OBSERVATION OF PRESENT STATE OF AGRICULTURAL LAND-USE BY ANALYSING LANDSAT DATA

' INVESTIGATION OF ENVIRONMENTAL CHANGE PATTERN IN JAPAN' (28990)

by

Shigechika Hayashi

Upland Farming Division,

National Agricultural Experiment Station,

Memuro, Hokkaido, 082, JAPAN

I. Introduction

In Hokkaido, where the scale of agricultural fields is comparatively large, wide area observation by LANDSAT has great possibility of effective use for analysing real state and changes of agricultural land.

In this study authors investigated the method of applying LANDSAT data for observing agricultural land in Hokkaedo as a part of 'Investigation of Environmental Change Pattern in JAPAN' (28990).

This study was performed by following members: Shigechika Hayashi and Michikazu Fukuhara of Upland Farming Division, Hokkaido National Agricultural Experiment Station; Yoshizumi

Do NOT Film

SCIENCE AND TECHNOLOGY AGENCY

2-2-1 Kasumigaseki Chiyoda-ku, Tokyo Japan

September 8, 1977

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Draft Final Report: Investigation No. 28990

Dear Sir:

I am pleased to send you herewith the "Draft Final Report" of our Investigation No.28990, "Investigation of Environmental Change Pattern in Japan", supported by the NASA approved Landsat-Follow-on Program.

This Draft Final Report consists of 9 reports listed on the attached sheet and each report has been titled as the subject which shows the main theme of the investigation.

You would kindly review these reports and send me back accordingly.

Yours faithfully,

Takakazu Maruyasu

Takakazu Maruyasu

Principal Investgator of 28990
Investigation of Environmental Change Pattern in Japan
c/o National Space Department Agency of Japan
L.A. Office 606 S. Olive St. Suite 310
Los Angeles, CA. 90014

(Attached Sheet)

Co-investigator's name	Theme
1. Hayashi	Observation of Present State of Agrocultural Land-Use by Analysing Landsat data
2. Nakajima	Investigation of the Ecological Environment Index from Observation of the Regional Vegetation cover and their Growing Condition
3. Murai	An Analysis on Vegetation cover by using Landsat MSS data
4. Shoji	(1) Classification of Shorelines (2) Investigation of Variations in the Prominent Oceanic Current, Kuroshio
5. Tsuchiya,Ochiai	Environmental Change Pattern in Central Japan as revealed by Landsat data
6. K.Watanabe	General Pattern of the Turbid Water in the Seto-Island Sea extracted from Multispectral Imageries by the Landsat-1 and -2
7. Ochiai	Significant Applications of Landsat-2 MSS Data to Marine Environment
8. Ochiai,Tsuchiya,Takeda	Application of Landsat MSS Data to The Study of Oceanographical Environment
9. T.Watanabe	Utilization of Landsat-2 Data for Fisheries

Yasuda and Yasubumi Emori of Institute of Color Technology Faculty of Engineering, Chiba University; Joji Iisaka of Scientific Center of JAPAN IBM.

II. Techniques

From LANDSAT data of agricultural fields in Tokachi District: (1). Ratio images were made by photographical treatment. (2). Digital analysis was performed using the computor. And the results were compared with ground truth data.

1. Data used (figure 1)

24 May, 1973, 'Kushifo' (LANDSAT-1), 70 mm B & W film.

11 June, 1975, 'Obihiro' (LANDSAT-2), 70 mm B & W film and CCT.

2. Channel used and wave length (μm)

4 (0.5 - 0.6), 5 (0.6 - 0.7), 6 (0.7 - 0.8), 7 (0.8 - 1.1).

3. Area used for analysis was overlapped part of both (1) and (2), and this part corresponds to Tokachi District (figure 2).

4. Preparation of ratio images by photographical treatment.

B & W bulk positives of 4, 5, 7 bands in the two scenes of LANDSAT data, the one 'Kushiro' (1973) and the other 'Obihiro' (1975), were enlarged to 1:200,000 scale, then the ratio images of 1975/1973 of each band were made.

These images were analysed using slicing instrument (GRAFI-COLOR 905) and difference between two years was extracted.

Process of making ratio images is illustrated in figure 3.

5. Digital analysis using computor.

Digital analysis of CCT of 'Obihiro' (1975) by computor was performed using LARSYS IBM-DCS version program. LARSYS analysis flow is illustrated in figure 4. Results of interpretation were color-displayed finally.

III. Accomplishment

1. In the season when the data were obtained, the crops planted in Tokachi fields having not grown so much except winter wheat and grasses, authors chosed grasses and soils as an object of analysis. Density distribution patterns in the B & W bulk

positives of three upland fields, belonging to different soil types, are shown in figure 5.

In this figure: (1). Seasonal difference between May and June is recognized. (2). The order of reflectance intensity among soil types did not change.

2. To extract the change pattern of agricultural fields which occured in process of time, ratio images were made. Change patterns obtained from ratio images were classified into 5 types as follows:

(1). Changes of land management-and-use during two years.

(2). Seasonal change of plant growth.

