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LANDUSE MAPPING AND CHANGE DETECTION WITH THE AID OF SYNTACTIC APPROACH

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I. ABSTRACT

Land uses change very rapidly in Japan. Sattelite remote sensing can be a very powerful tool to recognize these changes. This paper describes the land use mapping and change detection of Kinki area of Japan in these 10 years using LANDSAT MSS data.

The processings necessary for the change detection are devided into four stages, i.e. destriping, geometric correction, normalization and classification. A syntactic approach was introduced in order to raise the classification accuracy in the last stages. Three kinds of grammers were adopted for the syntax. They are the local natures, the tendency and the nature of land use. With the aid of this syntactic approach, satisfactory results were obtained.

II. INTRODUCTION

Land uses change very rapidly in urbanized areas in Japan. It is meaningful for knowing the state of the development or the changing tendency of target areas to detect these changes of land uses. For detecting changes of land uses, it is not enough to use conventional classification algorithms. There still exists many classification errors and lots of unclassified pixels. To raise the accuracy of classification or change detection of land uses, it is necessary to introduce another technique.

Sattelite remote sensing can be a very powerful tool to get data for the target area. It is mainly because of its periodical data collection and its broadness of data collection range.

This paper describes the land use mapping and change detection of Kinki area of Japan in these 10 years using LANDSAT MSS data. A syntactic approach was introduced in order to raise the accuracy of classifications of land uses.

III. STUDY AREA AND IMAGE DATA

In this study, the target area is Kinki area including Osaka, Kyoto, and Nara, where is the second biggest commercial and industrial area in Japan. The total area is about 200x150 Km^2 which can be covered by three scenes of LANDSAT MSS. Figure 1 shows a map of the target area.

The smallest unit for data collection and storage is 100x100 m^2 UTM grid cell. Land use categories are eleven and are shown in Table 1.

Three date LANDSAT data covering the study area taken at 1972, 1978 and 1981 were used for this study. As for 1981 data, three MSS data were mosaicked and used for classification to cover all the target area.

IV. CHANGE DETECTION WITH LANDSAT DATA

A. PREPROCESSING

The preprocessings necessary for the change detection are devided into four stages, i.e. destriping, geometric correction, normalization and classification.

LANDSAT MSS data were first destriped by means of a histogram equalization algorithm. In this algorithm, scan line noises were corrected by adding random noises in order to imporove the image quality. Random noises canceled the quantization errors and allowed to make smooth histograms.

Geometric corrections were applied for each LANDSAT image using system correction with the aid of ground control points within the mean accuracy of one pixel using a UTM projection. In this study, about thirty ground control points were selected. Resampled pixel size is 100x100 m^2 using a nearest neighbour algorithm, hence rectified image of the target area contained 2,000x1,500 pixels.

The normalization means a linear transformation which coincides mean and standard deviation of LANDSAT data acquired at 1972 and 1978 to those acquired at 1981. The reason of this normalization is to remove certain changes such as detector response differences and different atmospheric effects among three images.

The main algorithm for classification was a modified maximum likelihood classification which is an iterative algorithm using coefficient of Mahalanobis' distances. Training areas were carefully selected with the aid of intensive ground truth and low altitude aerial photographs. The classification accuracy of this algorithm is better than a simple maximum likelihood algorithm, but it is not sufficient for an operational use.

B. SYNTACTIC APPROACH TO LAND USE CLASSIFICATION

A syntactic approach was introduced in order to raise the classification accuracy and to remove the cloud coverage in each data. Three kinds of grammers were adopted for the syntax.

The first grammer utilizes the local natures of land use. For instance, classified iron works which locate inland were changed to other categories, because they usually locate at the sea side.

The second one utilizes the nature of land use itself. For instance, isolated one pixel rice field was changed to grasses, because rice fields usually occupy large areas.

The last one utilizes the tendency of land use changes. For instances, forests can be changed to urban areas, but urban areas cannot be changed to forests in Japan. In this study, following syntactic classification rules were adopted.

