Methods to Supplement Insufficient Ground Survey Data for Land Cover Classification

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1. Introduction

We have developed the method to apply remote sensing technology to grasp land cover classification to the area where sufficient ground information is not available.
There are two objectives in this research.
First one is the development of the simple method to carry out geometric correction to the area where is difficult to utilize necessary information.
Second one is the development of the method to improve classification accuracy by utilizing multi temporal data in the area where land cover changes quite rapidly.
The system used for this research is shown in figure 1.
This research is carried out as the joint research project among "Geographical Survey Institute, Ministry of Construction of JAPAN", "National Research Council of THAILAND, Ministry of Science, Technology and Energy" and "Land Development Department, Ministry of Agriculture and Cooperatives of THAILAND" under a budgetary support of "Science and Technology Agency of Japan".

2. Simple geometric correction method

2-1. Purpose

A purpose of the study is to enforce geometrical correction of Landsat MSS data by an easy method, in the area where sufficient map are not available.
In other words, this is a method to obtain information for geometrical correction as precisely as possible from as small as 1/250,000 scale maps.
However, ground resolution of Landsat MSS data is too low to get enough number of ground control point (GCP) for geometric correction.
We attempted to solve this problem by using areal or linear information peculiar to the area instead of identifying a pixel on image to GCP of maps.

2-2. Outline of the process

Bulk corrected satellite data is used as input image data.

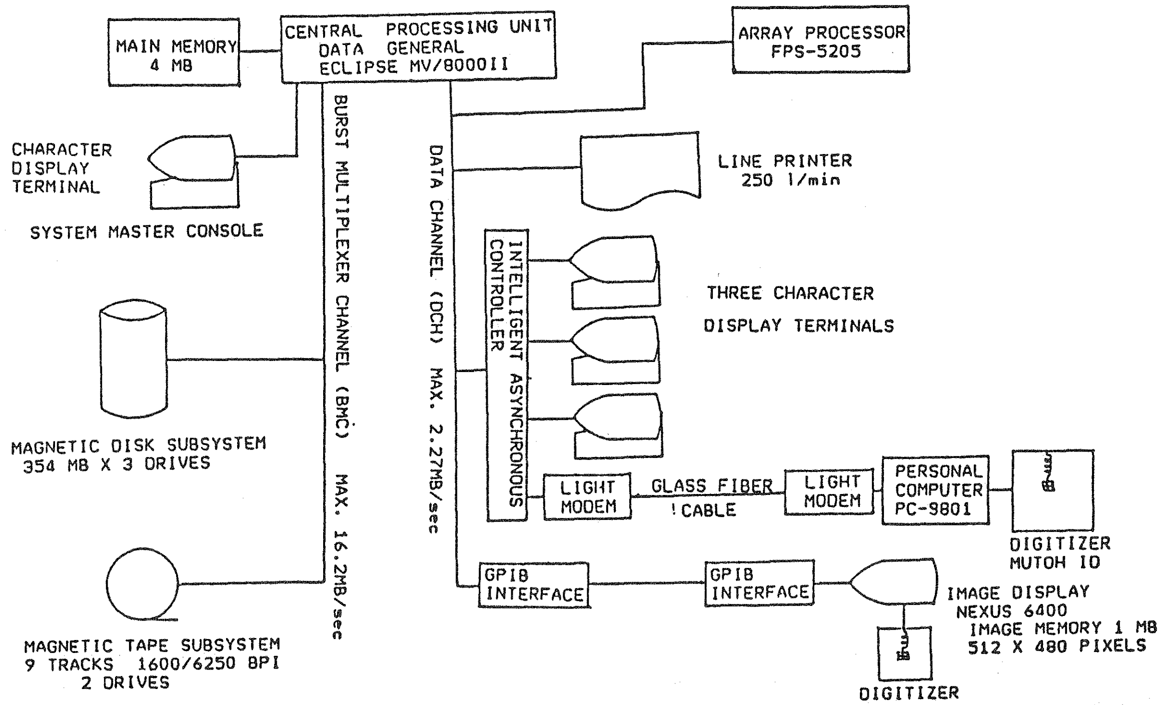

Figure 1 Hardware System Configuration.