(3). Apparent change produced by difference of relative densities among the subjects in the images.

(4). Influence of looking angle.

(5). And influences of noizes, clouds and etc...

The bare-ground produced by the reclamation practice was recognized remarkably in the ratio image of band 7 (figure 6 - 8).

3. Digital analysis using computor was performed on the area near Nakaotofuke and Nishishihoro, where the results of ratio

image analysis showed remarkable changes of land use.

This area had been markedly changed to bare ground owing to the renovation and establishment of grassland based on the agricultural land reclamation plan.

After clustering analysis a training field was chosen among run-data on the MIS (CCT) tapes, and then statistical values were obtained concerning this region (figure 9). By this treatment 13 classes were identified in this training field: 4 bare grounds (A - D), 6 grasslands (E - J), wheat field (K), range (L), woods (W).

On these statistical values maximum likelihood method was applied and then classification map was made (figure 10).

According to these results, it was considered that in this reclaimed land the main coverage was timothy which had been sowed 4 years before and the productivity is not high, because of the infertile soil (A, C) poor in organic matter, and that there were also unreclaimed area.

4. According to the ground truth data, it was proved that in the reclaimed grassland of this area, timothy was dominant coverage and the fertility was poor because of the shallowness of gravel stratum and of deficiency of organic matter.

The plan of application of waste water from the potato starch factory is being realized in this area to enrich the soil fertility.

Unidentified area in the classification map dominantly consisted of unreclaimed land, where the soil surface was covered with mixture of grass and woods.

IV. Significant Results

Significant results of this study are as follows:

1. In the Plains of Tokachi, where the scale of agricultural fields is comparatively large in JAPAN, LANDSAT data with its accuracy has proved to be useful enough to observe the actual condition of agricultural land-use and changes more accurately than the present methods.

2. Authors could identify the species and ages of grasses in pasture and classify the soils into several types, using LANDSAT data. Therefore, LANDSAT data is feasible in the application

to wide area planning of cultivation, reclamation or management on agricultural land.

V. Publications

M.Fukuhara, S.Hayashi, Y.Yasuda and Y.Emori: Multitemporal Analysis of Agricultural Land using LANDSAT Data, Proceedings of the 1977 Meeting, JAPAN SCCIETY OF PHOTOGRAMMETRY, May 1977, pp. 73 - 74.

VI. Problems

For practical use, following problems should be solved:

1. Periodical data acquisition suitable to special climatic condition in JAPAN.
2. Resolution suitable for the scale of agricultural fields in JAPAN.
3. Reducing the time of data acquisition.
4. Establishment of techniques for analysis and application suitable for agriculture, which has various local characteritics.

5. Accumulation of analytical case studies on agriculture.

VII. Data Quality and Delivery

No.

VIII. Recommendations

No.

IX. Conclusions

From the results of the analysis, LANDSAT data proved to be feasible to detect the actual condition of land use, namely, the changes of agricultural lands, grassland management and etc....

When timely information is available, LANDSAT data will be useful for remote sensing to study such large scale agricultural fields as in Hokkaido from the wide viewpoint.

