APPLICATION OF THE MULTI-LEVEL SAMPLING INTERPRETATION OF REMOTELY SENSED IMAGERY IN TERRAIN SURVEY AND MAPPING

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ABSTRACT:
The conventional approach for interpretation of land types on remotely sensed imagery depends mostly on one kind of imagery, usually on same scale, which has caused some problems to the interpretation. The present sutdy deals with the utility of multi-level sampling interpretation method for extracting land type information from remotely sensed imagery, taking Huangpuchuan River catchment in Jungar County of Inner-Mongolia, China as the test area. Based on this approach, land types at the different levels, namely, land system, land unit and land site were interpreted and mapped. The study demonstrated that this approach could make the interpretation more efficient and, therefore, much reducing time and costs in terrain survey and mapping. Nevertheless, the accuracy of resultant terrain maps depends greatly on appropriate selection of sampling areas.

KEY WORDS: Remotely Sensed Imagery , Multi-level Sampling Interpretation, Land Type

1. INTRODUCTION

As one of the most foundamentary tasks in land studies, land classification and mapping can provide a significant basis for land use planning. Remotely sensed imagery has been used in land classification and mapping for several decades. However, the conventional approach for interpretation of land types on remotely sensed imagery depends mostly on one kind of imagery, usually on same scale, which has caused some probelems to the interpretation. This is because of not only apparent difference in overall characteristics of land types at different levels on a given kind of imagery, but also of great variation in apperance of land types even at same level but on different kinds of imagery.

Townshend (1981) has made a recommendation on using the multi-level sampling method for extracting terrain information from remotely sensed imagery. Recently, this approach was used and further developed in our study on the Loess Plateau in China.

2. STUDY AREA AND IMAGERY

Huangpuchuan River catchment as the study area with approximately 1847 sq. km is located in Jungar County of Inner-Mongolia. In topography it is dominated by loess hills and sandstone hills along with sand-mantled loess or sandstone hills.

Two kinds of imagery were used in this study, namely, the false-colour Landsat TM image on 1: 100, 000 scale, composited by bands 2 (blue), 3 (green) and 4 (red), acquired in later August. 1986, and the colour infrared aerial photographs on 1: 50, 000 and 1: 10, 000 scales, obtained in early September 1987.

3. PROCEDURES AND RESULTS

The multi-level sampling interpretation consists of several stages (Fig. 1) in which the information of land type at the different leverls were extracted based on interpretation of the imagery together with consulting thematic maps and field survey.

3.1 Interpretation and Mapping of Land Systems

A land system is defined as "an area or group of areas, throughout which there is a recurring pattern of topography, soil and vegetation" (Christian and Stewart, 1968). In order to identify and delineate the land systems on the TM image the study area was divided into five kinds of region based mainly on variation or spatial combination of photomorphic characteristics, especially colour tones. In other words, each kind of region has own notable photomorphic features, in particular colours and their combination. Region A is characteristic of long and very narrow white stripe accompanied with wide brown-red stripes on both flanks, sometimes on one flank. Region B appears to be dark green broad stripes as well as light brown or light yellow patches. Region C is dominanted by redish yellow colour together with light green narrow stripes. In region D, the major colours are brown-red and green, or brown-yellow, brown-red and greyish white. In region E, greyish white is the dominant colour, along with patched brown-yellow, light yellow or brown-red colours.

By consulting the land cover/use map and other ancillary data and through reconnaissance surveys an integrated analysis on the relationship between photomorphic characteristics of each region and its probable land system was conducted. As a result, each of these regions was assigned to a given land system with some indispensable modifications in its boundary. The resultant land system map was shown in Figure 2, and the main characteristics of each land system were briefly described in Table 1.

Table 1 The Main Characteristics of Land Systmes

Land system symbol	Characteristics	Total area (sq. km)
A	River beds in greyish white colour; and river terraces cultivated and in brown-red colour, with patches of woodland in dark brown colour or grassland in light yellow colour.	161.5
B	Loess hillside, cultivated and in light brown colour or grass-covered and in light yellow colour; and sandstone gullies, mostly bared and in dark green colour.	443.9
C	Sandstone hillside, mostly grass-covered and in reddish yellow colour, and partly cultivated and in light brown colour; and sandstone gullies, mostly bared and in light green colour, and large gully bottoms in brownish red colour.	390.4
D	Sand-mantled loess hillside, forested and in brown-yellow colour, or cultivated and in brownish red colour, or bared and in greyish white colour; and grass-covered loess gullies in yellow green colour or cultivated and in brown-red colour.	679.5
E	Sand-mantled and nearly level to gently undulating ground, mostly bared and in white colour and partly forested and in reddish yellow colour, or cultivated and in brownish red colour; and sand-mantled shallower gullies, mostly cultivated and in red colour, or forested and in brown-red colour.	171.2

