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

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

by

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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 Hokkaido 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; Yukizumi...
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,

[Signature]

Takakazu Maruyasu
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II. Techniques

From LANDSAT data of agricultural fields in Tokachi District:

1. Ratio images were made by photographic treatment. (2).

Digital analysis was performed using the computer. And the results were compared with ground truth data.

1. Data used (figure 1)

24 May, 1973, 'Kushido' (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 (\(\mu m\))

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).

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 (GRAFICOLOR 905) and difference between two years was extracted.

Process of making ratio images is illustrated in figure 3.

5. Digital analysis using computer.

Digital analysis of CCT of 'Obihiro' (1975) by computer 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 chose 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.

To extract the change pattern of agricultural fields which occurred 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 noises, clouds and etc...

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

Digital analysis using computer 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


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 characteristics.
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).

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

$$D_{AB} = D_A + D_B' = D_A + D_s - \gamma D_B$$  \hspace{1cm} (1)$$

where $D$ is density of constant level.

When

$$\gamma = 1$$

$$D_{AB} = D_A - D_B$$  \hspace{1cm} (2)$$

then

$$D_A = -\log(\bar{r}H)^{r_A}$$  \hspace{1cm} (3)$$

$$D_B = -\log(\bar{r}H)^{r_B}$$  \hspace{1cm} (4)$$

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

Therefore the transmissivity of the image obtained is

$$T_{AB} = \gamma \frac{(\bar{r}H)^{r_B}}{(\bar{r}H)^{r_A}}$$  \hspace{1cm} (5)$$
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 District.
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.)
Figure 11. Ground truth data.

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