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On the Analytical Method of 1:1,000,000 Land Use Map of China based on Image Processing

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画像処理ソフトを用いた 100万分1中国土地利用図の分析手法の開発

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要　旨

中国土地利用図編集委員会 (Wu Chuanjun 代表) が編纂した「1:1,000,000 中国土地利用図」は、1980年頃の中国全土の土地利用状況を知る上で無二の情報源であり、同国の土地利用・土地被覆変化研究に欠かすことができない。その土地利用分類は大変詳細で、60種以上の土地利用の識別が可能である。しかし一方、その情報の多さと印刷技術上の問題、それに印刷図が本来もつ数量分析上の困難などのため、これまで十分に活用されてきたとは言いがたい。そこで中国北部沿岸地域を対象として、画像処理ソフト Adobe Photoshop とプログラムソフト BASIC/98 を用い、原図をスキャナーで読み取り画像処理し、さまざまな土地利用情報を選択的にあるいは統合的に図示・数量化し分析するまでの一連の手法を開発した。その中には土地利用種別面積集計、重ね合わせ、バッファリングなどのGIS的機能も含まれる。その結果、原図では直接把握することが困難な広葉樹林と針葉樹林の分布の違いや、渤海湾・莢州湾沿岸、遼東半島沿岸において大規模な塩田の分布が見られることなどが明瞭に示された。

Keywords: 1:1,000,000 中国土地利用図 , Adobe Photoshop, LUCC

1. Introduction

1:1,000,000 Land Use Map of China (Wu ed. 1988) is an invaluable source of information on the state of land use in China ca. 1980, and is used widely in the study of land use/cover changes in China (Himiyama et al. 1997, Himiyama et al. 1999). It is a series of 64 map sheets that have over 60 land use categories. However, it is difficult to read, interpret and utilise the information fully by a direct visual observation alone, not only because of its complexity and richness of information, but also because of the quality of printing of the map. The vectorised digital database of the map, which has been prepared by L. Crissman (1997), may be used effectively in a GIS environment, but it requires a substantial amount of money and

technical experience that are not always easy to get, as well as a written permission to use it. In order to avoid these difficulties, Adobe Photoshop, a popular image processing software, and BASIC/98 have been used as the principal tools to assist reading and analysing the printed map sheets. They are low-cost and easy to handle, yet have advanced functions that are of great use for the study of land use/cover. The present paper outlines the new method, applies it to a portion of the 1:1,000,000 map covering the northern China (maps J-50 & J-51), demonstrates its uses and discusses its effectiveness and significance. The study area is 36 °- 40 ℕ and 114 °- 125 ℉, including the northern part of the North China Plain, Beijing, Tianjin, Shantung Peninsular and Liaotung Peninsular (Figure 1). It has long been a centre of not only politics and economics, but also agriculture of the country.

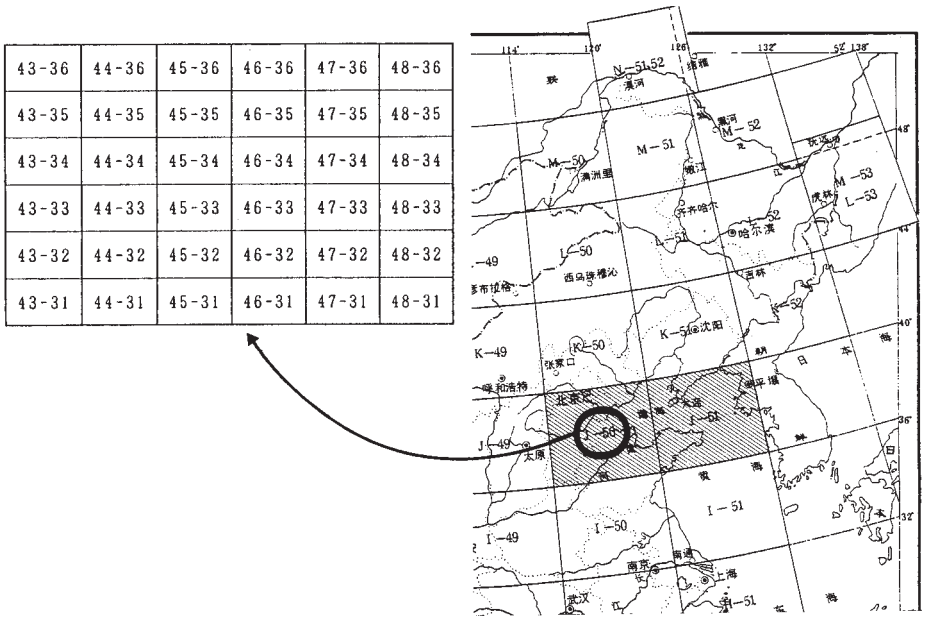

Figure 1 Study area and file names of 80 km grid squares

2. Processing of Land Use Map

2.1 Land use map image file

The quantity, quality and complexity problems of 1:1,000,000 Chinese Land Use Map can be greatly improved by processing of the map image. It can be done as follows:

a) Scan each unit area of the map by a scanner.

