

STUDY ON METHODS OF LAND USE DYNAMIC MONITORING AT COUNTY LEVEL —Taking Dehui County, Jilin Province for Example

LI Lin-yi¹, HUANG Fang², LIU Zhao-li¹, WAN En-pu¹

(1. Changchun Institute of Geography, the Chinese Academy of Sciences, Changchun 130021, P. R. China;

2. Northeast Normal University, Changchun 130021, P. R. China)

ABSTRACT: Remote sensing technique has played an important role in land use dynamic monitoring, but as for the land use dynamic monitoring at county level, traditional remote sensing methods such as satellite imagery visual interpretation and computer classification can not meet its demand for accuracy. The result of 1:10 000 land use investigation map has high accuracy, but this method can not be used to dynamically monitor the land use because of its big expenses, long period and difficulty in updating data. In this paper, the characteristics of physiognomy, climate and the status of land use in Dehui County are taken into consideration and a set of method, which takes use of 3S techniques and applies to Northeast China Plain, is come up with. When the land use type of a land parcel changed as a whole, the date updating can be make by changing its land type ID in the attribute table in a GIS. When the land use type of an irregular area changed, GPS receivers are used to position its border. This set of method is characteristic of high accuracy and low expenses. It gets the information of land use change timely and can be used to dynamically monitor the land use.

KEY WORDS: land use at county level; dynamic monitoring; GPS; attribute alternation in GIS

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1 INTRODUCTION

More arable land is needed to meet the continuous increase of population, at the same time, with the rapid development of economy in China, more and more arable land were occupied for the construction of transportation, industry and settlement. Increasing arable land by reclaiming and cultivating unused land and forestland or filling up lakes give rise to environmental deterioration, ecological disturbance and want of natural resources. In order to balance the various kind of requirements for land, utilize the natural resources

validly and protect ecosystem efficiently, the land use change such as arable land change, natural vegetation change, water body change and other information such as urbanization, desertation and soil degeneration should be taken timely and accurately(LIU, 1998). Namely, it is imperative to dynamically monitor the land use.

Land use should be dynamically monitored at national, provincial and county level(LIU, 1997). National and provincial land use dynamic monitoring provide information of resources and environment for national decision-making department to macro-control the

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Biography: LI Lin-yi(1968 –), female, a native of Jilin, Ph. D. candidate of Changchun Institute of Geography, the Chinese Academy of Sciences. Her research interest includes land use change monitoring and crop yield estimation using “3S” techniques.

land use. The TM imagery is the main information resource of this level, and the land use changes can be obtained by TM imagery computer visual interpretation (HUANG, 1998).

Land use dynamic monitoring at county level provides land use changes for basic land managing department to make programs of land use of village level even of every land parcel. The demand of accuracy of the land use dynamic monitoring at county level is much higher than that of the national and provincial level. The resolutions of remotely sensed imagery is not high enough to map land use at a fine scale (TM imagery 30 meters, SPOT imagery 10 meters), the land use change monitoring at this level can not be carried out by remotely sensed imagery interpretation at present. The changes can be detected from remotely sensed imagery, but the change area can not be positioned within the range of error. GPS receiver can be used to position the border of the change area, but if method of GPS field survey were the only means to be relied on, the large amount of field work would reduce its feasibility. The approaches to the land use dynamic monitoring at this lever are exploring.

In the middle and late 1980's, national land managing bureau made a detailed investigation of land use at village level and formed 1:10 000 land use maps. These data of investigation are full of information and have high accuracy, but this work had lasted for several years, in which a lot of labors and funds were put. It is difficult to update the investigation results, and it is impossible to obtain the information of land use changes annually.

National key project, "Establishment of demonstrating project of Resource and environment dynamic monitoring system at county level by remote sensing", aimed to explore a set of approach to dynamically monitor land use by means of RS, GIS and GPS techniques. "Demonstration of land resources dynamic monitoring technique in Dehui" is a key subject of the project. We take Dehui as an example to study the land use change and come up with a set of method that is based on "3S" technique, applies to Dongbei Plain, meet the demands for accuracy of fine scale (1:10 000) land use dynamic monitoring and is easy to implement.

2 DATA PRE-PROCESS

The detailed survey maps of land use of Dehui made in the late 1980's was chosen as the working base maps in this paper. Based on the available topographic maps of 1:10 000, the detailed investigation maps had been made by land type field investigation and aerial photograph transfer. In the process of forming of these maps, The accuracy is demanded as follows: the accuracy of the liner objects including rivers, roads, fixed canals and ditched and ridges should be up to 0.1m. The positioning error of complementary measurement should be lower than 0.8-1.2mm. The smallest patch of arable land, forestland, grassland and settlement (industrial land) in the topographic map and aerial photograph are 6.0mm², 15.0mm² and 4.0mm² respectively.

Two hundred sheets of land use investigation map were digitized by Manual Digitizer with the tracing error less than 0.2mm. The land use map based on the detailed investigation maps of 1:10 000 scale was formed after editing, projecting, edge matching and map joining in PC ARC/INFO environment, and it was stored in ARC/INFO coverage or ARC/VIEW shape file format. This map will be called "land use investigation map" in the following discussion so that it would be distinguished from other maps. The Landsat TM images were the main remote sensing information resource in this study. TM images in October 1996 and September 1998 covered Dehui were used after being rectified, strengthened, edge filtered.