3.2 Interpretation and Mapping of Land Units

Land units are the broader components of a land system. Each land unit formed on a basic topographic unit has its corresponding soil and vegetation. In order to delineate land units in a land system, a number of sub-region with relatively homogeneous photomorphic characteristics were distinguished on the TM image. In addition, one sampling area was selected in each sub-region and its boundary was as accurately as possible depicted on 1:50,000 scale aerial photographs. As a result, land units were interpreted through analysis on the relationship between photomorphic characteristics and physiographic features combined with the consulting of the thematic maps and field observation.

In the interpretation of land units such information as landform readily to interprete was extracted in the first and could be taken as the starting for further interpretation. Land cover/use types are distinguishable based mainly on colour variation on the photographs. For example, cultivated farmland, fallow, pasture, woodland and settlement cold be distinguished by colours of red, greenish grey, yellowish green, brownish red, and greyish white, respectively. Besides, size, texture and shadow of ground features on the photographs also were used, for instance, to make a differentiation between tree, shrub and grass. Shadows are particularly useful for the estimation of dissection intensity of gullies. Nevertheless, there are still a certain amount of information related to land unit which are not readily to interprete directly on the photographs. Consequently, the deductive inferences added some advantages, for instance, to the differentiation of such ground features as irrigated farmland and dry-farming land based on irrigation canals or special large wells. Through these stages all land units in the sampling area were recognized and mapped on the 1:50,000 scale base map.

Figure 3 shows the sampling area in a sub-region of land system B (loess-covered sandstone hill). The sampling area consists chiefly of two kinds of land unit, namely, cultivated and gently sloping hillside and rocky gully slope. They together account for approximately 85 per cent of the total sampling area, indicating a close correlation between the sampling area depicted by photomorphic characteristics on the TM image and the real distribution of the land units. Using this approach, not only all land units in the sampling area were recognized and mapped, but also all land units in the land system were deduced based on the area proportion and real distribution of the land units in the sampling area, and the area proportion of the sampling areas in the sub-region or even in the land system.

3.3 Interpretation and Mapping of Land Sites

A land site as part of the land unit is, for all practical purposes, uniform throughout its extent in landform, soil and vegetation. In general, the interpretation and mapping of land sites in a land unit followed the approach similar to that for land unit. First, the land unit was divided into a number of small areas with more homogeneous photomorphic characteristics on 1: 50, 000 scale photograph. Second, a sampling plot was chosen for each of small areas and its boundary was as accurately as possible located on 1: 10, 000 scale photograph. Third, elementary relief units and the associated soils and land cover/use types in the plot were identified. Final, all land sites in the sampling plot were interpreted and delimited based on comprehensive analysis on photomorphic characteristics and consulting thematic maps as well as field studies.

Figure 4 illustrates a rocky gully slope plot. In this plot, the land site of gully slope (581) accounts for approximately 68 per cent in area, indicating a good correlation between the sampling plot depicted by photomorphic characteristics on 1: 50, 000 scale for land site interpretation and mapping. Based on the area proportion and spatial distribution of land sites in the sampling plot as well as the area proportion of the sampling plot in the land unit, all land sites in the unit could be deduced and mapped.

4. CONCLUSSIONS

The multi-level sampling interpretation of remotely sensed imagery in terrain survey and mapping conducts the interpretation successively from entirety to part and from higher level to lower level of land type. This stage-by-stage approach is much beneficial to improving quality of the interpretation. In addition, time and costs in the survey and mapping can be substantially reduced as the approach is based on the statistical sampling theory and land type information is extracted step-by-step from sampling areas with relatively homogeneous photomorphic characteristics on imagery. However, it should be noted that the accuracy of resultant land type maps produced based on the approach is largely dependent on appropriate selection of sampling areas. Therefore, while using this approach much attention should be paid to field survey and investigation to ensure the accuracy of the interpretation and mapping.