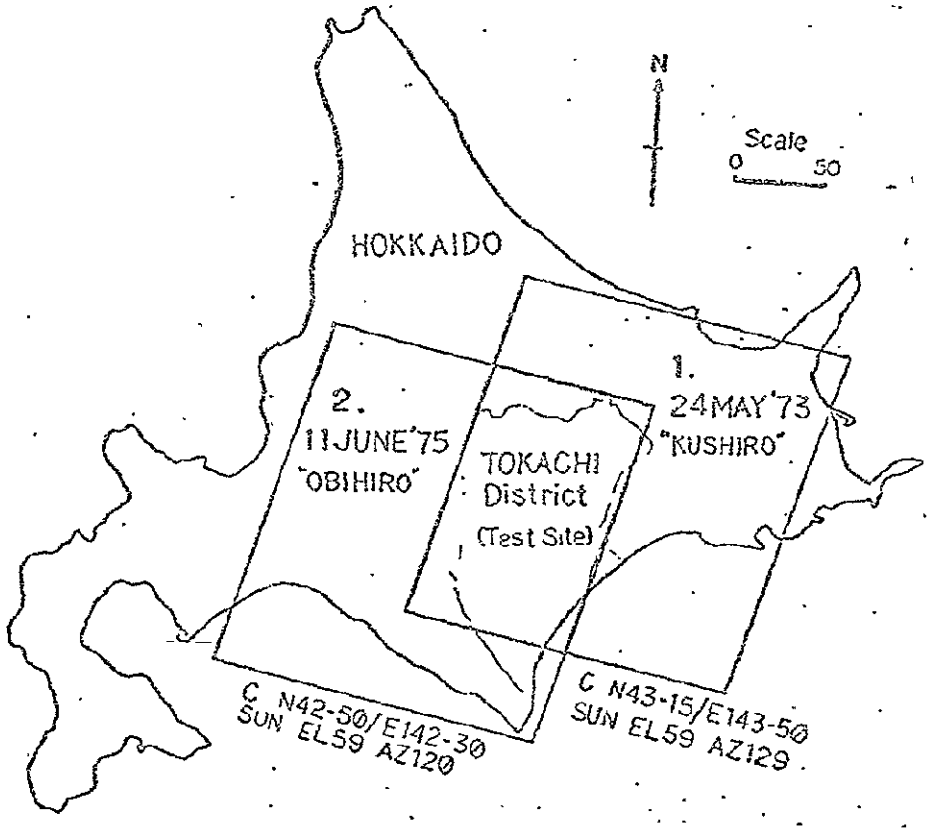


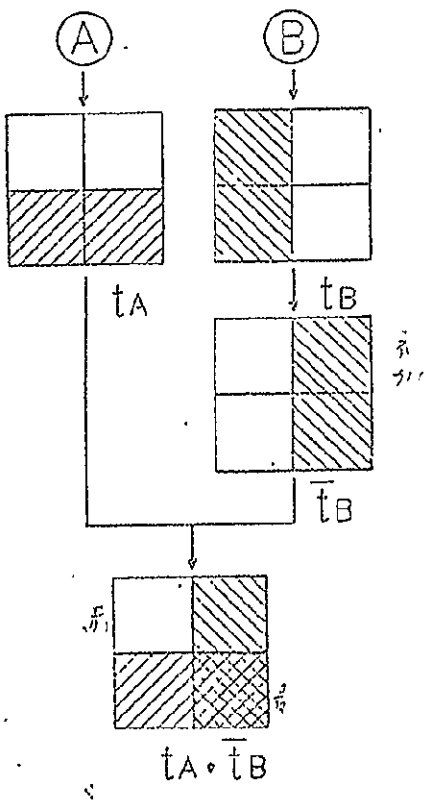
Figure 1. Observed area in the scenes used.

Figure 2. Photographs of analysed area (Tokachi District).

(1). 24 May 1973, 'Kushiro', band 7 image.

(2). 11 June 1975, 'Obihiro', band 7 image.

Figure 3. Process of preparing ratio images.



Let the negative density of image A, B be D_A, D_B, respectively, and let the positive density of B be D_B^{γ}. Density of superimposed image of negative A on positive B, i.e. D_{AB}, becomes