3 STUDIED AREA

3.1 Climate Characteristics

Dehui, located in the middle of Northeast China Plain between 125°14' - 126°23'E, 44°03' - 44°45'N and covers an area of 3458.7 km², belongs to temperate continental monsoon climatic region. The fine days in which the amount of low clouds is less than 20% of the sky are more than 200 days annually in Dehui. There are 19 fine days monthly in spring and autumn, even though in the rainy season there are still 12 fine days

monthly. So the remote sensing images with no cloud contamination are easier to obtain. The spectral characteristics of the main land use types such as settlement land, industrial land, dryland and paddy land are quite different, and this made it easy to identify them from each other in TM images.

3.2 Land Use Status

Dehui located in the middle area of Northeast Plain, where is flat with small undulation relief and elevation is between 149–241m. The arable land dominates this area by the area of 253 474ha, which account for more than 70% of the total land area in Dehui. Arable land is partitioned into big or small regular-shaped land parcels by the linear object such as field-shelter-forests and road networks. The border of these parcels can be distinguished easily in TM image.

3.3 Land Use Change Characteristic

The land use types in Dehui are various, but the land use changes from year to year is not complicated. The main changes mainly occurred from dry land to paddy land, unused land to arable land or arable land to industrial land and traffic land.

4 METHOD OF MONITORING LAND USE CHANGE AT COUNTY LEVEL

The working flow of land use dynamic monitoring in Dehui is shown in Fig. 1.

4.1 Detection of Land Use Change from TM Images

Based on the topographic maps of 1:10 000, the TM image was registered, rectified, strengthened under the environment of ENVI. With the same mathematical base, the TM image in 1996 was overlaid with the land use investigation map, then the areas on which the land use changed were detected by visual interpretation and analysis on TM image. The aim of these processes is not to position these areas accurately, so the resolution of the TM image had little influence on the result. In

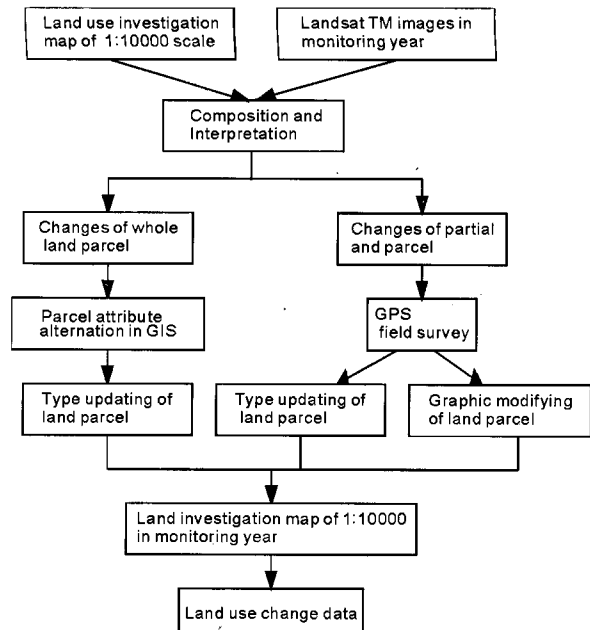


Fig. 1 Working flow of the land use dynamic monitoring in Dehui County

the land use investigation map, the land use type is recorded at the unit of land parcel. It is easy to find the counterpart of these parcels in the TM image. Sometimes the land use type of a whole parcel change completely, and in other cases, a part of the land parcel change its land use type. So these type-changed areas are divided into two categories: whole parcel changing area and part of parcel changing area. As for the former, we dynamically monitor the land use change by a method of attribute alternation in GIS. As for the latter, we dynamically monitor the land use change by GPS field measuring.

In addition, the traditional manual investigation should be effectively adopted when some scattered change areas could not be detected on TM images.

4.2 Land Type Changing of the Whole Parcels and Method of Attribute Alternation in GIS

Each polygon of land parcel has a corresponding record in the attribute table in GIS software. The record represents its specific attribute including area, land use

type, etc. When the land parcel convert from one type to another, altering the original land use type ID to a new land use type ID in the attribute table can fulfill the database updating. The accuracy of the result from this method is the same as that of the land use investigation.

In dynamically monitoring the land use in Dehui, this method is applied to two cases, which is shown in Fig. 2 as a sketch map.

One case is applied to the regularly distributed land parcels bordered with liner objects such as roads, shelter-forests and big ridges, which are very clear both in the land use investigation map and on the TM image (Fig. 2a). Whether the change covers the whole area of a parcel can be judged by comparing the land use investigation map with the TM image. Most of the situations in which dryland changed to paddy land belong to this case.

Another case is applied to the situations under which a plot of land shrank gradually until turned to the type of the land around it completely. (See Fig. 2b).