5. REFERENCES

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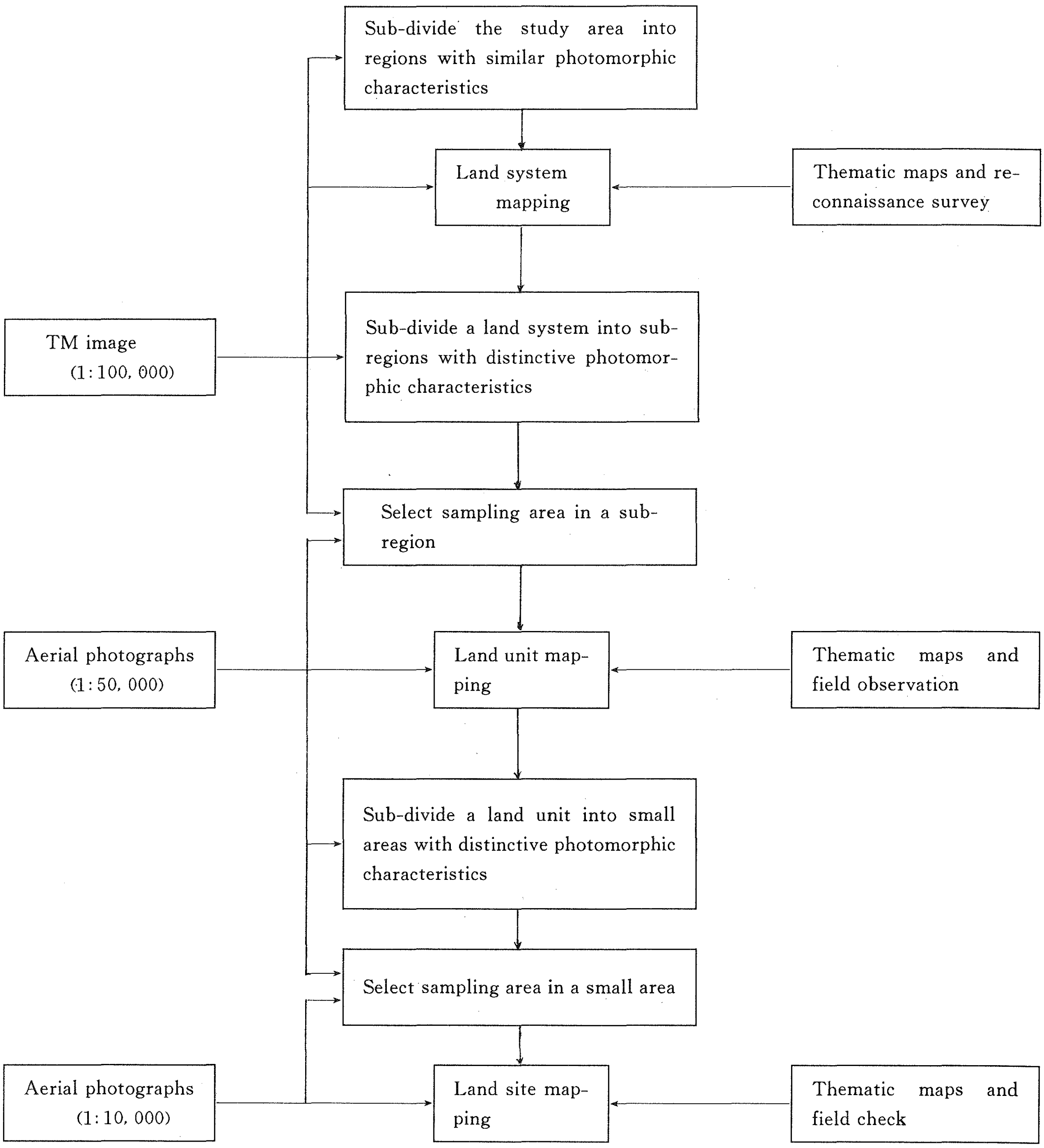


Figure 1 Flow Chart Showing Extracting Land Type Information from Imagery Using the Multi-level Sampling Interpretation Approach.

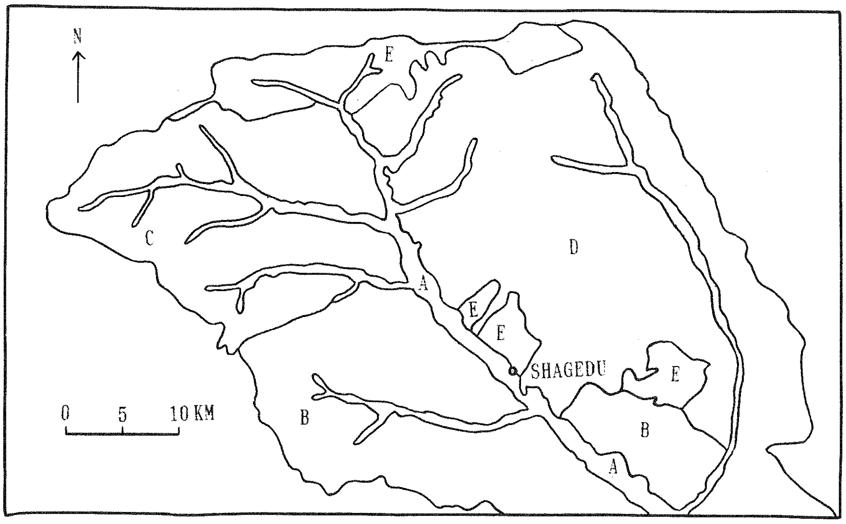


Figure 2 Land Systems of the Study Area.