b) Divide each sheet of the 1:1,000,000 map into 6 × 6 unit areas. They are 1 ℉-W and 40 ′N-S each, and may be called a 80 km grid.

c) Adjust each unit area to a standard 8.1 cm (horizontal) × 7.25 cm (vertical) rectangle by Adobe Photoshop in order to make the digitizing process (see Section 4.1) easier.

c) Remove lines, characters and bugs and blurs on the map by painting by Photoshop. Save the image data as an image file (.pds), which may be called an image data file.

The .pds file corresponding to each 80km grid square is given a file name as shown in Figure 1. The two numbers of each file name are the sequential number of west to east and south to north, respectively.

The land use classification of the 1:1,000,000 Chinese Land Use Map is very detailed, and over 60 types of land use are classified. In the present study, 66 categories are identified, including urban, agricultural, forest, and other uses.

2.2 Processing of image data file

The image data files produced as above can be processed as follows:

1) change colour

It is easy to change the original colour of each land use on the map sheet to the colour one wants by Photoshop. It helps one to identify the distribution of certain types of land use, or to investigate in the spatial relationships of different types of land use.

2) selection of certain land use

Each type of land use or group of land uses can be selectively shown by Photoshop. This function is particularly useful when one deals with certain type of land use or group of land uses.

3) selection of certain area

If there is an image to be overlaid on the land use image, such as that showing the area of a province, the overlapping part can be cut off or be selectively shown.

4) buffering

The pixels within the designated range from the selected type of land use can be shown as a buffer zone. It is done by using the “extension” function in the “change of selection area” function of Photoshop. The pink-colour zones in Figure 2 are created by buffering of urban areas within Greater Tianjin.

3. Land Use in the Study Area in ca. 1980

Figure 3 shows the general land use map produced by the method outlined above, while Table 1 shows the land use structure of the region derived by the method in Section 4.2. The land use in the study area is now examined based on them.

3.1 Agricultural land use

Agricultural land use includes paddy field, dry field, grassland, orchard, and other tree crops. Figure 4 shows the distribution of agricultural land use. Thanks to the good climate, favorable soil and extensive flat land, it occupies as much as 79.0 % of the land in the study area, and is distributed widely except in the Luliang Mountains in the north-east of the study area.

1) dry field

Figure 5 shows the detail of agricultural land use. Dry field is the predominant type of land use in the study area, occupying 67.4% of the land area. Irrigated field is more common in the central and northern part of the North China Plain, where the summer time precipitation is not enough nor stable. Wheat and maze are the common crops of the region. Non-irrigated dry field is more common in the southern part of the study area and in the Shantung Peninsular. In the former, beans and potatoes, as well as maze are common, while in the latter peanut is specialty. Vegetable field is only 0.5 %, concentrated in the suburbs of large cities, such as Beijing, Tianjin and Shihkiachwang.

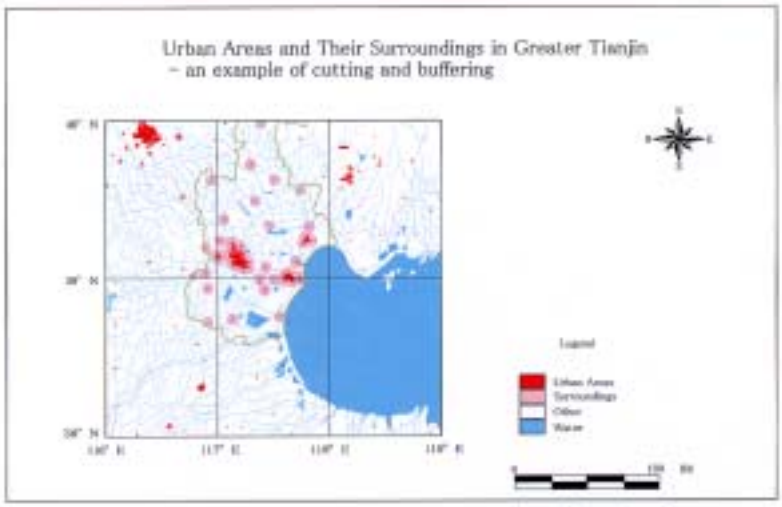

Figure 2 Urban areas and their surroundings in Greater Tianjin–an example of cutting and buffering

