0.03	-0.25
12	-0.33	-0.21	-3.51	-0.21	-0.45
13	0.64	0.70	-3.54	0.53	0.10
14	-0.33	-0.21	-3.51	-0.21	-0.45
15	-0.19	-0.39	-3.48	-0.31	-0.27
16	-0.33	-0.21	-3.51	-0.21	-0.45
17	-0.79	-0.03	-2.47	-0.11	-0.03
18	-0.43	0.86	-2.63	-0.37	0.44
19	0.98	-0.33	-3.22	1.63	-0.12
20	-0.79	-0.03	-2.47	-0.11	-0.03
21	-0.79	-0.03	-2.47	-0.11	-0.03
22	1.02	0.23	-3.45	0.26	0.58
23	0.41	-0.36	-3.34	0.69	-0.20
24	0.03	0.58	-3.67	-0.47	0.03
25	0.78	0.53	-3.51	0.43	0.28
26	0.05	0.68	-3.57	-0.47	0.03
27	0.76	0.53	-3.51	0.43	0.28
28	-0.16	-0.21	-3.47	0.07	-0.42
29	0.03	0.68	-3.67	-0.47	0.03
30	1.21	0.73	-3.41	1.47	0.18
31	-0.43	0.86	-2.63	-0.37	0.44
32	-0.33	-0.21	-3.51	-0.21	-0.45
33	0.98	-0.33	-3.22	1.63	-0.12
34	-0.16	-0.21	-3.47	0.07	-0.42
35	-0.79	-0.03	-2.47	-0.11	-0.03
36	0.42	0.21	-3.58	-0.74	0.50
37	0.41	-0.36	-3.34	0.69	-0.20
38	0.66	-0.65	-3.29	0.52	0.11
39	0.78	0.53	-3.51	0.43	0.28
40	0.17	0.50	-3.64	-0.57	0.20
41	0.64	0.70	-3.54	0.53	0.10
42	-0.19	-0.39	-3.48	-0.31	-0.27
43	0.03	0.68	-3.67	-0.47	0.03
44	1.21	0.73	-3.41	1.47	0.18
45	-0.79	-0.03	-2.47	-0.11	-0.03
46	-0.79	-0.03	-2.47	-0.11	-0.03
47	0.03	0.69	-3.67	-0.47	0.03
48	0.34	0.51	-3.60	-0.29	0.22

14074	1.11	0.86	-0.11	-1.19	-0.33
14075	1.11	0.86	-0.11	-1.19	-0.33
14076	1.11	0.86	-0.11	-1.19	-0.33

0EIGEN VALUE(VARIANCE)

1.80	1.02	0.92	0.71	0.55

1

***** COEFFICIENT OF OV FACTOR ROADING FOR COMPONENT SCORE

COMP.NO.	1	2	3	4	5
0 ALTITUD 1	0.004	-0.003	0.001	-0.002	0.003
0 BIOMASS 2	0.029	0.053	-0.009	-0.013	0.021
0 SOILDEP 3	-0.021	0.006	0.033	0.003	0.010
0 RAINFAL 4	0.001	0.000	0.000	-0.000	-0.000
0 SLOPE % 5	0.031	0.001	0.005	0.032	0.002
0CORRECTION CONSTANT					
	-2.420	-3.054	-8.225	0.592	-1.509