$$D_{AB} = D_A + D_B^{\gamma} = D_0 + D_A - \gamma D_B \qquad \cdots\cdots\cdots\cdots (1)$$

where D is density of constant level.

When

$$\gamma = 1$$

$$D_{AB} = D_A - D_B \qquad \cdots\cdots\cdots\cdots\cdots (2)$$

then

$$D_A = -\log(\bar{r}H)_A^{\gamma A} \qquad \cdots\cdots\cdots\cdots\cdots (3)$$

$$D_B = -\log(\bar{r}H)_B^{\gamma B} \qquad \cdots\cdots\cdots\cdots\cdots (4)$$

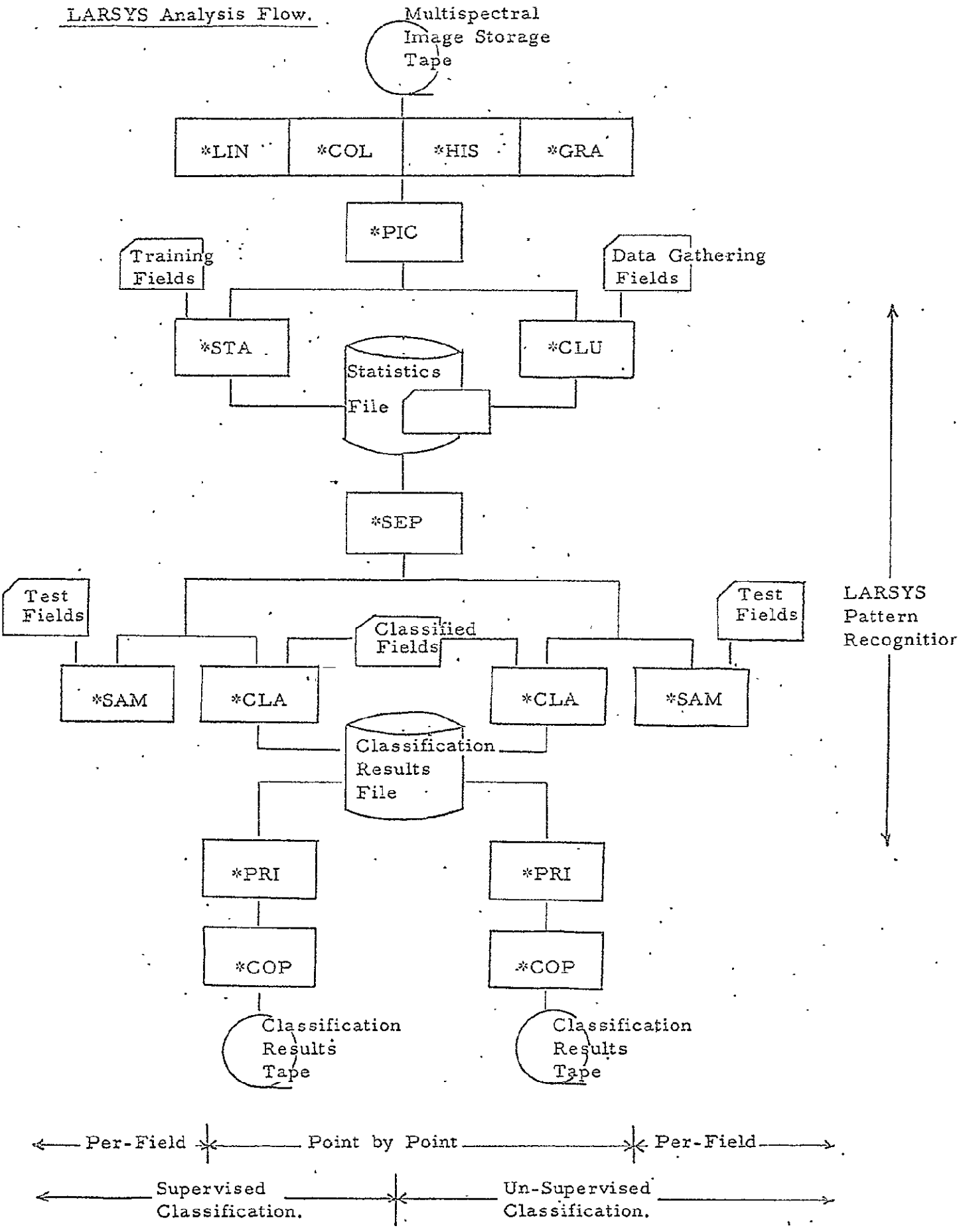
where r is reflectivity of the body, H is illumination intensity of reflection of sunlight.