(1) High density urban area or factory is the last form of the progress of urbanization.
(2) Low density urban area can be changed only to high density urban area.
(3) Nothing can be changed to rice field or forest or water body.
(4) Grass land or bare ground or soil can be formed only by development.

Table 2 shows abovementioned syntactic rules.

C. CHANGE DETECTION

There are several algorithms for change detection such as subtraction, ratioing and so on. In this study, following ratio adopted for detecting land use changes.

Land use composition ratio =
Number of pixels corresponding to interested classified field
total number of pixels

Table 3 shows results of change detection.

V. RESULTS AND DISCUSSION

Figure 2, 3 and 4 show the original data and land use classification data at 1972, 1978 and 1981, respectively.

Results of land use change detection are as follows.

(1) The population of specific areas around big cities had grown from 1972 to 1978, because of large scale developing lands into home sites.
(2) Large scale developing stopped at 1981. After that, small scale developing has been extending at several areas.
(3) Reclamation of the foreshore has been extending.

As a result, with the aid of abovementioned syntactic approach, satisfactory results were obtained to classify land uses.

VI. REFERENCES

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Kiyonari Fukue received the M.S. and Ph.D. degrees from the Tokai University of Kanagawa, Japan, in 1978 and 1982, respectively. Currently, he is an assistant at the Institute of Research and Development, Tokai University. His research interests include digital image processing and system, especially in remote sensing.

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Table 1. Land Use Categories.

	Categories	Details
1	High density urban area	densely built-up areas
2	Low density urban area	residential areas with green and unoccupied ground
3	Factory	large scale factory, warehouses
4	Bare ground	bare ground, unoccupied ground
5	Soil	bare ground in or after developing rice field
6	Rice field	rice field
7	Grass land	grass land, crop field, golf ground
8	Forest	conifer and broadleaf forests
9	Forest (Low density)	land covered with trees and grass
10	Water body	rivers, lakes and marshes, sea areas
11	Undefined	undefined area

Table 2. Various types of the land use change pattern.

From \ To	1	2	3	4	5	6	7	8	9	10
1	x									
2	a	x								
3			x							
4	a	a	a	x			a			
5	a	a	a	a	x		a			
6	a	a	a	a	a	x	a			
7	a	a	a	a			x			
8	a	a	a	a	a		a	x		
9	a	a	a	a	a		a		x	
10	a	a	a	a	a		a			x

Table 3. Composition ratio and ratio of changes of land use.

Categories	Composition ratio (%)			ratio of changes (%)		
	1972 (a)	1978 (b)	1981 (c)	(b-a)	(c-b)	(c-a)
1	2.7	4.9	8.1	2.2	3.2	5.4
2	17.3	18.3	23.3	0.5	5.0	5.5
3	1.9	2.8	3.5	0.9	0.7	1.6
4	4.8	5.9	5.1	1.1	-0.8	0.3
5	0.2	0.2	0.3	0.0	0.1	0.1
6	27.1	23.0	13.3	-4.1	-9.7	-13.8
7	1.8	1.6	6.9	-0.2	5.3	5.1
8	22.4	20.2	18.5	-2.2	-1.7	-3.9
9	5.1	7.5	5.9	2.4	-1.6	0.8
10	16.2	15.6	15.0	-0.6	-0.6	-1.2
11	0.0	0.0	0.1	0.0	0.1	0.1