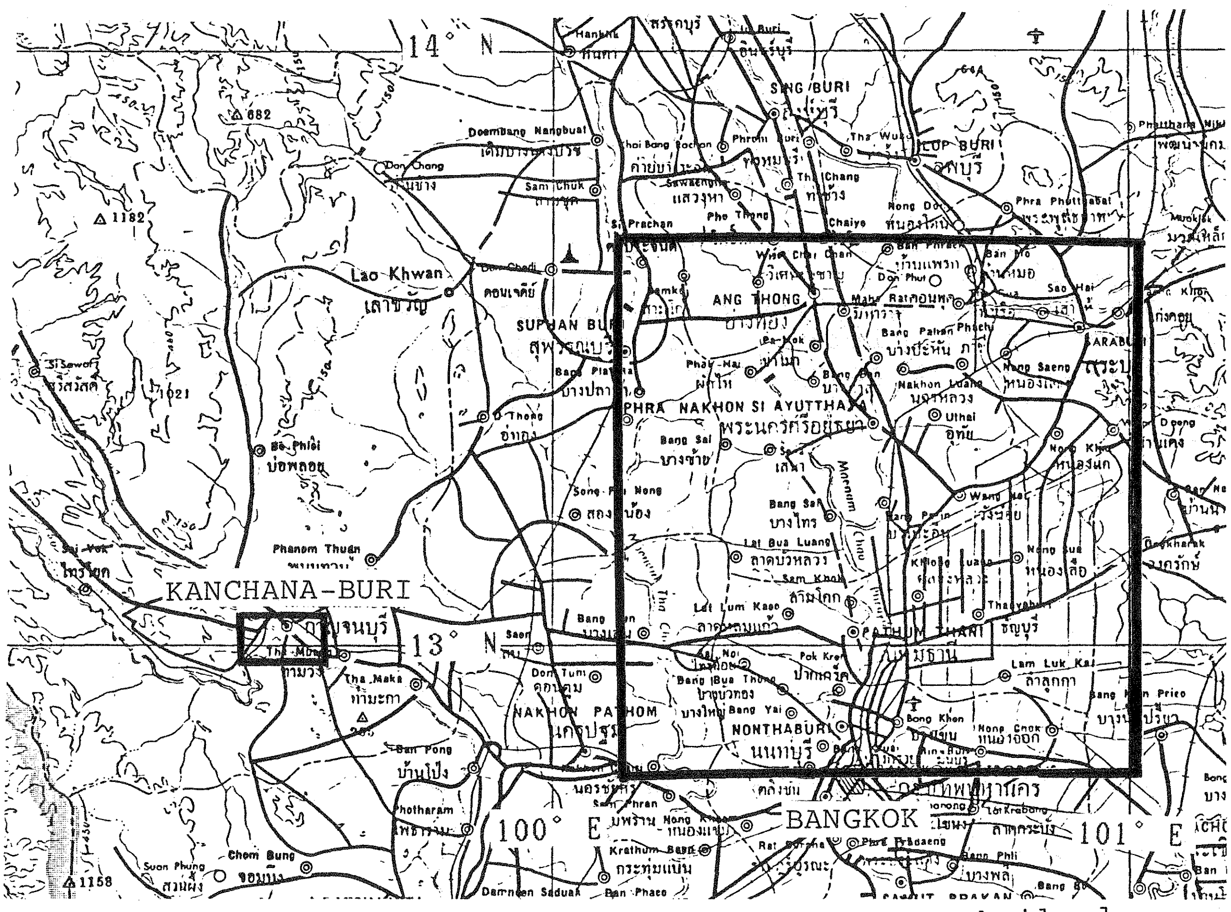

Figure 2 Locality map for these studies in Thailand.
Scale is 1:1,400,000.

Conventional geometric correction is carried out by using GCP of four to five points during one scene as pre-processing.
Map is digitized in raster data with a scanner where resampling pixel size is as same pixel size as pre-processed image data.
The map raster data and image data are overlapped on color display with different color.
Image plane is moved manually while paying attention to the area or line object of map plane, so that both data can be fitted.
In the mean time, the quantity of motion of image plane is measured which corresponds to the residuals of pre-processing at the center of each area. This process is repeated by an area of 500 - 1000 pixel square to cover the whole area.
Final geometrical correction is carried out with linear transformation by using measured residuals of four points enclosing the point being corrected.
Finally, whole output image are obtained by mosaicing all the blocks corrected independently.