Therefore the transmissivity of the image obtained is

$$T_{AB} = \gamma \frac{[\bar{r}H]_B^{\gamma B}}{[\bar{r}H]_A^{\gamma A}} \qquad \cdots\cdots\cdots\cdots\cdots (5)$$

Figure 4.

LARSYS Analysis Flow.



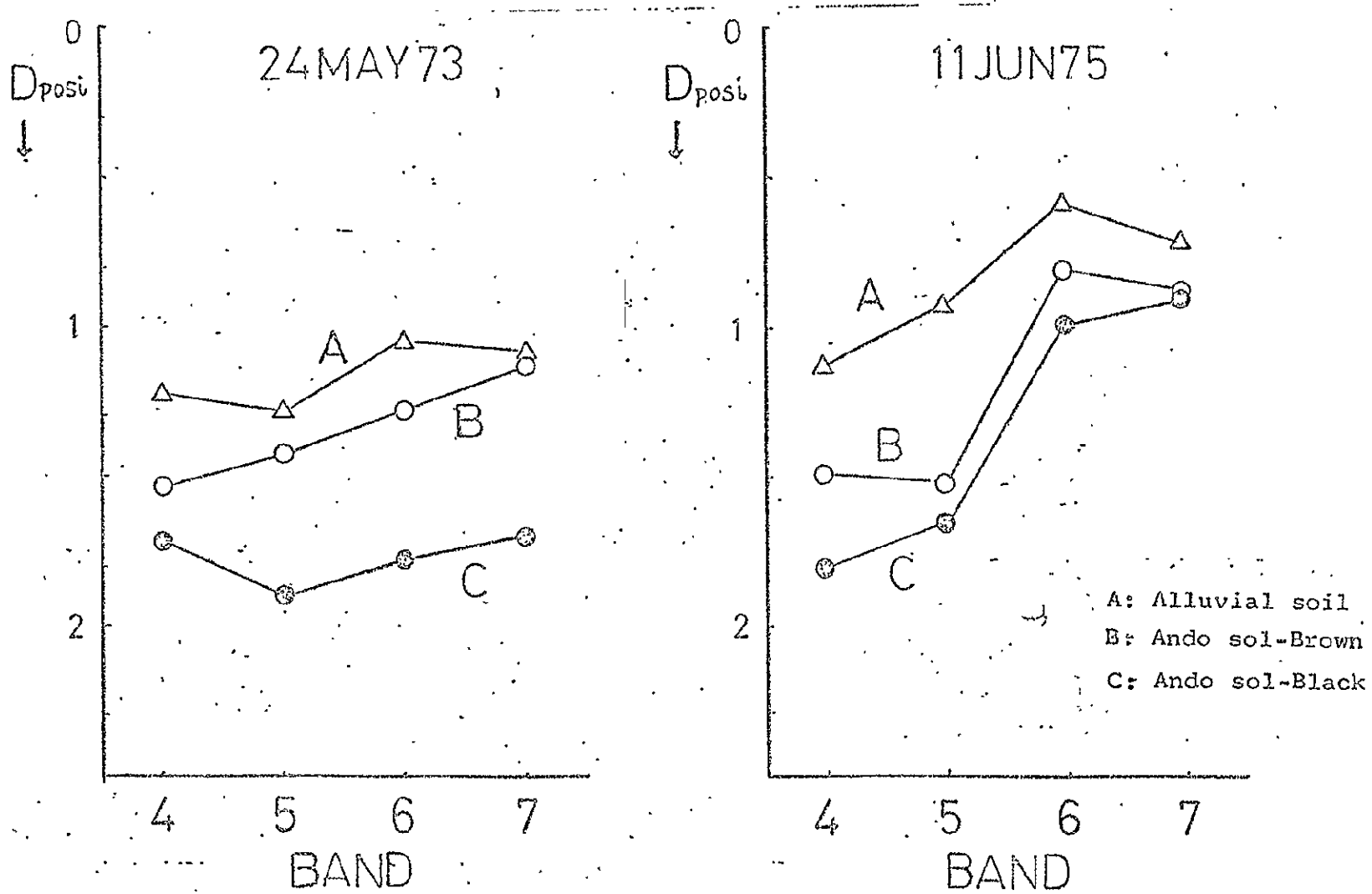


Figure 5. Density distribution patterns of different soils determined by B & W positives.
(1973, 'Kushiro', 1975, 'Obihiro')

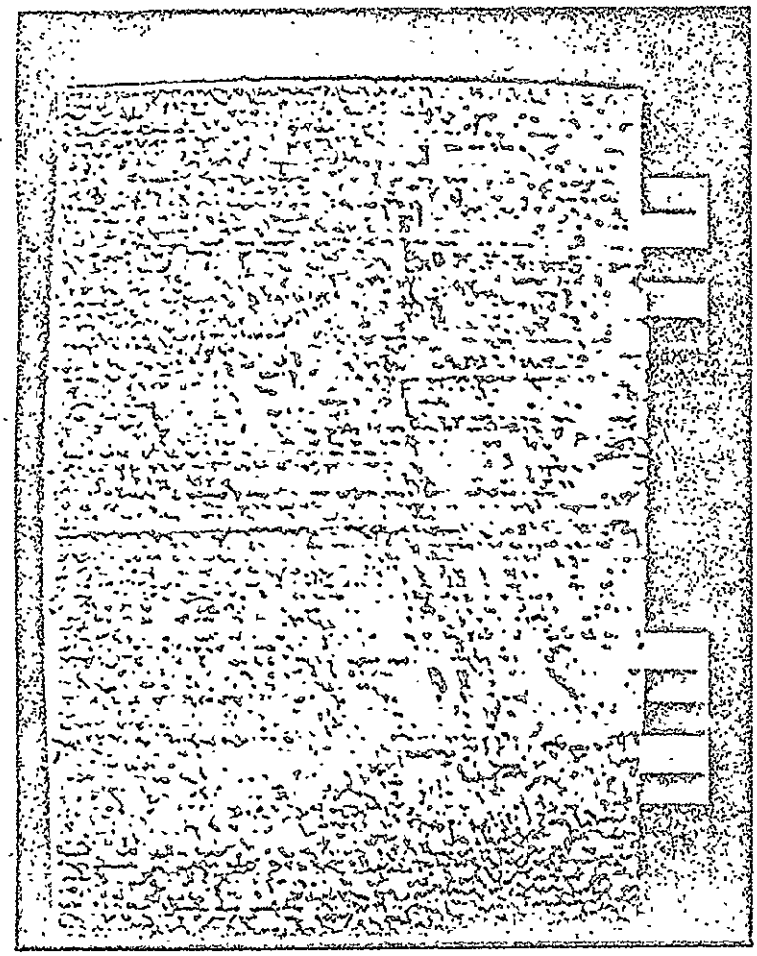


Figure 6. Ratio image of band 4.