1

***** COMPONENT SCORE

COMP.NO. / DATA NO.	1	2	3	4	5
1	0.04	0.68	-3.52	-0.40	0.02
2	0.27	0.69	-3.48	-0.16	0.04
3	-0.44	-0.22	-3.36	-0.18	-0.33
4	-0.97	-0.29	-3.71	0.03	0.01
5	-0.97	-0.29	-3.71	0.03	0.01
6	-0.49	0.61	-3.87	-0.18	0.36
7	-0.49	0.61	-3.87	-0.18	0.36
8	-1.59	-0.10	-2.72	0.12	0.32
9	-1.59	-0.10	-2.72	0.12	0.32
10	0.27	0.69	-3.48	-0.16	0.04
11	-0.03	-0.38	-3.29	-0.02	-0.19
12	-0.44	-0.22	-3.36	-0.18	-0.33
13	0.85	0.71	-3.39	0.44	0.08
14	-0.44	-0.22	-3.36	-0.18	-0.33
15	-0.26	-0.39	-3.33	-0.26	-0.20
16	-0.44	-0.22	-3.36	-0.18	-0.33
17	-1.06	-0.03	-2.36	-0.10	-0.02
18	-0.58	0.87	-2.52	-0.31	0.33
19	1.32	-0.33	-3.08	1.37	-0.09
20	-1.06	-0.03	-2.36	-0.10	-0.02
21	-1.06	-0.03	-2.36	-0.10	-0.02
22	1.37	0.24	-3.30	0.22	0.43
23	0.55	-0.36	-3.20	0.58	-0.15
24	0.04	0.68	-3.52	-0.40	0.02
25	1.04	0.54	-3.35	0.36	0.21
26	0.04	0.68	-3.52	-0.40	0.02
27	1.04	0.54	-3.35	0.36	0.21
28	-0.22	-0.21	-3.33	0.06	-0.31
29	0.04	0.68	-3.52	-0.40	0.02

+

14055	0.23	-1.30	-0.12	0.39	-0.57
14056	-0.10	-1.00	-0.18	0.54	-0.79
14057	0.45	1.07	-0.63	-0.57	-0.02
14058	0.78	0.77	-0.57	-0.72	0.21
14059	0.67	-0.97	-0.06	1.33	-0.74
14060	1.00	-1.27	-0.00	1.19	-0.51
14061	0.78	0.77	-0.57	-0.72	0.21
14062	1.49	0.87	-0.10	-1.00	-0.25
14063	1.49	0.87	-0.10	-1.00	-0.25
14064	0.35	-1.22	0.25	-0.50	-1.06
14065	0.35	-1.22	0.25	-0.50	-1.06
14066	2.51	1.22	0.06	0.54	-0.37
14067	1.89	1.41	1.05	0.62	-0.07
14068	1.89	1.41	1.05	0.62	-0.07
14069	1.73	0.21	1.26	0.70	-0.19
14070	2.22	1.11	1.11	0.48	0.16
14071	0.87	1.06	0.89	-0.92	0.06
14072	1.49	0.87	-0.10	-1.00	-0.25
14073	1.49	0.87	-0.10	-1.00	-0.25
14074	1.49	0.87	-0.10	-1.00	-0.25
14075	1.49	0.87	-0.10	-1.00	-0.25
14076	1.49	0.87	-0.10	-1.00	-0.25

Output 2

****

PRINCIPAL COMPONENT ANALYSIS

****

0

..... 1234567890123456789012345678901234567890123456789012345678901234 .....

