# STUDIES ON THE COMPILATION METHOD OF AFFORESTATION SITE MAP AT A SCALE OF 1:100000 IN PIN QUAN COUNTY CHINA

Zhang Xiu yin. Liu Yang
Subcenter of Agri. Remote Sensing
Heilongjiang Academy of Agri. Sciences

## Abstract

This paper described the experimental result and the compilation method of afforestation site map at a scale of 1:100000 by using remote sensing data in Pin Quan county where was the test county of "Three North" protection forest system remote sensing survey.

## Introduction

An afforestation site map is a basic data for afforestation and forest planing and is the basis for the forest planing and afforestation of "Three North" protection forest system. It shows the relationship between the plot in place and its evironmental factors which determened the category of forest and production on the plot.
At present (up to the present ) airphoto were more applied to compile afforestation site map at large scale (1:10000, 1:25000 and 1:50000). Landsat images were applied to compile the afforestation site map not reported at home . So landsat 5 TM images for the major interpretation data and other reference data as well as field survey were used in the Pin Quan where was the "Three North" protection forest system remote sensing survey test county to compile the afforestation site map at a scale of 1:100000. It was the first time to use landsat images for compile afforestation site map in China.

## General Discription of the Area

Pin Quan county is situated in the North-eastern part of Hebei Province. The geographical position of the area is between latitude 40°41'N--41°21'N and longitude 118°20'E--119° 15'E. The total area of Pin Quan county is 3290 square kilometers (3308 thousends hectares ). The major part of the area is consisting of high. low mountains, about 65% of the area is covered by mountains and hills which are located on the settlement zone of Yan San mountain range that is extend into North-east. In this area, the mountains and hills have been eroded and dissected due to the degradation. So with the result that complex topograph (high and low mountains, hills terraces, vallies, gullies alluvial plains, flood plains and so forth) was formed.
The highest point in the county is Guang-tu mauntain which is about 1756 m high above the sea level at North-west corner of the county. The average altitude of the county is 700-800 m above the sea level.
In the county there are 5 major rivers which are called Lao Ha river, Bao river, Qing Long river, Lao Niu river and Da Ling river that origin and pass through the county.

The climate of this area blongs to warm semihumid-semiarid continental monsoon climate where are 4 seasons a year clearly with strong wind, drought and cold. Its mean annual temperature is 7.3 Co, the maximum temperature is about 39.4 C° and the minimum temperature is -29.6 C°. Annual mean frost-free period is 135-140 days. In the northern mountainous district, it is about 90-100 days, and it is about 140-150 days in the sourth. The rainfall in the south is about 400-900 mm, in the centeral part of the county it is about 350-820 mm and in the north area it is about 320-700 mm. 70 percent of the annual precipitation are centralized in July, August and September. Maximum rainfall in one time reaches about 129-152 mm. Therefore, the flood and soil erosion always tock place during the months having high rainfall.

There are 5 soil great groups and subgroups (brown soil, brown earthened soil, drab soil, drab earthened soil and meadow soil), 53 soil family and 146 soil series in this county.

Due to the complex landform and the different climates, the types of vegetation are complex which distributed both horizontally and vertically. The total number of arbor types are about 40, and the number of shrubes types are about 10, such as Pine (Pinus), Birch (Betula), Oak (Quercus) and Poplar (Populus), Hazel (corylus), Bush clover (Lespedeza) and so forth.

Information Data and Comperison of Resolution of Them

1. Information Data
   Landsat 5 TM and MSS images, territory census satellite images, false colour infrared airphoto and white and black airphoto were used for interpretation, and the topograph maps, soil maps,geograph maps were used for reference.
2. The comparision of resolution of the information data
   Due to the difference of resolution of landsat image, the accuracy and the scale of maping are different, the comparision of resolution is given as follow:
   Table 1. Resolution of various remote sensing information data

| Information data | Ground reality relative resolution | Spectra resolution | Comparision |
|---|---|---|---|
| Infrared airphoto 1/130000 | 20.32 | 26* | 46.37 |
| Landsat image TM 1/100000 | 14.39 | 30·30 | 32.84 |
| Infrared false colour airphoto 1/30000 | 43.82 | 6* | 100 |
| Landsat image MSS 1/100000 | 6.27 | 57·79 | 14.31 |
| Territorry census satellite image 1/40000 | 3.24 | 8-10 | 7.39 |

* ground reality resolution.