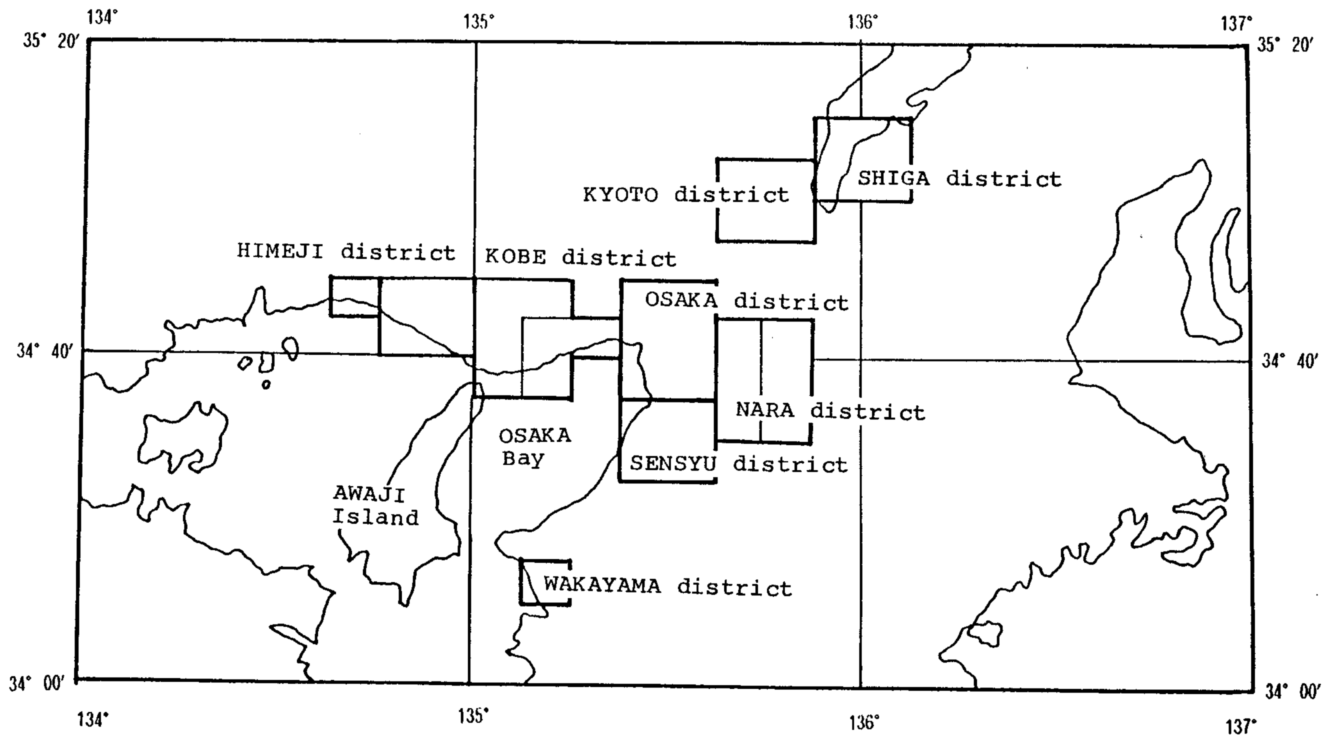

Figure 1. A map of Kinki area.

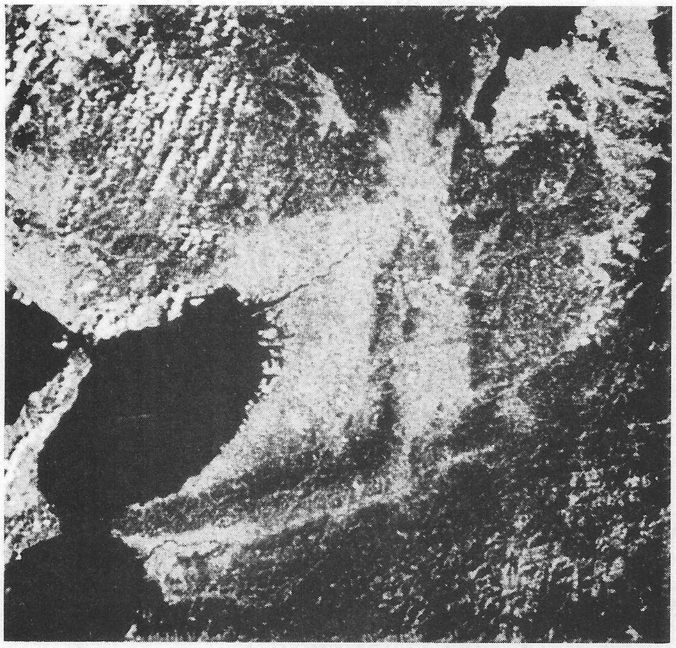

Figure 2-a) The original LANDSAT image in 1972.