0***** INPUT DATA

DATA NO.	ALTITUD	BIOMASS	SOILDEP	GEOLOGY	RAINFAL	SLOPE %
1	12.50	39.50	15.00	1.00	750.00	1.00
2	12.50	39.50	15.00	1.00	750.00	8.50
3	12.50	22.50	15.00	1.00	750.00	1.00
4	12.50	22.50	15.00	1.00	0.0	1.00
5	12.50	22.50	15.00	1.00	0.0	1.00
6	12.50	39.50	15.00	1.00	0.0	1.00
7	12.50	39.50	15.00	1.00	0.0	1.00
8	12.50	22.50	45.00	1.00	0.0	1.00
9	12.50	22.50	45.00	1.00	0.0	1.00
10	12.50	39.50	15.00	1.00	750.00	8.50
11	62.50	22.50	15.00	2.00	750.00	8.50
12	12.50	22.50	15.00	2.00	750.00	1.00
13	12.50	39.50	15.00	1.00	750.00	27.50
14	12.50	22.50	15.00	1.00	750.00	1.00
15	62.50	22.50	15.00	1.00	750.00	1.00
16	12.50	22.50	15.00	1.00	750.00	1.00
17	12.50	22.50	45.00	1.00	750.00	1.00
18	12.50	39.50	45.00	1.00	750.00	1.00
19	62.50	22.50	15.00	1.00	750.00	52.50
20	12.50	22.50	45.00	2.00	750.00	1.00
21	12.50	22.50	45.00	1.00	750.00	1.00
22	150.00	39.50	15.00	2.00	750.00	27.50
23	62.50	22.50	15.00	2.00	750.00	27.50
24	12.50	39.50	15.00	2.00	750.00	1.00
25	62.50	39.50	15.00	2.00	750.00	27.50
26	12.50	39.50	15.00	1.00	750.00	1.00
27	62.50	39.50	15.00	1.00	750.00	27.50
28	12.50	22.50	15.00	1.00	750.00	8.50
29	12.50	39.50	15.00	2.00	750.00	1.00
30	12.50	39.50	15.00	2.00	750.00	52.50
31	12.50	39.50	45.00	1.00	750.00	1.00
32	12.50	22.50	15.00	1.00	750.00	1.00
33	62.50	22.50	15.00	1.00	750.00	52.50
34	12.50	22.50	15.00	2.00	750.00	8.50
35	12.50	22.50	45.00	2.00	750.00	1.00
36	150.00	39.50	15.00	2.00	750.00	1.00
37	62.50	22.50	15.00	2.00	750.00	27.50
38	150.00	22.50	15.00	2.00	750.00	27.50
39	62.50	39.50	15.00	2.00	750.00	27.50
40	62.50	39.50	15.00	2.00	750.00	1.00
41	12.50	39.50	15.00	2.00	750.00	27.50

14067	62.50	39.50	105.00	3.00	3500.00	52.50
14068	62.50	39.50	105.00	3.00	3500.00	52.50
14069	150.00	22.50	105.00	3.00	3500.00	52.50
14070	150.00	39.50	105.00	4.00	3500.00	52.50
14071	150.00	39.50	105.00	4.00	3500.00	8.50
14072	150.00	39.50	75.00	4.00	3500.00	8.50
14073	150.00	39.50	75.00	4.00	3500.00	8.50
14074	150.00	39.50	75.00	4.00	3500.00	8.50
14075	150.00	39.50	75.00	4.00	3500.00	8.50
14076	150.00	39.50	75.00	4.00	3500.00	8.50
0 TOTAL	1616725.000	297706.000	1256385.000	29715.000	32338500.000	263732.500
0 MEAN	114.857	21.150	89.257	2.111	2297.421	18.736
0 ST.DEV.	167.725	15.260	24.342	0.911	991.777	22.488
0 C.V.	1.460	0.722	0.273	0.431	0.432	1.200

1

***** CORRELATION MATRIX

	ALTITUD 1	BIOMASS 2	SOILDEP 3	GEOLOGY 4	RAINFAL 5	SLOPE % 6
0 ALTITUD 1	1.000	-0.018	-0.230	0.033	0.316	0.254
0 BIOMASS 2	-0.018	1.000	-0.144	0.213	0.237	0.181
0 SOILDEP 3	-0.230	-0.144	1.000	-0.144	-0.091	-0.192
0 GEOLOGY 4	0.033	0.213	-0.144	1.000	0.241	0.314
0 RAINFAL 5	0.316	0.237	-0.091	0.241	1.000	0.311
0 SLOPE % 6	0.254	0.181	-0.192	0.314	0.311	1.000