The information data quantity of one sheet of TM image was 7.5 times of one sheet of MSS image.

3. The assessment of various information data

In oder to assessment the effect in application of various information data, a representative area which having about 6.6 square k.lometer was chosen as interpretation window, to compare the depth and the detail of interpretation.

Table 2. The comparision of interpretation depth and the detail

| Information data | Range $Km^2$ | Number of interpretation unit | The smallest interpretation unit | The depth of interpretation |
|---|---|---|---|---|
| Landsat image TM false color composite 1/100000 | 42.21 | 172 | $1mm^2$ | Coniferous, broad leaved forest, valley rock, forest belt can be identified |
| Landsat image MSS false color composite 1/100000 | 44.22 | 99 | $4mm^2$ | Coniferous, broad leaved forest can be identified valley rock, forest belt were not clear. |
| Infrared false colour airphoto 1/30000 | 30.25 | 547 | $1mm^2$ | Trees species can be identified. tree nursery, vegetable garden, large isolated tree can be identified also. |
| Territory census satellite image 1/40000 | 36.00 | 8.7 | $4mm^2$ | Coniferous, broad leaved forest can not be identified, but linear ground subject sach as railway, road, rivers were clear. |

Landsat images showed a very good ground thouth and the information is cylicity fast and system for geting, the techinique is easyer for maping by using the landsat image data. Although the landsat image TM false color composite the ground reality relative resolution was lower than the infrared false color airphoto resolution but it has enough information for maping at a scale of 1:100000 and it is easy to get and more economic.

4. Resolution of landsat image and maping scale

In oder to guarantee the accuracy of maping, the different scale of maping were chosen according to the resolution and number of pixele of image.

Table 3. The relationship between maping scale and the number of pixele

| Maping scale | 1mm representative area on the map ($m^2$) | The number of pixele on 1 mm image | |
|---|---|---|---|
| | | TM image | MSS image |
| 1:500000 | 250000 | 278 | 55 |
| 1:200000 | 40000 | 44 | 10 |
| 1:100000 | 10000 | 11 | 2 |
| 1:50000 | 2500 | 2.8 | 0.6 |

In the practise of forest site map interpretation, general more than 2-3 pixele can be identified, therefore, in oder to guarantee the accuracy, general speach, MSS image can be maped at a scale of 1:200000 and TM image canbe maped at a scale of 1:100000 and larger scale.

The classification principle and system

1. The classification principle
   A. The natural geographical characteristics and the difference of hydroth ermal condition in the whole "three north" area were considered.
   B. The difference of natural and hydrothermal condition in Pin Quan must be considered as well.
   C. According to interpretable degree and depth of the landsat image on TM image at a scale of 1:100000.
   D. The method of multifactor comprehensive analysis combining with major factor were applicated for the afforest site type named.

2. The classification system
   According to the priciple mentioned above, the classification system was:
   A. The forest site zone--the highest classification unit. It was divied according to the difference of hydrothermal condition, latitude and vegetation distribution. (see Table 4)
   B. The forest site region--according to the difference of hydrothermal condition and vegetation in the above site zone.
   C. The forest site type district, mainly according to the medium geographical, situation and humidity ( rainfull and vaporation ).
   D. The forest site type group, in a site type district, according to the difference of site type factor such as sloping direction, sloping gradient and soil type subdivided into different kind of site type groups.
   E. The forest site type is the lowest unit of forest site classification system, mainly according to the major factor of forest growing, such as slope location thickness of soil horizon, vegetation type and so forth. This class can compiled the map at a scale of 1:30000. ( see Fig 2 )

Table 4. Afforest site map classification system of Pin Quan county

----------Forest site zone (First class)----------

Callente Coniferous Broad Leaved Forest Site Zone

----------Forest site region(Second class)----------

Callente North Defoliated Oakery Forest Site Region

--Forest site type district(Third class)(scale 1:500000)-----

1. North-West cold-humidity medium-low mountain site type district
2. North cool moisture low mountain-hill site type district
3. North-East semiarid low mountain-hill site type district
4. Center warm moisture hill-terrace site type district
5. South genial humidity iow mountain site type district