Though the border of these areas can not be identified on the TM image, we can judge that it belongs to the whole parcel changing because the original type has disappeared. The following examples belong to this case: a plot of vegetable land surrounded by settlement land changed to settlement land completely with city expansion; a polder among paddy field changed to paddy field and a plot of unused land was reclaimed to arable land.

A part of the result obtaining from the method mentioned above is shown in Fig. 3.

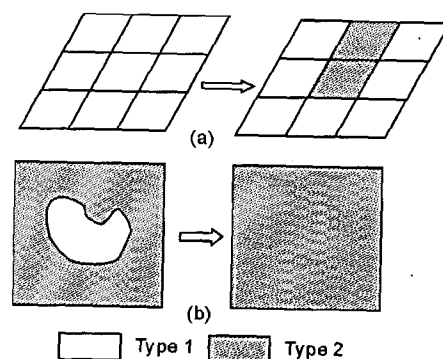


Fig. 2 A sketch map of the whole parcel change from one land type to another land type(left: 1: 10 000 land use investigation map in 1986, right: TM image in 1996)

4.3 Land Type Changing of Partial Parcels and GPS Field Survey

The areas whose land type could not be updated by the attribute alternation in GIS software should be surveyed on the spot by means of GPS receivers(HONG, 1998). These situations include the changes of partial parcel of arable land, the expansion of settlement land and new-build linear object such as roads and highways. In this study, GPS receivers made in Magellan Co., U. S. A are chosen to survey the change areas. We positioned the border of the changed area with DGPS, with data accuracy lower than 1m. Take our work in Songbai Village, Dehui City for example, the GPS differential base station was set on the top of the building of the Songbai Village government. The surveying pro-

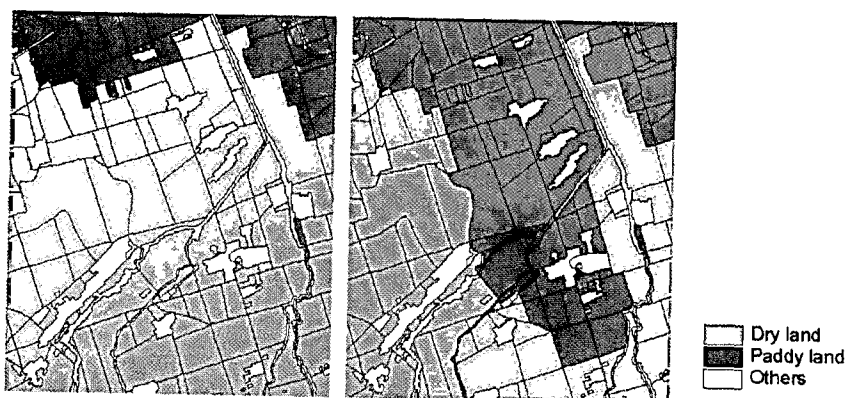


Fig. 3 Land use change obtained by the method of attribute alternation in GIS(part)

cedure is not explained in detail any longer in this paper (WANG, 1999; ZHANG, 1999).

The land use change data was storage in ARCINFO coverage and ARCVIEW shape file format after processed using GPS data processing software, MSTAR. Land use database was updated by composition of land use change data and land use investigation map. Fig. 4 shows the areas surveyed by DGPS in Songbai village, Dehui, which changed from arable land to industrial land.

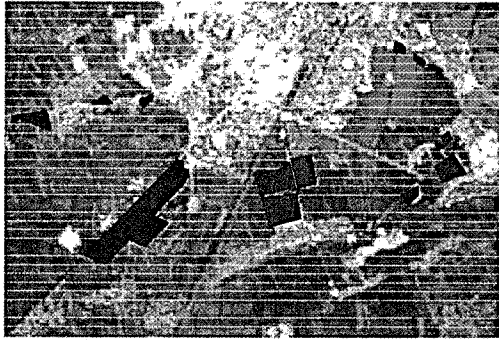


Fig. 4 Land use change (the dark black polygons) obtaining by field survey using DGPS(part)

5 RESULTS

The area of land use change from 1986 to 1996 is listed in Table 1.

6 CONCLUSION

(1) It is significant to dynamically monitor land use. The methods of satellite imagery visual interpretation can not meet the needs of accuracy. It is difficult for land use detailed investigation to dynamically monitor land use because of its big expenses and long period.

(2) Two methods are introduced in this paper to update the land use database: changing the land use ID in the attribute table in GIS and measuring with GPS receiver on the spot, aiming to monitor the change covered a whole land parcel and the change of partial parcel respectively. The combination of these two methods made the land use dynamic monitor in Dehui feasible with its low expenses, short period and high accuracy.

Table 1 Land use change from 1986 to 1996 (ha)

Area	Dryland	Paddy land	Industrial and settlement land	Transportation land	Unused land
1986	223487	31240	26300	8980	14240
1996	212473	41027	26527	9320	13647
Change	- 11014	+ 9787	+ 227	+ 340	- 5936

(3) Dehui is located in the middle of the North-east China Plain, and its characteristics of the climate and its statuses of land use is typical in this region. So this set of approach come up with in this paper can apply to the land use dynamic monitoring in other counties in this region.

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