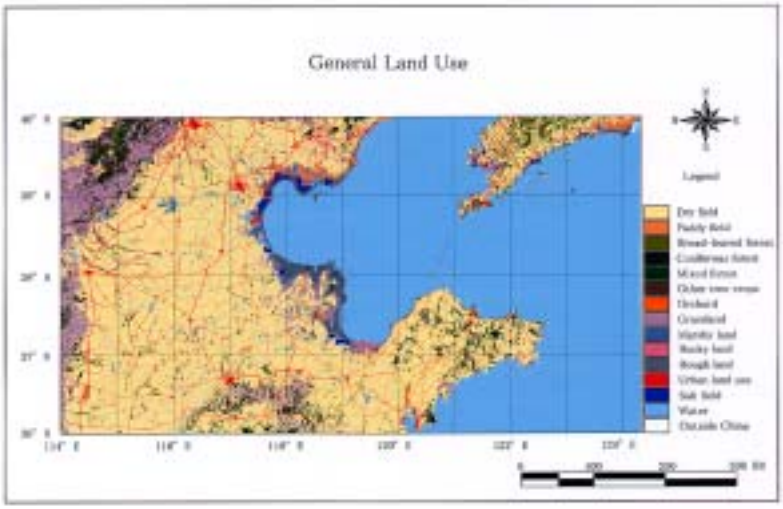

Figure 3 General land use

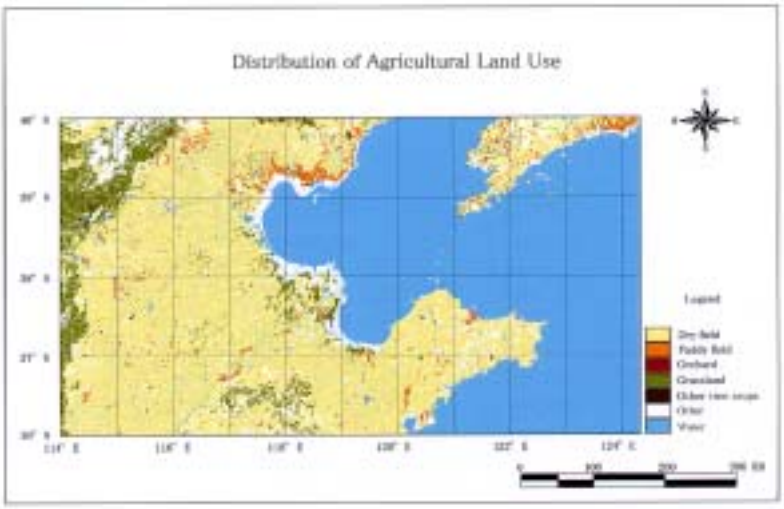

Figure 4 Distribution of agricultural land use

Table 1 Land Use Structure of the Study Area

Agricultural land use	**79.0%**	**Urban land use**	**3.9%**
Dry field	67.4%	Urban area	1.6%
Paddy fierd	2.0%	Road·Railway	2.3%
Orchard	0.8%		
Grass land	8.5%	**Other land use**	**8.9%**
Other tree crops	0.3%	Rough land	2.5%
		Rocky land	1.5%
Forest	**8.2%**	Marshy land	1.7%
Broad leaved forest	3.0%	River	3.6%
Coniferous forest	2.1%	Lake	0.6%
Mixed forest	3.1%		**100.0%**

2) paddy field

Paddy field occupies only 2.0% of the land area, distributed along major rivers such as the Hwang Ho, in the low lands near Beijing and Tianjin, and in the Liaotung Peninsular.

3) grassland

Grassland occupies 8.5%, mainly in the hilly and low mountain areas in the west, centre and Liaotung Peninsular.