2-3. Case study

Test site is an area including Bangkok city of central Thailand ranging 100km east and west by 100km north and south (figure 2).
Landsat MSS data received in Thailand was used as input image data (table 1).
The map is 1/250,000 scale map of Thailand (table 2).
As for pre-processing, geometric correction was carried out by using four GCP points. It is re-sampled in accordance with UTM projection by using linear transformation into 50m pixel size.
1/250,000 maps were digitized to raster data with a scanner.
The sampling pitch of a scanner is 0.2mm quantized in 256 levels with red channel which is most clear and useful among four channels (R, G, B and B/W).
Map raster data was resampled in 50m by linear transformation into UTM projection. Four sheets of resampled data were gathered into one plane.
The displacement quantity of image data plane to map plane were measured in 16 blocks by dividing whole test area.
The displacement quantities of image plane to a map plane are shown in figure 3. And the geometric correction was made by using them.
The remainder difference at the verification points after geometric correction are shown in figure 4.

2-4. Conclusion

It became clear that this simple geometric correction method using small scale map has enough accuracy.
Besides, it is applicable to register multiple image data which are, in fact, used in the second study of this report.

3. Classification method using multi temporal data

3-1. Purpose

It is difficult to carry out a land use condition survey to

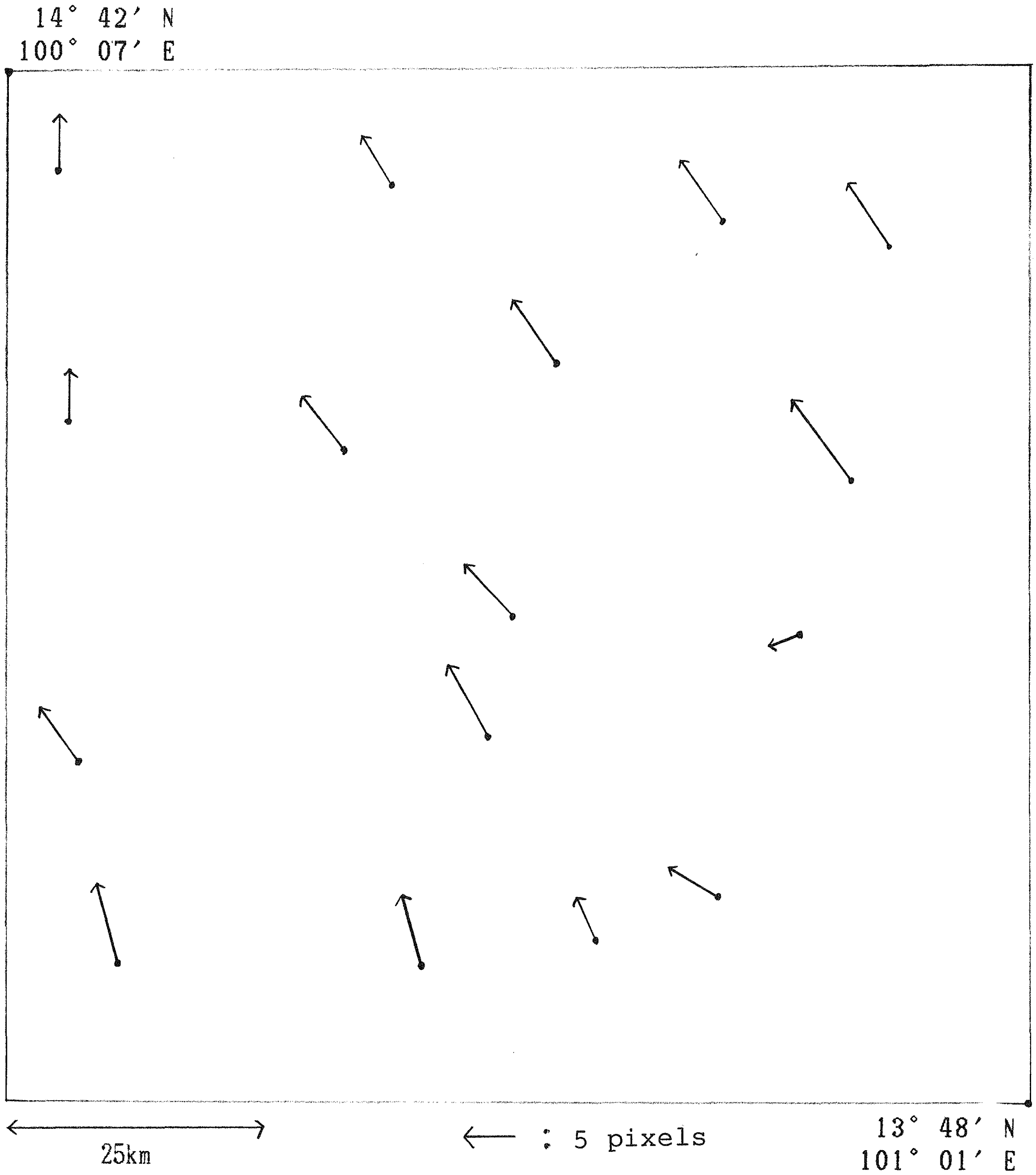

Figure 3 Distributions of GCPs and quantity of motion.