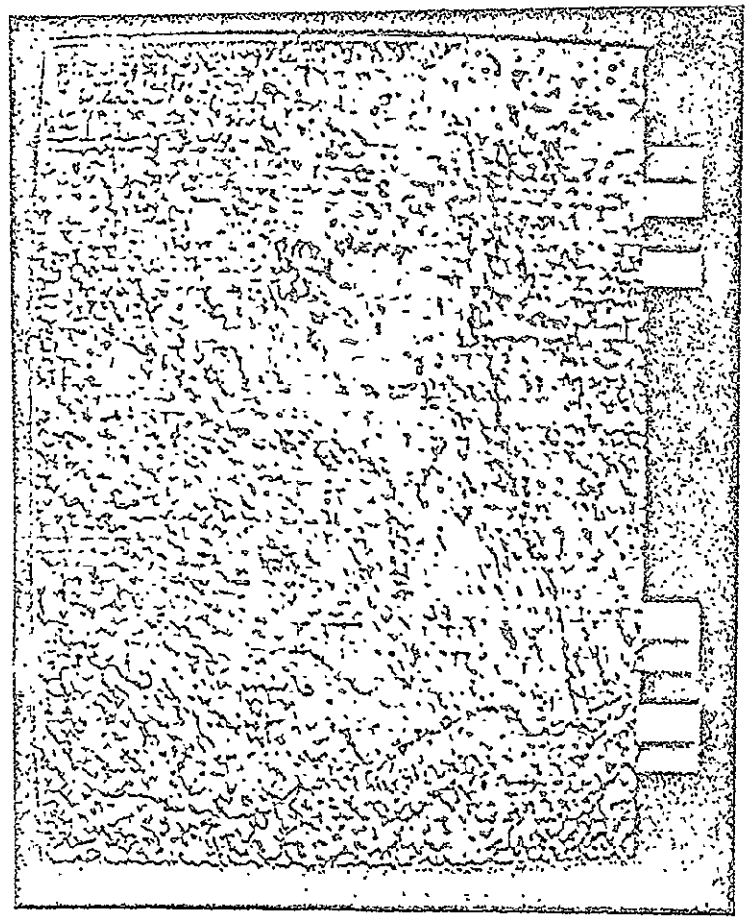


Figure 7. Ratio image of band 5.

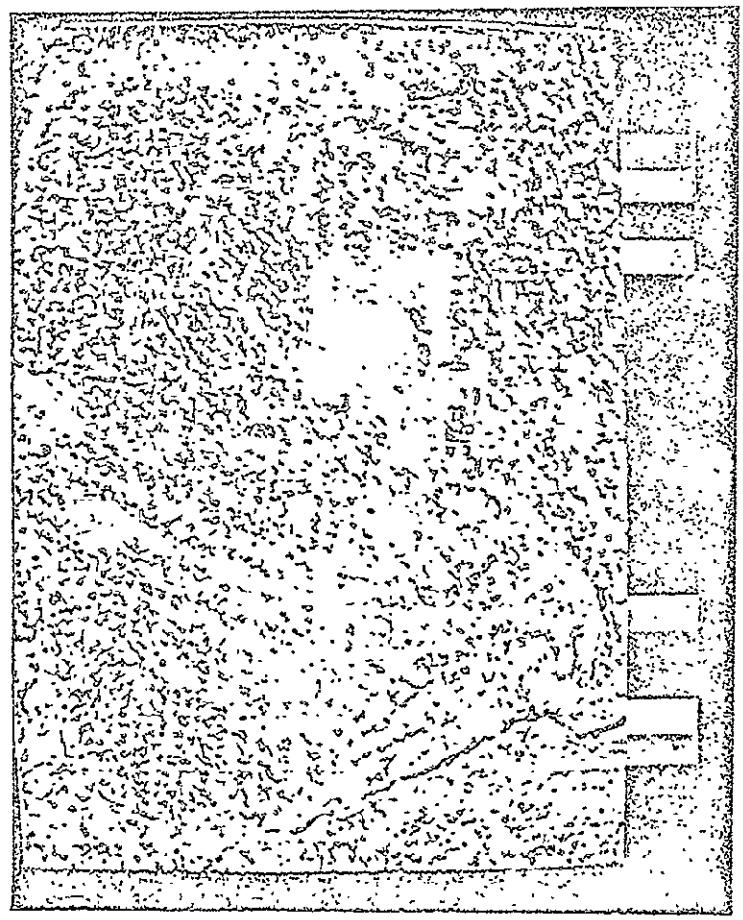


Figure 8. Ratio image of band 7.