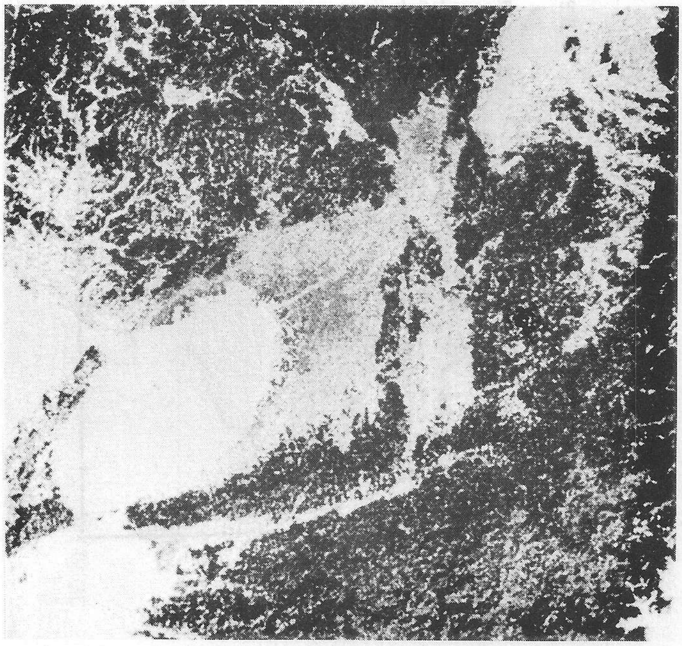

Figure 2-b) The landuse classification result of Figure 2-a).

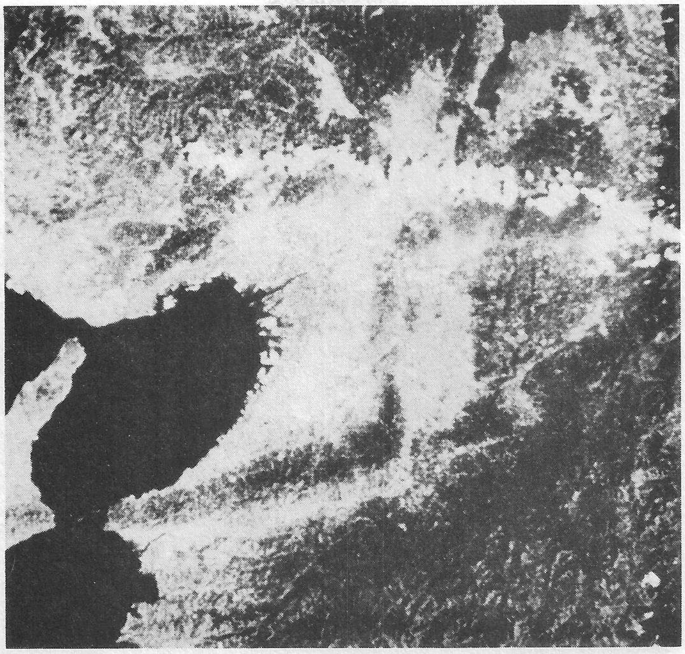

Figure 3-a) The original LANDSAT image in 1978.