4) orchard

Orchard occupies only 0.8%. Apart from the high concentration around Chefoo (Yentai) on the northern coast of Shangton Peninsular, the distribution is rather scattered in Liaotung Peninsular and in and around the North China Plain. Shantung Peninsular occupies 45% of the fruit production in Shantung Province, while Liaotung Peninsular occupies about half of the production in Liaoning Province. In fact, the study area includes the major fruit producing areas of the country.

3.2 Urban land use

Urban land use includes urban areas, roads and railways. It occupies 3.9% of the land area, and is distributed as shown in Figure 6. Apart from Beijing, Tianjin and other major cities, the study area includes numerous medium and small cities which appear as small dots on the map. Industrial areas are mostly seen adjacent to major cities.

3.3 Forest

Forest, which occupies 8.2%, is conspicuous in the Luliang Mountains in the west and inland of Liaotung and Shantung Peninshular. Coniferous forest is concentrated in Shantung Peninsular, while broad-leaved forest shows a high concentration in Liaotung Peninsular.

3.4. Salt field

Large scale salt fields are seen along the coast of Bohai, where the climatic and coastal conditions help salt production.

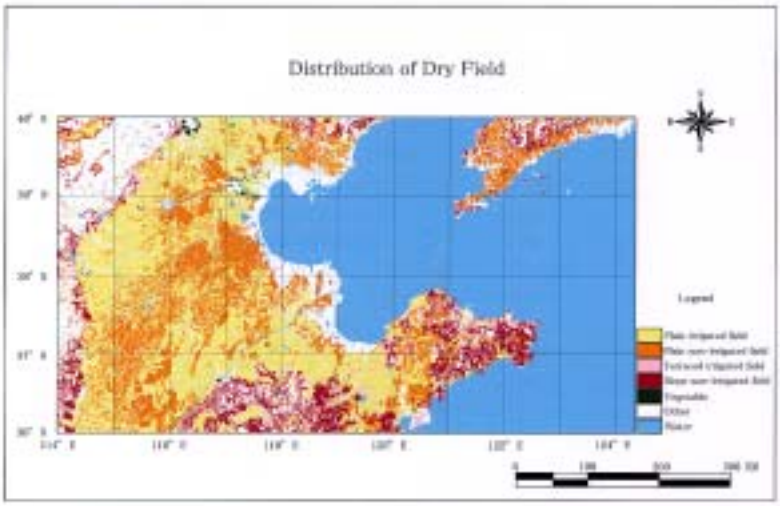

Figure 5 Distribution of dry field

Figure 6 Distribution of urban land use

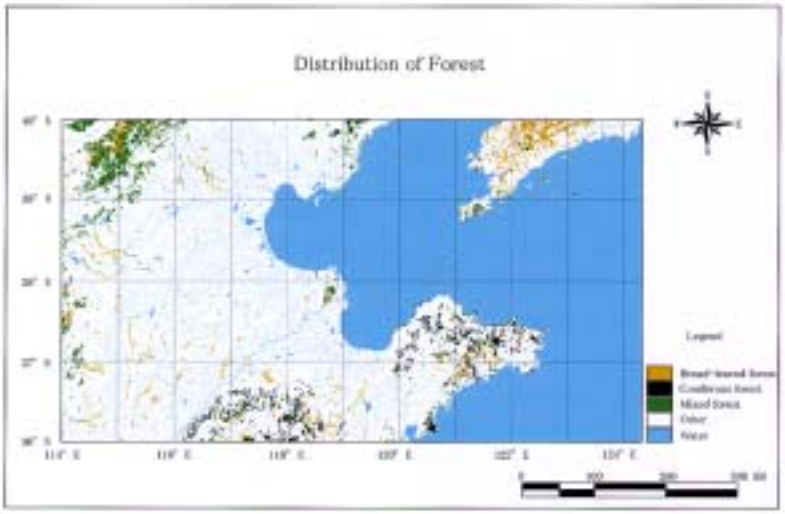

Figure 7 Distribution of forest

4. Land Use Grid Data

4.1 Pixel data file

The land use map image data file produced as above can be converted to a digital form by using BASIC/98, as follows:

a) Reduce the resolution level of the image data file to the right level. If the resolution level is kept too high, the image data will be too heavy to process in the BASIC/98 environment. Save the image data at the reduced resolution level as a bit map file (.bmp).

b) Paste the .bmp map image produced above on the BASIC/98 screen.

c) Run 'point' function, and get the colour code number of all pixels of the map. The colour code ranges 0 - 4096. Within a 80km grid, there are 280 (N-S) × 320 (E-W) pixels, i.e. a pixel represents about 300m × 250m. Save the pixel colour data as a text file (.txt), which may be called a pixel data file.

d) Group the four-figure pixel colour code into two-figure pixel land use code by using BASIC/98.

e) Save the pixel land use data file as a text file (.txt).