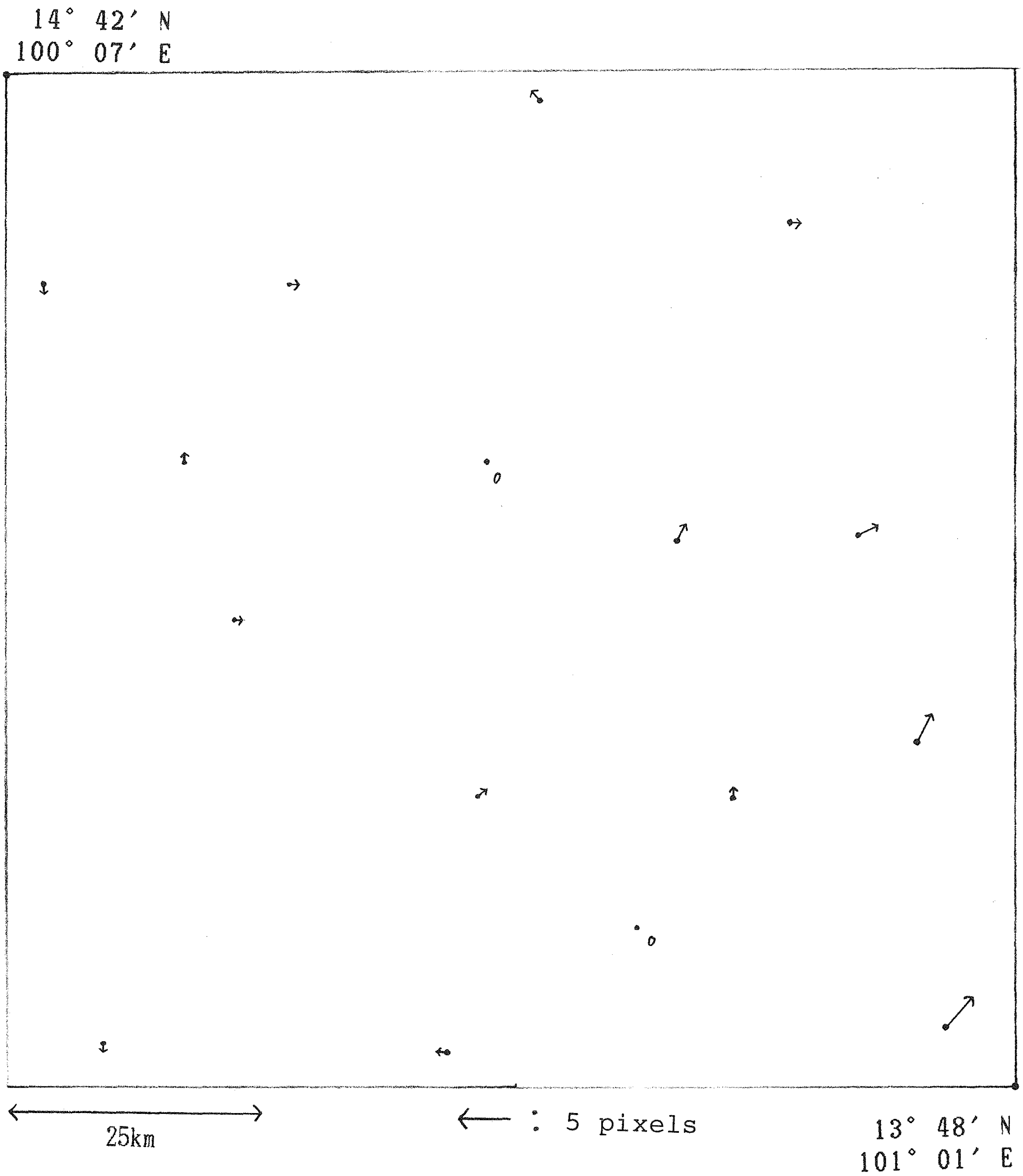

Figure 4 The remainder difference at the verification points after geometric correction.

tropical country by using artificial satellite data of one time. In this regard, a method to improve classification accuracy by using multi temporal artificial satellite data and a specialty knowledge of researchers was developed.

3-2. Outline of process

First of all, all data were geometrically corrected and registered to each other by using the method described above. Next, a classification is carried out independently by Maximum Likelihood Method. The result is filed in BIP format.
Extracting one category from each classification result and overlayed on color display.
Considering one category of single date data , each pixel should be classified in two cases whether it is of the category or not. In other words, there are square of n cases as for n date data. Accordingly, each pixel is belonged to any of square of n cases. Each different case is indicated on a color display with different color so that researcher can extract optimal combination of cases interactively out of all cases.
Final classification is carried out by repeating the aforementioned processing for every categories.
Of course the pixel fixed by the former turns were omitted from the pixels being classified in the next processing turn.
After finishing all the turns, there is still possibility of remaining un-classified pixels.
Those un-classified pixels were classified by using the majority vote method along time axis which counts the classification result of four date data or the majority vote method over spacial axes which counts adjacent eight pixels around the pixel.

3-3. Case Study

Test site is KANCHANA-BURI area (ranging 26km east and west by 24km north and south) about 130km west of Bangkok city of Thailand (figure 2).
Major land use of this area is paddy field, sugarcane and orchard. It is in wide variety of terrain as flat ground, plateau and a low mountainous region.
Four seasons of Landsat MSS data received at Thai receiving station were used (table 3).
Test area were extracted from each of the four date data and geometrically corrected.
Then all data were classified independently into nine categories by Maximum Likelihood Method.
A part of the classification result is shown in figure 5 and figure 6.
Then, one category was chosen to be displayed for interactive decision making process.
In this case, since four date data were used, there were 16 cases of combination displayed in 16 colors.
The order of categories to be processed were decided as easy to interpret by visual as water surface, paddy field, town , sugar cane, bamboo, ballen land, forest land and shade.
In other words it is the order that high classification accuracy