***** VARIANCE CO-VARIANCE MATRIX

	ALTITUD 1	BIOMASS 2	SOILDEP 3	GEOLOGY 4	RAINFAL 5	SLOPE % 6
0 ALTITUD 1	0.281D+05	-0.462D+02	-0.938D+03	0.499D+01	0.525D+05	0.959D+03
0 BIOMASS 2	-0.462D+02	0.233D+03	-0.535D+02	0.297D+01	0.359D+04	0.620D+02
0 SOILDEP 3	-0.938D+03	-0.535D+02	0.593D+03	-0.318D+01	-0.221D+04	-0.105D+03
0 GEOLOGY 4	0.499D+01	0.297D+01	-0.318D+01	0.830D+00	0.216D+03	0.643D+01
0 RAINFAL 5	0.525D+05	0.359D+04	-0.221D+04	0.218D+03	0.984D+06	0.693D+04
0 SLOPE % 6	0.959D+03	0.620D+02	-0.105D+03	0.643D+01	0.693D+04	0.506D+03

1

***** ORIGINAL MATRIX FOR P.C.A IS CORRELATION MATRIX . *****

0***** VARIABLE SELECTION

ALTITUD BIOMASS SOILDEP GEOLOGY RAINFAL SLOPE %

0***** DIAGONAL MATRIX (CHECK MATRIX FOR EIGEN VALUE)

	1	2	3	4	5	6
0 1	0.530D+00	0.318D-11	0.0	-0.150D-07	-0.403D-16	-0.878D-08
0 2	0.318D-11	0.110D+[illegible]	-0.103D-06	0.177D-09	-0.915D-06	0.233D-08
0 3	0.0	-0.103D-[illegible]	0.916D+00	0.974D-10	-0.762D-11	0.483D-13
0 4	-0.150D-07	0.177D-09	0.974D-10	0.819D+00	-0.133D-06	0.0
0 5	-0.403D-16	-0.915D-06	-0.762D-11	-0.133D-06	0.199D+01	-0.273D-07

0 6 -0.878D-08 0.233D-08 0.483D-13 0.0 -0.273D-07 0.640D+00
1

***** EIGEN VALUE AND ITS CONTRIBUTION

	EIGEN VALUE	CONTRIBUTION RATIO	CUMULATIVE CONTRIBUTION
1	1.992	0.33206	0.33206
2	1.102	0.18367	0.51573
3	0.916	0.15265	0.66837
4	0.819	0.13653	0.80491
5	0.640	0.10672	0.91163
6	0.530	0.08837	1.00000

0***** EIGEN VECTOR

COMP.NO.	1	2	3	4	5	6
0 ALTITUD 1	0.365	-0.680	0.117	-0.131	-0.087	0.606
0 BIOMASS 2	0.334	0.545	-0.168	-0.649	0.184	0.328
0 SOILDEP 3	-0.333	0.229	0.845	0.004	0.149	0.316
0 GEOLOGY 4	0.406	0.431	0.015	0.580	-0.476	0.293
0 RAINFAL 5	0.481	-0.058	0.479	-0.309	-0.350	-0.564
0 SLOPE % 6	0.498	-0.011	0.117	0.360	0.766	-0.147

1

***** FACTOR ROADING

COMP.NO.	1	2	3	4	5	6
0 ALTITUD 1	0.515	-0.713	0.112	-0.119	-0.069	0.441
0 BIOMASS 2	0.472	0.572	-0.161	-0.588	0.147	0.239
0 SOILDEP 3	-0.470	0.240	0.809	0.003	0.119	0.230
0 GEOLOGY 4	0.574	0.452	0.014	0.525	-0.381	0.213
0 RAINFAL 5	0.679	-0.061	0.458	-0.279	-0.280	-0.411
0 SLOPE % 6	0.703	-0.011	0.112	0.325	0.613	-0.107

0***** CUMULATIVE CONTRIBUTION OF K-COMPONENTS TO ORIGINAL VARIABLE

COMP.NO.	1	2	3	4	5	6
0 ALTITUD 1	0.265	0.774	0.787	0.801	0.806	1.000
0 BIOMASS 2	0.223	0.550	0.576	0.921	0.943	1.000
0 SOILDEP 3	0.220	0.278	0.933	0.933	0.947	1.000
0 GEOLOGY 4	0.329	0.533	0.533	0.809	0.954	1.000
0 RAINFAL 5	0.461	0.465	0.675	0.753	0.831	1.000
0 SLOPE % 6	0.494	0.494	0.507	0.612	0.988	1.000