----Forest site type group(Fourth class)(scale 1:100000)-----

1. South direction gentle sloping brown soil site type group
2. South direction gentle sloping drap soil site type group
3. South direction steep sloping brown soil site type group
4. South direction steep sloping brownearthened soil site type group
5. North direction gentle sloping brown soil site type group
6. North direction gentle sloping drap soil site type group
7. North direction steep sloping brown soil site type group
8. North direction steep sloping brownearthened soil site type group
9. East west direction gentle sloping drap soil site type group
10. East west direction gentle sloping brown soil site type group
11. East west direction steep sloping brown soil site type group
12. East west direction steep sloping brownearthened soil site type group
13. Flood terrace drap soil site type group
14. Flood terrace drapearthened soil site type group
15. Flood plain meadow soil site type group
16. Bare rock

-------Forest site type (Fifth class)(scale 1:30000)---------

According to slope direction, slope location, soilhorizon thick vegetation etc. were divided. (see Figure 2)

---

The Procedures and Methodology of Map Compilation

The 1:100000 forest site map was compiled depeds on fouth classification. The procedures of map compilation include 4 phases.

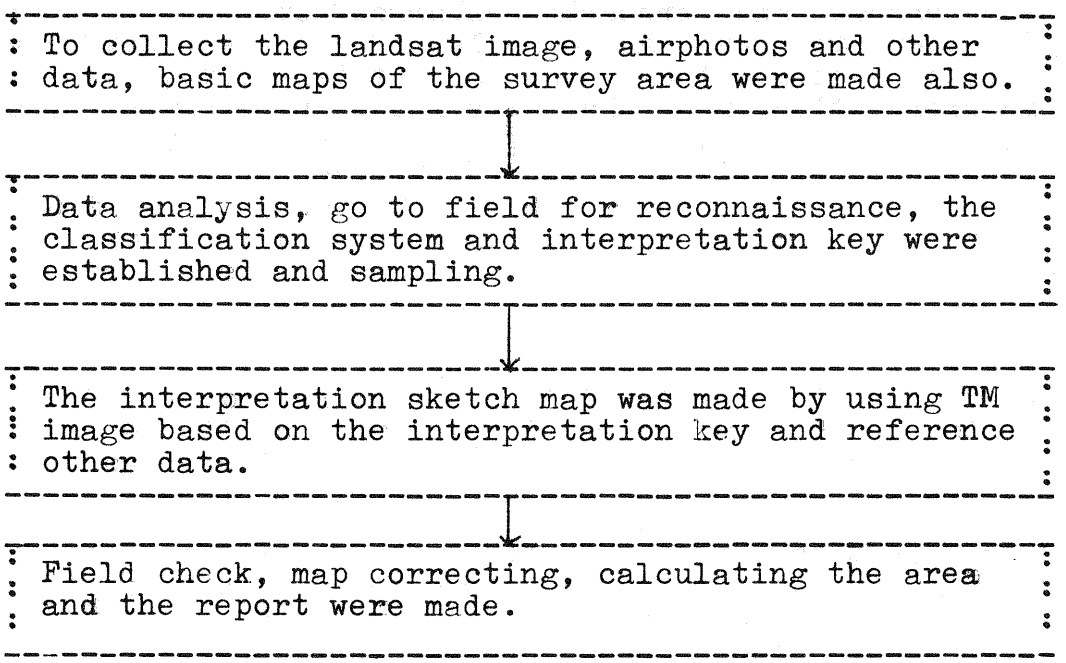
a. The preparation phase
In this phase involved not only collecting the landsat image, airphoto and other data, but also involved making the basic map of the survey area and field work preparation.

b. Reconnaissance phase
General knowleges were knew by various information data analysis of the survey area in laboratory and then go to the field for reconnaissance and then the classification system, interpretation key were established, as well as the relationship between the image characteristic and the ground truth were found out also.

c. Interpretation phase were made based on the interpretation key and image characteristics analysis on the basic map which was overlaid on the landsat TM image at a scale of 1:100000. The other information data such as topograph map, soil map, forest distribution map for reference. This is the initial interpretation sketch map.

d. The field check phase
The initial interpretation sketch map was often misleading before the field check. One of them was detail investigation check in the sample areas; another method was the route investigation check. The route where pass through various kind of site type was chosen. After checking, analysed the reason of the error and corrected it, then calculating the area and the report was written.
The compilation procedures sketch was given as follow:

Table 5. The compilation procedures sketch



## The method of compilation

According to the results of evaluation of the information data , the landsat TM 2.3.4. false colour composite images (scale 1:100000) were the major image for interpretation and the topograph maps, infrared false colour airphotos were used to compile the site map for inferent level also. The detail method of compilication map is given as follows:

a. Put the basic map on the landsat TM false colour composite image (both scale 1:100000). The place on the basic map exactly coincided with the same place on the image, based on the feature on the image, delineated along the contour line on the basic map that divided the feature into medium mountains, low mountains, hills terraces and flood plains etc. geomorphology units.
b. On the basic map , based on the trend of the contour, first found out the divid line and valley line , delineated the boundary line between the different direction . Then determined the direction of slope and wrote down S(south direction), N(north direction), E( half south, half north and east, west).
c. Based on the density of the contour determined the slope which was steep sloping(P) or gentle sloping(G).
d. Based on the characteristics of the image on the TM 2.3.4. false colour composite determined what the vegetation cover was and wrote f(forest), s (shrub) and c (crop) on the right above of the N. S. E.(such as $S^f$ , $N^f$ etc.) on the interpretation sketch map.
e. The minimum unit of maping was 4mm$^2$. In one unit , if it has two or more than two different kind of vegetation cover, the more or large one was chosen for the vegetation cover . If there were several areas of vegetation cover less than the minimum unit of maping, based on the regularity of the vegetation distribution, no scale maping were used, the large one was chosen and properly enlarged it.
f. In oder to have an example of comprehensive classification system, there was a detail survey and detail interpretation map that was made in example area at a scale of 1:30000. The detail survey by using infrared false colour airphoto (23·23 cm$^2$ see Figure 2).

## Conclusion

1. According to the comparision of various information data and their application in practice, landsat TM image at a scale of 1:100000 was more suitable data for forest site map compilication at a scale of 1:100000.
2. Due to the application of landsat TM image in the compilication of the map, the accuracy of the interpretation of the map was increased, because of the high resolution which was 30·30 m$^2$ for one pixele and was 5-15 meters for linear objects.

3. The geometric accuracy of plot location of TM image was higher than that of MSS image. The maximum point displacement of the optical corrected TM image is about 2 pixeles (about 60 m on the ground) compared to the topograph. It was about 0.6 mm on the interpretation map at a scale of 1:100000. The computer corrected image was no point displacement.
4. The point displacement error was avoided and the maping accuracy was increased by using the divid line, valley line and contour line of topograph as control line to interprete site types.
5. The displacement error of the highest mountain of Pin Quan which altitute was 1756 m, is about :