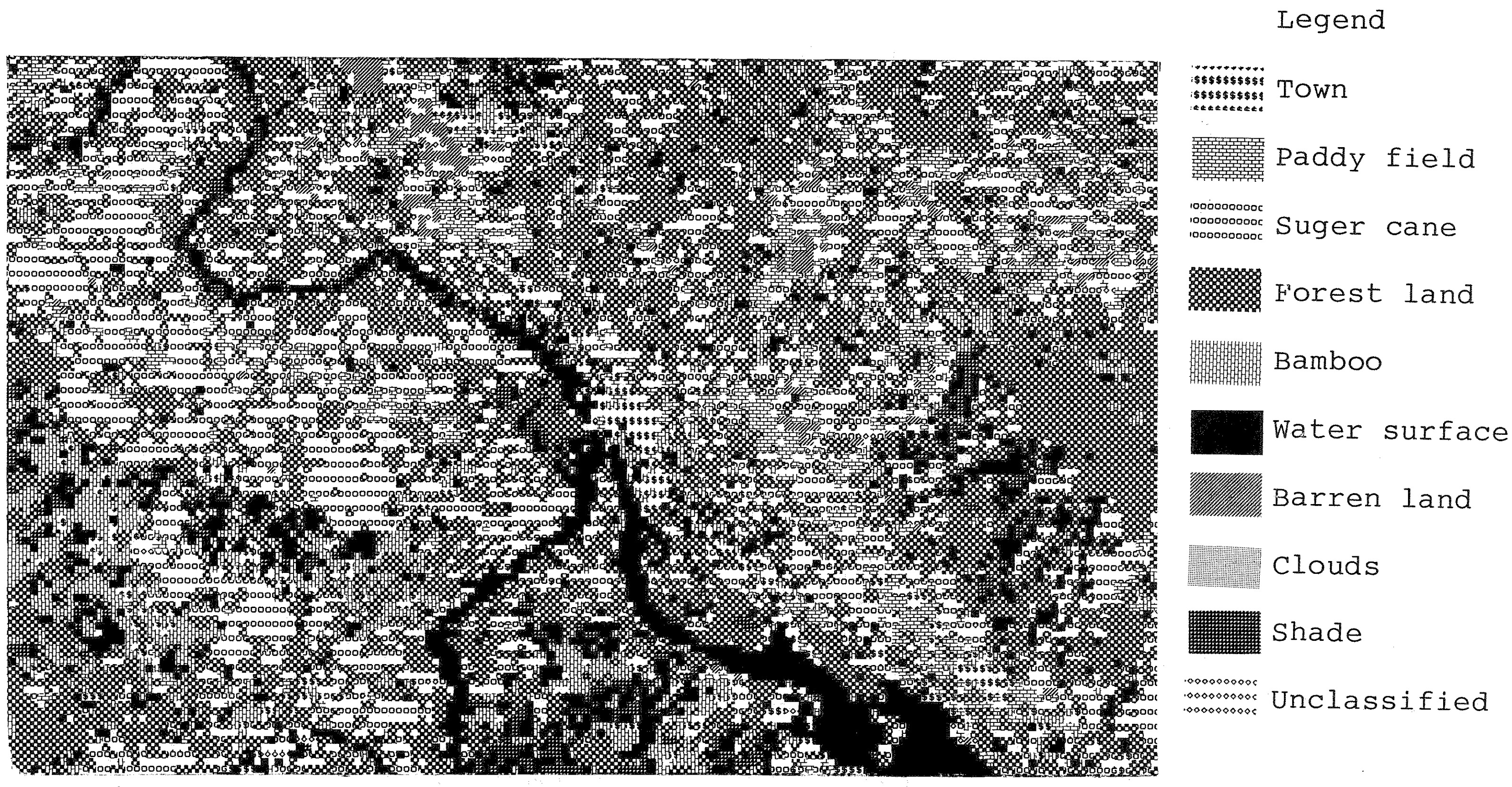

Figure 5 Land Cover Classification of KANCHANA-BURI.
Scale is 1:100,000.
Base data: 14 January 1987 Landsat-5 MSS.