4.2 2km grid data file

The pixel land use data can be grouped into a set of small grid squares. Here the 80km grid is divided into 2km grids, each of which having 7 × 8 pixels, and a 2km grid data file is made as follows (Figure 8):

a) Use BASIC/98 to check the colour code of each of 7 × 8 pixels, and count the number of pixels having each colour code.

b) For each 2km grid, write x-coordinate, y-coordinate, code of the land use on the top-left corner of the grid, code of the largest land use type in the grid, code of the second largest land use type in the grid, and so on by using BASIC/98.

c) Save the 2km grid land use data file of the 80km grid as a BASIC data file (.txt).

d) Combine 6 × 6 80km grid data files to make a new data file for each 1:1,000,000 map sheet, and save it with the file name shown in Figure 1.

The area figures in Table 1 have been calculated by using the land use information on the top-left corner of each grid square based on systematic point sampling.

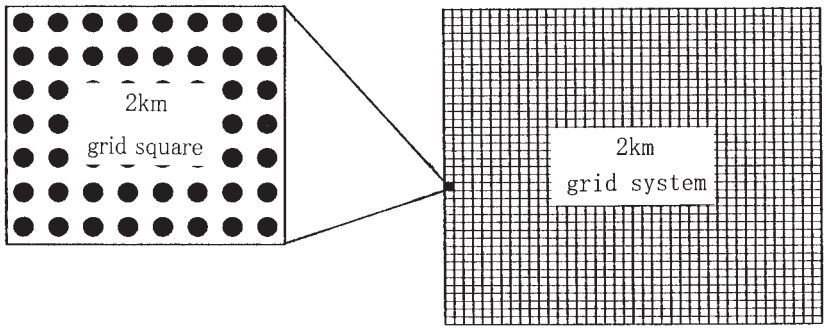

Figure 8 7 × 8 Pixels in each grid square of a 2 km grid system

5. Conclusions

The data files produced here and the procedures to make them are schematically shown in Figure 9. The study revealed that a popular image processing software, together with an easy programming language, can be of great use for the analysis of a printed land use map. It is hoped this simple but effective method is used by those who do not have an easy access to sophisticated GIS environment and contribute the progress of the study of land use/cover change.

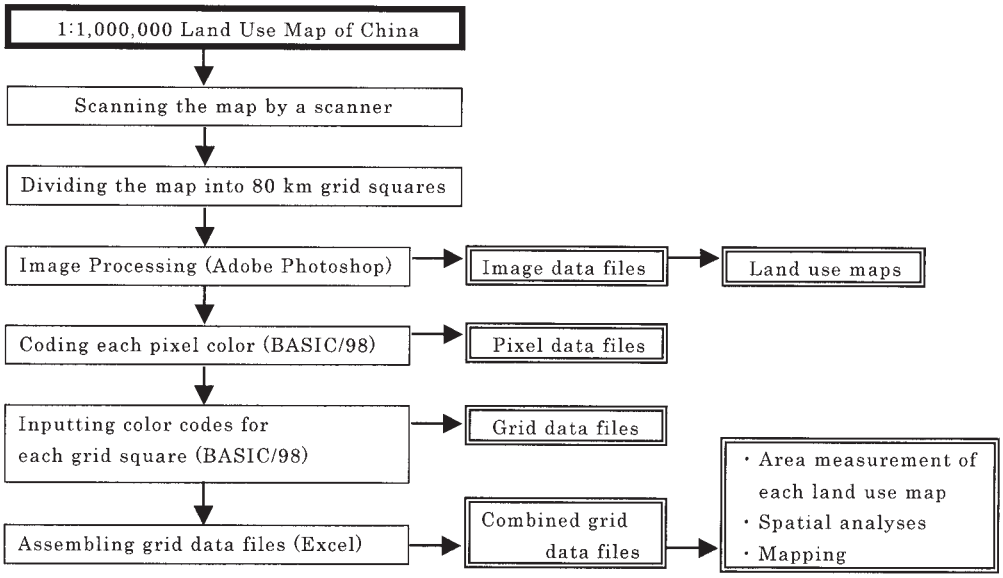

Figure 9 Workflow and outputs of the scheme

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