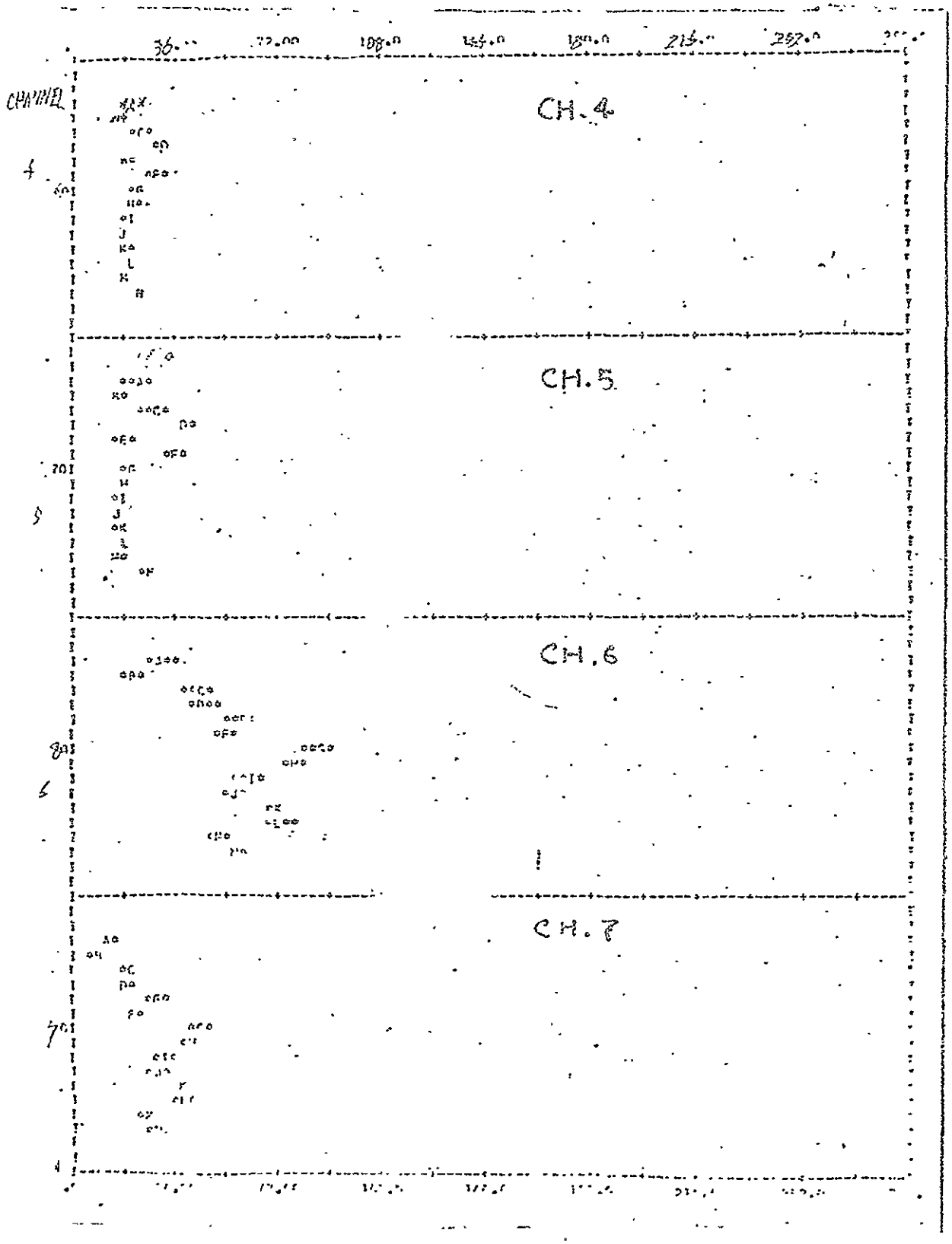
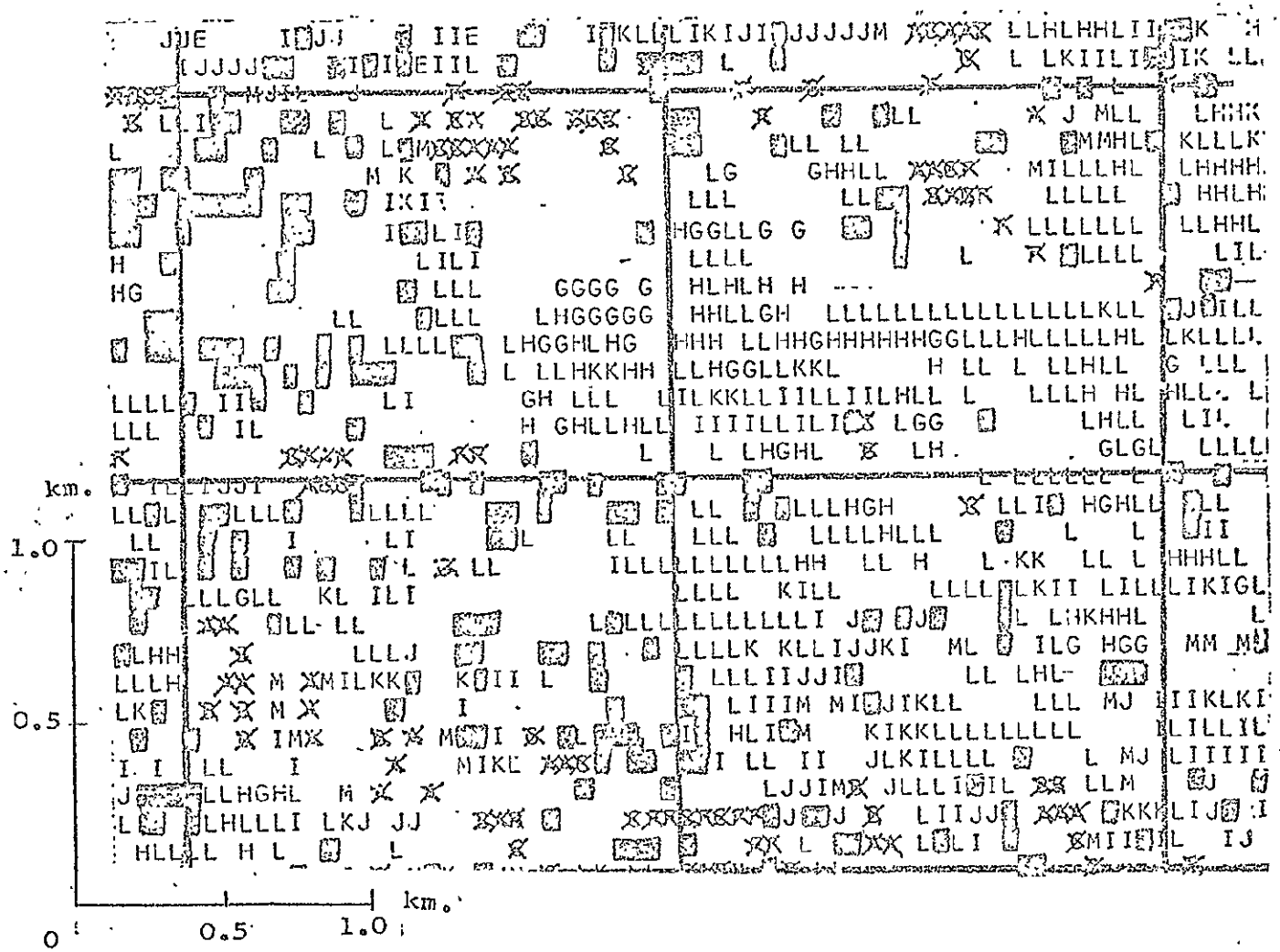