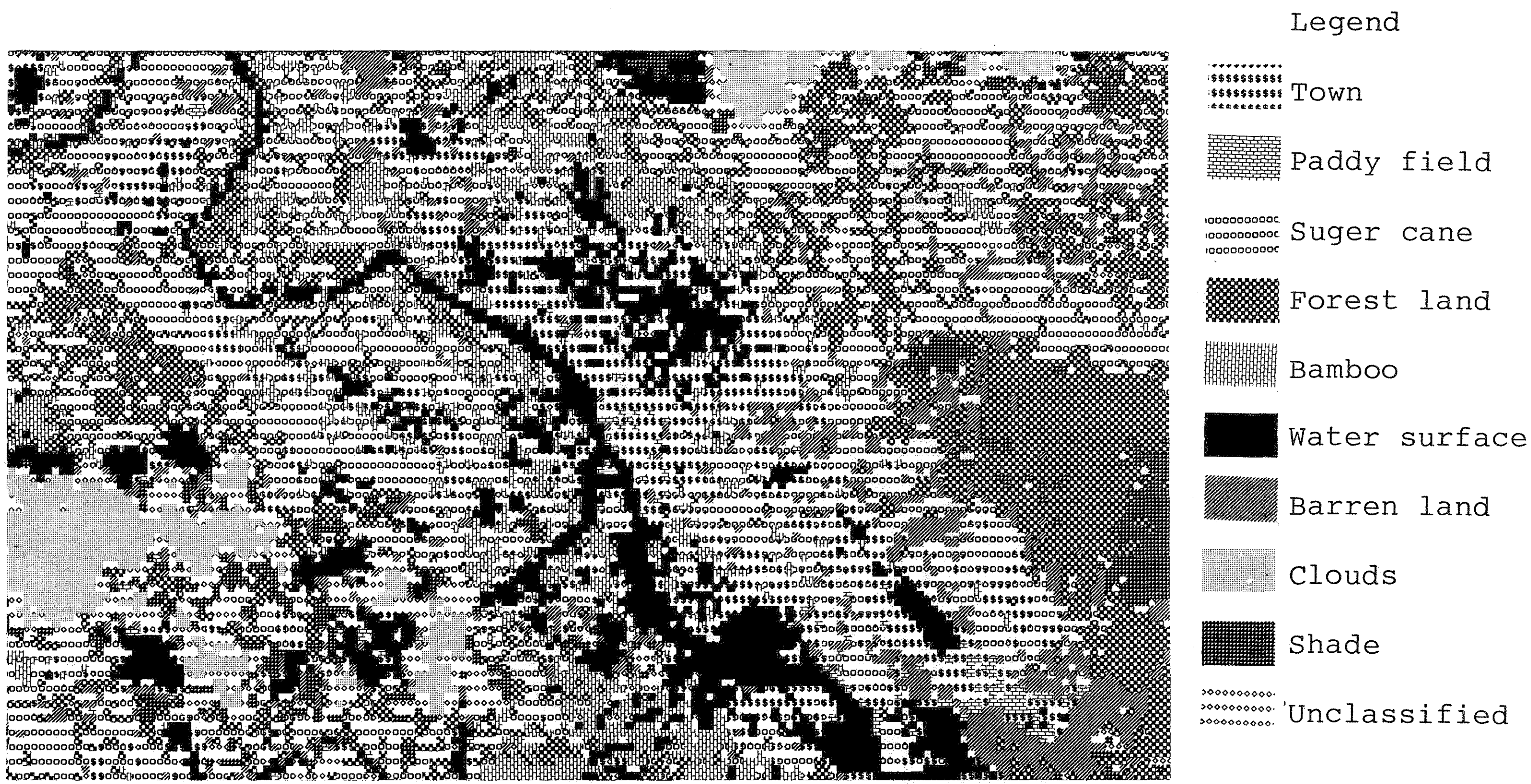

Figure 6 Land Cover Classification of KANCHANA-BURI.
Scale is 1:100,000.
Base data: 26 September 1984 Landsat-4 MSS.