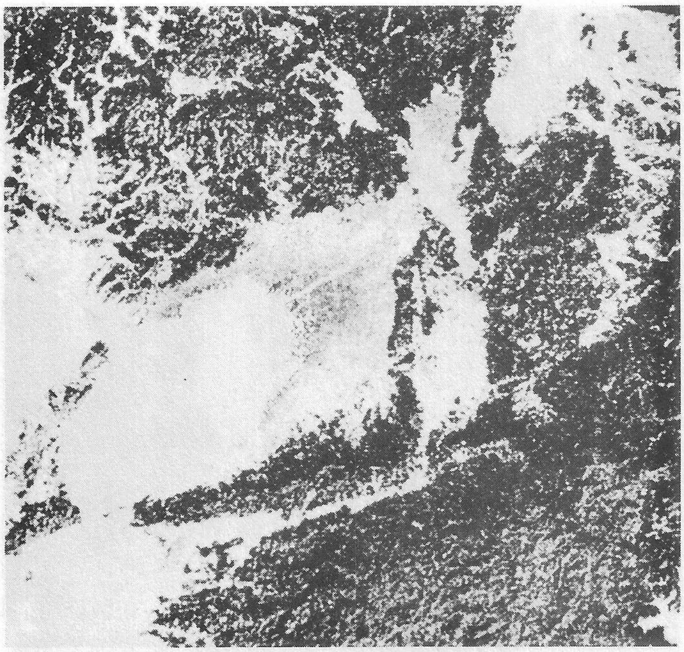

Figure 3-b) The landuse classification result of Figure 3-a).

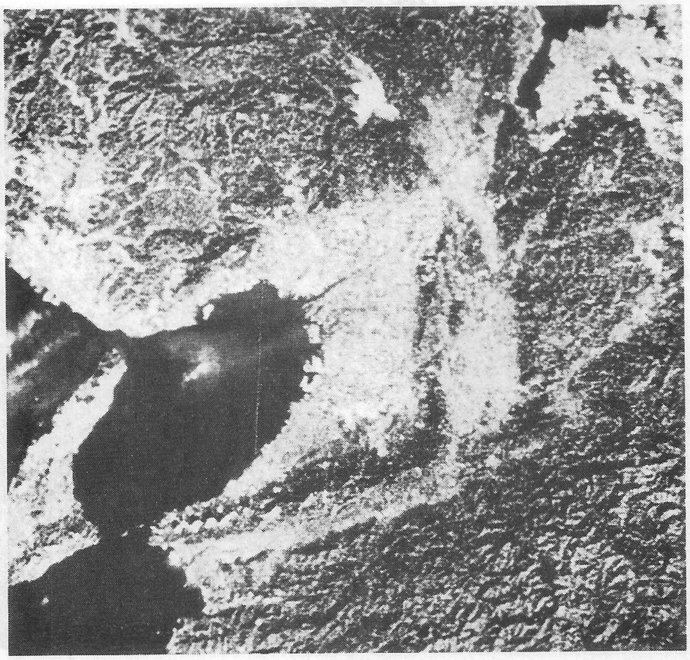

Figure 4-a) The original LANDSAT image in 1981.

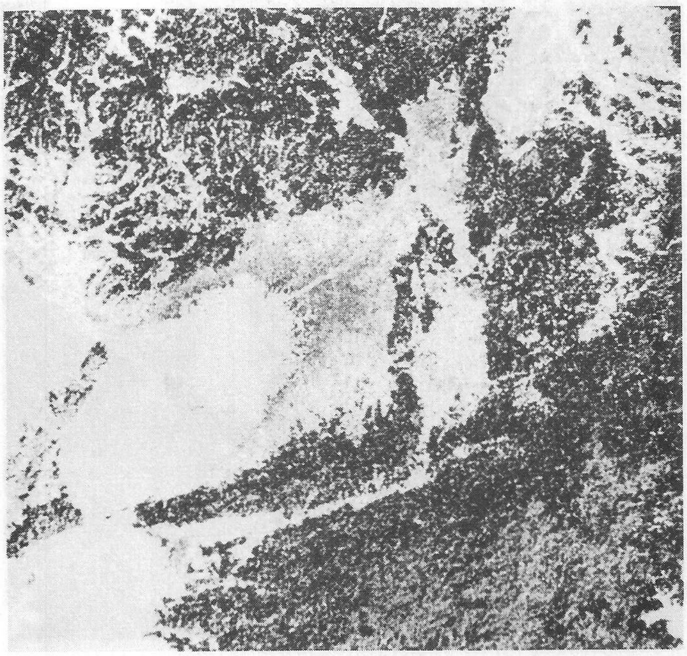

Figure 4-b) The landuse classification result of figure 4-b).