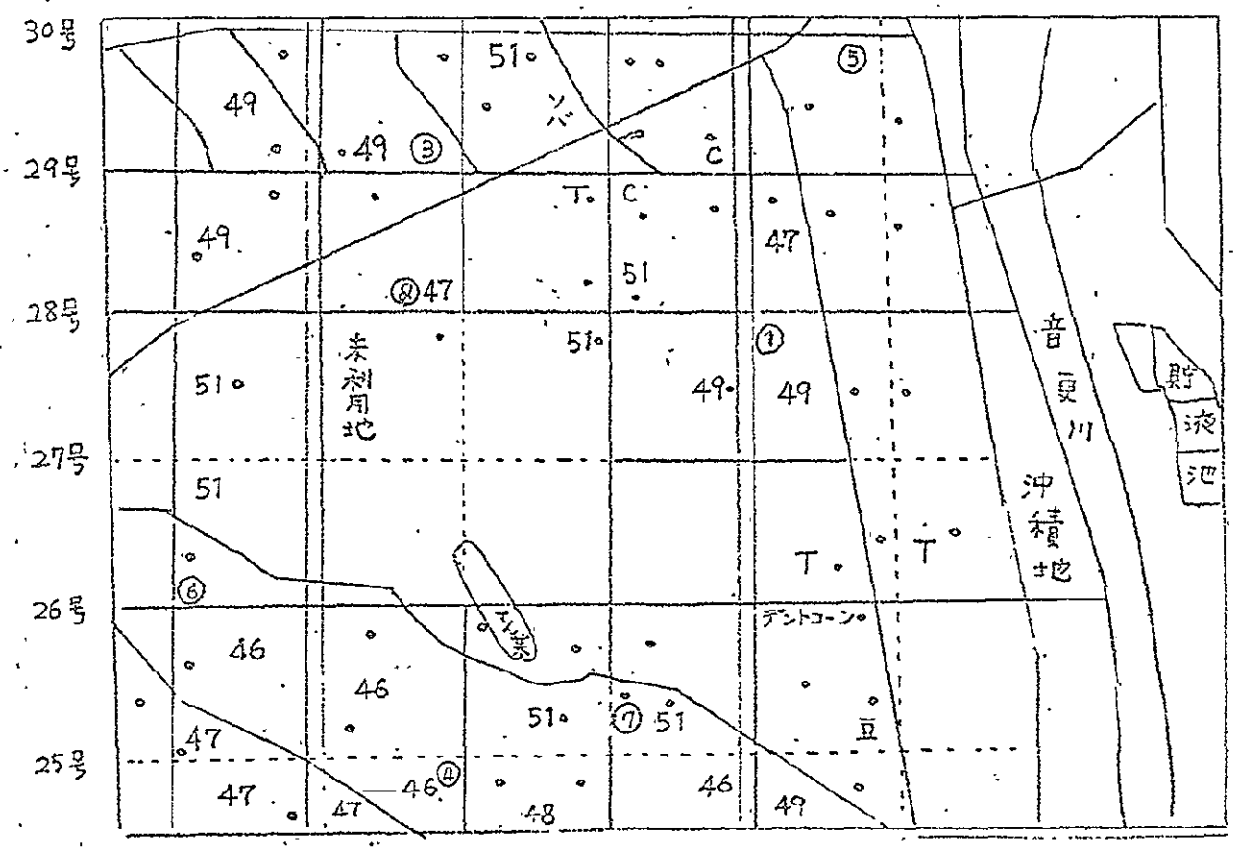
Figure 9. Spectral response of ground covers in Tokachi Disgrict.

Figure 10. A part of classification map of reclaimed land used as a test field. (Discrimination rate of training field is 87.5 % as a whole.)



▨	Unreclaimed area
A, B, E, K	Bare ground, upland field.
H	Timothy (sowed 2 years before).
G	Timothy (sowed 3 years before).
K	Orchard grass (sowed 2 years before).
I	Orchard grass (sowed 4 years before).
J	Ladino clover (sowed 2 years before).
M	Wheat.
No sign	Unidentified area

Figure 11. Ground truth data.



T .....Timothy.
C .....Red clover.
46-51 ....Years when timothy was sowed.
① - ⑦ ...Experimental Fields.
o ....Points to be examined.