$$x=L\cdot h/H=1756\cdot 46/705=114 \text{ (m)}.$$

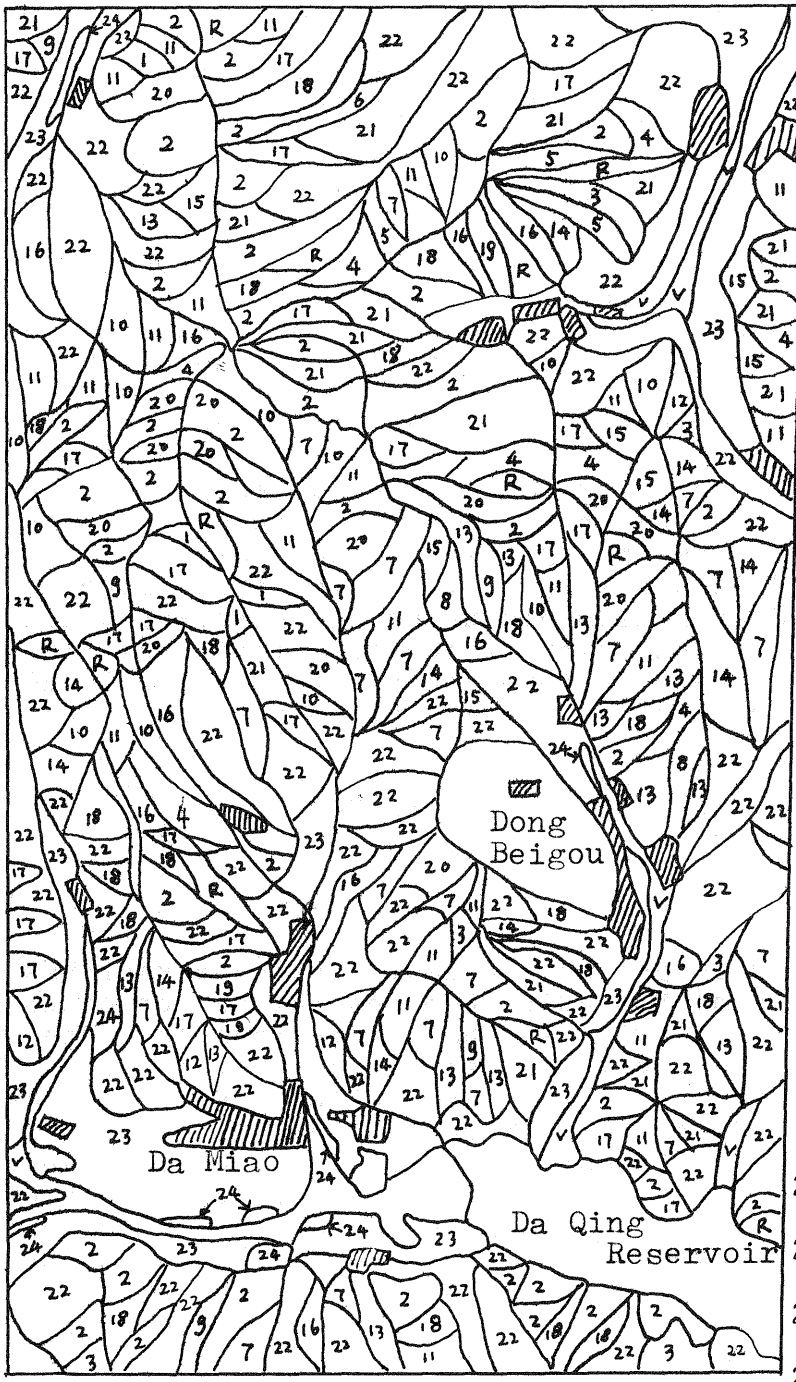
It is about 1 mm long on the interpretation map at a scale of 1:100000. But the displacement error was limited in 0.4 mm by appling the divid line, valley line and contour line, and the displacement error of low mountains were negligible.
6. Anumber of field check showed that the interpretation accuracy of the forest site map was 98.31% , the interpretation accuracy of example area was 98.90% and the accuracy of routes check were 97.73%.

Reference


1. Agricultural Plan Office of Pin Quan
   The Report of Agricultural Plan of Pin Quan 1984
2. Special Subject Group for the Study of Forest Site Classification System,Evaluation and Preper Kind of Tree at Forest Base
   Scheme of Invastigation of Forest Site Classification System, Evaluation and Preper Kind of Tree at Forest Base
   Forest Ministry of China 1987.2 Beijing
3. Zhao Hua chan. Hua Rong kui
   General Studies on the Application of Landsat TM Image Data
   Remote Sensing Information 2 1986 Beijing


Fig 1. The Location of Pin Quan County and "Three North" Forest Protection System

Figure 2. Forest Site Type Map of Example Area (scale 1:30000)




Legend

1. North up-sloping-medium-Pine(Pinus)
2. North down-sloping-medium-thick-Pine (Pinus)
3. North down-sloping medium-Oak(Quercus)
4. North up-sloping medium-thin-Pine
5. North down-sloping medium-thin-Spiraea L
6. North up-sloping thin-Carex L.
7. East down-sloping medium-thin-Locust
8. East up-sloping thin-B.Ischaemum
9. East down-sloping medium-thin-Spiraea L
10. East up-sloping medium-thin-Pink
11. West down-sloping medium-Pink
12. West up-sloping thin-Carex L.
13. West down-sloping medium-thin-B.Ischaemum
14. West down-sloping medium-thin-Locust
15. West up-sloping thin-Pine
16. West down-sloping medium-thin-Oak
17. South up-sloping thin-Bush Clover (Lespedeza)
18. South down-sloping medium-thin-Bush Clover(Lespedeza)
19. South down-sloping medium-Oak
20. South up-sloping medium-thin-Pine
21. South down-sloping medium-thin-Locust
22. Terrace-medium-thick-Crop
23. Flood plain-thick-Crop
24. Valley-Poplar (Populus)

R . Bare rock

V . Valley

Maping renge: 41°07'N-41°10'08"N

118°38'04"E-118°42'08"E