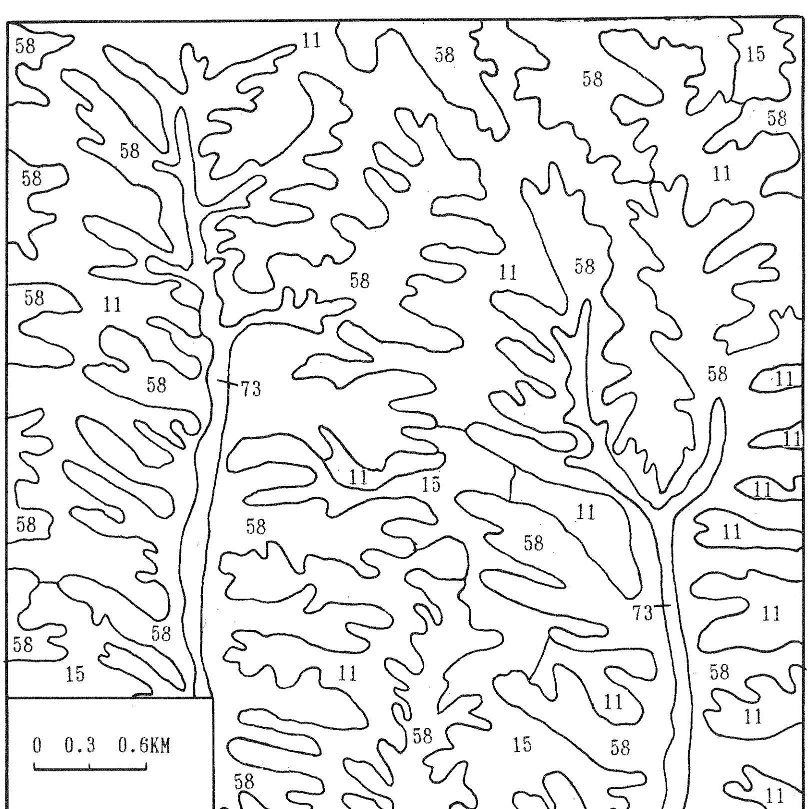
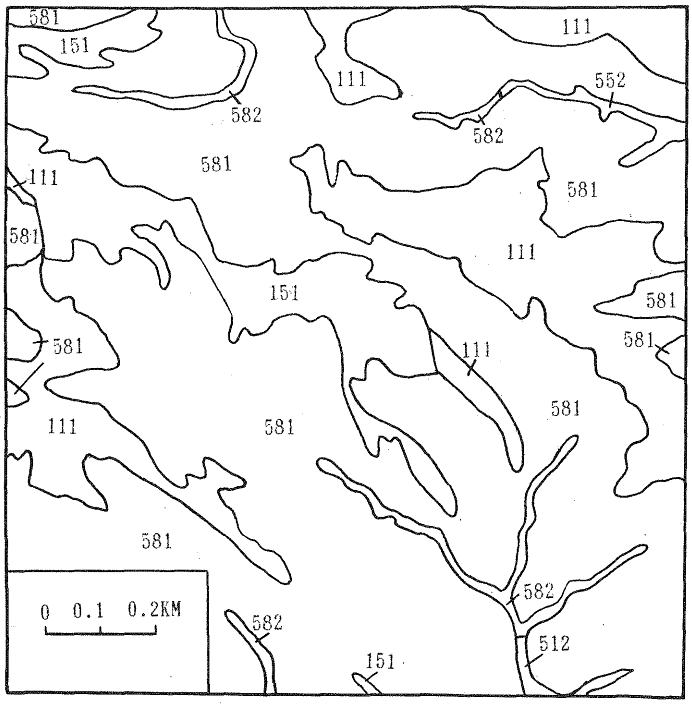


Figure 3 Land Units of a Sampling Area in the Sub-region of Loess-covered Sandstone Hill in Land System B.



111 - Cultivated and loess-covered gently sloping hillside
151 - Loess-covered hillside with grass
512 - Moderate sloping gully slope with shrub
552 - Gully bottom with shrub
581 - Rocky gully slope
582 - Stony gully bottom

Figure 4 Land Sites of a Sampling Plot in the Land Unit of Rocky Gully Slope.