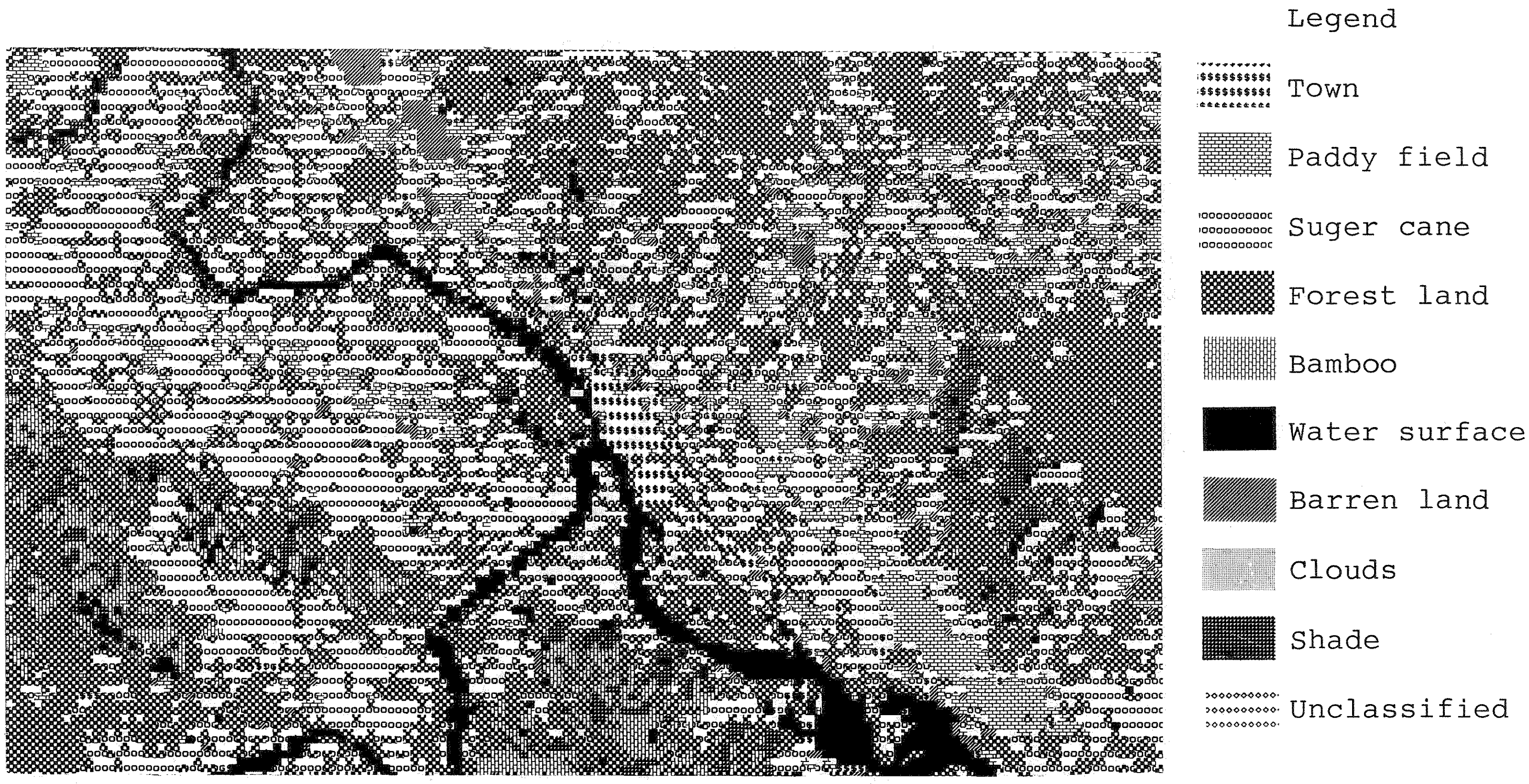

Figure 7 Result of Land Cover Classification.
Scale is 1:100,000.

can be expected. After processed all categories, unclassified pixels were processed.
A part of the final classification result is shown in figure 7.

3-4. Conclusion

We think that the classification result was improved in comparison with each of the single date classification, an accuracy estimation has not finished yet though.
We will further improve this method by adding a capability to utilize soil condition maps, terrain elevation data and so on. This method can take account of the knowledge of a researcher and improve classification accuracy.

4. Acknowledgment

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table 1 Satellite data parameter of case study.

satellite	sensor	path-row	date	level	format
Landsat-5	MSS	129-50	85.2.2	BULK	CCRS

table 2 Map data of test site.

scale	number	name of map
1/250,000	ND47-07	CHANGWAT SUPHAN BURI
1/250,000	ND47-08	CHANGWAT PHRA NAKHON SI AYUTTHAYA
1/250,000	ND47-11	CHANGWAT NAKHON PATHOM
1/250,000	ND47-12	BANGKOK METROPOLIS

table 3 Satellite data of test site.

Satellite	sensor	path-row	date	level	format
Landsat 4	MSS	130-50	84. 5. 5.	Bulk	CCRS
Landsat 4	MSS	130-50	84. 9.26.	Bulk	CCRS
Landsat 5	MSS	130-50	85.12.10.	Bulk	CCRS
Landsat 5	MSS	130-50	87. 1.14.	Bulk	CCRS