1

***** COEFFICIENT OF ORIGINAL VARIABLE FOR COMPONENT SCORE

COMP.NO.	1	2	3	4	5	6

0 ALTITUD	1	0.002	-0.004	0.001	-0.001	-0.001	0.004
0 BIOMASS	2	0.022	0.036	-0.011	-0.043	0.012	0.022
0 SOILDEP	3	-0.014	0.009	0.035	0.000	0.006	0.013
0 GEOLOGY	4	0.446	0.473	0.016	0.637	-0.523	0.322
0 RAINFAL	5	0.000	-0.000	0.000	-0.000	-0.000	-0.001
0 SLOPE %	6	0.022	-0.000	0.005	0.016	0.034	-0.007

0CORRECTION CONSTANT

-1.965	-1.984	-4.189	0.046	0.535	-1.280

1

***** COMPONENT SCORE

COMP.NO. / DATA NO.	1	2	3	4	5	6
1	-0.44	-0.05	-3.71	-1.22	0.34	-0.30
2	-0.28	-0.06	-3.67	-1.10	0.60	-0.35
3	-0.82	-0.66	-3.52	-0.50	0.14	-0.67
4	-1.18	-0.62	-3.89	-0.27	0.40	-0.24
5	-1.18	-0.62	-3.89	-0.27	0.40	-0.24
6	-0.81	-0.01	-4.07	-0.99	0.61	0.12
7	-0.81	-0.01	-4.07	-0.99	0.61	0.12
8	-1.59	-0.34	-2.84	-0.26	0.59	0.15
9	-1.59	-0.34	-2.84	-0.26	0.59	0.15
10	-0.28	-0.06	-3.67	-1.10	0.60	-0.35
11	-0.10	-0.40	-3.43	0.22	-0.16	-0.21
12	-0.37	-0.19	-3.51	0.14	-0.39	-0.35
13	0.14	-0.07	-3.57	-0.80	1.25	-0.48
14	-0.82	-0.66	-3.52	-0.50	0.14	-0.67
15	-0.71	-0.86	-3.49	-0.54	0.11	-0.49
16	-0.82	-0.66	-3.52	-0.50	0.14	-0.67
17	-1.23	-0.38	-2.48	-0.49	0.32	-0.28
18	-0.85	0.23	-2.67	-1.22	0.53	0.09
19	0.43	-0.39	-3.22	0.29	1.87	-0.82
20	-0.78	0.09	-2.46	0.14	-0.20	0.04
21	-1.23	-0.38	-2.48	-0.49	0.32	-0.28
22	0.89	-0.15	-3.46	-0.27	0.65	0.34
23	0.32	-0.40	-3.33	0.52	0.49	-0.34
24	0.00	0.42	-3.69	-0.58	-0.18	0.02
25	0.70	0.20	-3.52	-0.20	0.70	0.03
26	-0.44	-0.05	-3.71	-1.22	0.34	-0.30
27	0.25	-0.27	-3.54	-0.84	1.22	-0.29
28	-0.55	-0.67	-3.48	-0.38	0.39	-0.72
29	0.00	0.42	-3.69	-0.58	-0.18	0.02
30	1.14	0.39	-3.43	0.24	1.57	-0.32
31	-0.35	0.23	-2.67	-1.22	0.53	0.09
32	-0.82	-0.66	-3.52	-0.50	0.14	-0.67
33	0.43	-0.39	-3.22	0.29	1.87	-0.82
34	-0.21	-0.19	-3.47	0.26	-0.13	-0.39
35	-0.78	0.09	-2.46	0.14	-0.20	0.04
36	0.30	-0.14	-3.60	-0.69	-0.25	0.52
37	0.32	-0.40	-3.33	0.52	0.49	-0.34
38	0.51	-0.76	-3.27	0.45	0.45	-0.02
39	0.70	0.20	-3.52	-0.20	0.70	0.03