AUTOMATED IDENTIFICATION OF SWAMP LAND INCORPORTATING LANDSAT TM IMAGE AND GIS DATA

Genong Yu[1], Dingchang Liu, Huaomao Zhou, Liangxiu Zen, Yafeng Zhong, and Chizhang
Chengdu Subcentre of Agriculutural Remote Sensing, Ministry of Agriculture, Jingjusi 20, CHENGDU, China 610066

Keywords: Remote sensing, GIS, Swamp, Peat

ABSTRACT

The paper describes an on-going project on the potential study of Landsat TM for the monitoring of wetland resources with a concern of peat deposit. The method is to incorporate remotely-sensed data and ground-based GIS data to improve the accuracy of automated interpretation. The main systems used in the project are ER MAPPER (UNIX VERSION) and ARC/INFO. The study area is Ruergai plateau in the southwest of China. Preliminary results show the following improvements. (1) The outlines of the swamp are clearly drawn out by incorporating geomorphical data and the accuracy is reasonable. (2) The estimation of peat deposit could be improved with the DEM data. (3) The whole procedure can be easily and automatically repeated when new data are available.

1. INTRODUCTION

There is an on-going project on the study of potential of satellite remote sensing in the investigation and the management of wetland resources. Rouergai, located in the northwest of Sichuan province, China and has a large area of swamps, was chosen as the study area. It is typical in terms of wetland resources, peat deposit, historical document, and landscapes. The project involves the study of wetland resources classification, peat deposit estimate, and GIS capability in management of all the related data. There are several key techniques to be studied, which include scheming of proper wetland resources classification to meet the requirements of potential users and the technical capacity of satellite remote sensing technology, extracting or identifying the wetland resources, precisely and/or automatically, by adopting the-art-of-the-state techniques, determining the mechanisms useful in the image interpretation comprehensively and geographically, and analyzing and estimating the peat deposit and their components. The results should include thematic maps of wetland resources, tabular databases of wetland resources and necessary attached information, status analysis of the resources, friendly and operational management information system (MIS), and related study reports.

Identifying and extracting wetland resources on satellite remotely-sensed data is one of the most important techniques to be studied. The basic requirements are as follow.

- Mapping scale should be at least to 1:100000. Polygon line displacement should be less than 0.3 mm on the map and those for point and linear features should be less than 0.2 mm. Minimum of mapping units is 4.0 mm^2.
- Interpretation general accuracy should be above 90%.
- Percentage correction of wetland resources classification should be over 90% and the estimate of peat deposit should meet the requirements of geological investigation at E level mostly and at F level partially, decreed by Ministry of Geology and Minerals, China.

This paper focuses on the interpretation and classification of wetland resources by means of computer-assistant image processing and pattern recognition.

2. METHODOLOGY

Basic data to be used in the study is Landsat TM data covering the whole study area, about 26000 km, in the northwest of Sichuan province, China. The test data in this paper is Landsat TM in June 1997. The pre-processed data acquired from the Beijing receiving station of Landsat TM was registered geometrically by using 52 ground control points.

2.1. Classification system of wetland resources

Swamp is the principle wetland resource in the plateau of northwest Sichuan and many research team and expert have carried out investigation in some extent. There are several classification schemes. A special survey group of Chinese Academy of Sciences investigated the area in 1990 by using a classification scheme of one type, four categories, and nine swamp entity (Chai et al 1962). Sichuan Institute of Grassland has evaluated the area in views of botany and surveyed the are with a scheme of one type, 5 sub-category, 8 swamp group, and 25 sub-groups (Yang et al 1988). Changchun Geography Institute of Chinese Academy of Sciences has carried out a peatland survey covering this area and provide a classification scheme of 4 type, and 12

[1] Contact information of the primary author: phone: +86 28 4504161, 4504777. Fax: +86 28 4791844. E-mail: genong.yu@usa.net

categories (Sheng 1992). Sichuan Bureau of Geology and Mineral carried out a investigation of peat resources by using remote sensing images and a scheme of one type, 4 sub-type, and 10 categories was used (Shi et al 1989). Fan X. has tested the potential of Landsat MSS in peat resources investigation by using a scheme of four broad categories (Fan 1987). A pilot study on the potential of remote sensing techniques carried out in 1980's has used a scheme of one general type, three types, and 12 categories (Yu et al 1992). An operational system on the investigation of wetland resources has been developed (Yu et al 1997).

These schemes have certain emphasis in geology, botany, land sciences and/or engineering. Some adjustments should be made to be classifiable by using present Landsat TM data. Table 1 show the classification scheme used in the project. This classification scheme put emphasis on the development of peat resources and swamp entities.

Table 1 Classification System of Swamp Entities[1]

Category	Geo-position	Hydrological condition	Landscape	Soil	Peat deposit class
1.Extremely developed	Lowland and lake basin or wide and flat valley	Permanently watered, and 30 cm deep.	Ridges or vegetation meadows	Peat soil	Lake basin type Wide valley type
2.Well developed	Similar as above	Constantly watered, and 5-30 cm deep.	Spotted.	Peat soil	Similar as above
3.Moderately developed	At edge of lake basin, or wide valley and at the terraces along valley	Over-wetted, and 0 of ground water level.	Spotted.	Peat soil, swamp soil	All six types.
4.Slightly developed	Upper edge of lake basin or wide valley, upper terraces along streams or rivers	Seasonally watered, and ground water level is 0-1 meters.	Spotted.	Swamp soil, peat soil	All six types.
5.Developing	Similar as above	Temporary watered, and ground water level is 1-2 meters.		Swamp soil, humus soil	All six types
6. Other	Top of muntain	Dry.			
7. Settlements					
8. River					

2.2. Procedure

In the experimental classification of swamp resources by using computer-assistant techniques, we tested the possibility to incorporate digital terrain model (DTM) to enhance the accuracy of classification. The procedure is as follow.

- **Building of DTM:** Digitize principle contours and height points on the topographical map of 1:100000. Construct the Smooth the contour lines with a grain of 100 and change them into points. Combine these with height points in a file and use the point file to build DTM. This takes much time, even with a Pentium/II computer.
- **Calculating of aspect and slope:** Calculate aspect and slope of each pixel by using the DTM and form their map respectively.
- **Visual interpretation of swamp resources:** The result of the visual interpretation of swamp resources is transferred into digital map and geo-referenced to a projection of Gauss-Kreg tranverse Mecator. Necessary field work has been carried out to guarantee the results in reseasonable accuracy.
- **Geomatching of all the data:** Match all the data into a common projection and cut them into a comparable size, i.e. 1200 by 1500 pixels in 30 by 30 meters.
- **Classification:** Do the classification in different combinations of bands and DTM data by using Maximum Likelihood Enhanced provided in ER MAPPER 5.2 / SUN UNIX (Solaris 2.5). Training regions are the same for the combinations. The combinations are Landsat TM (band 1, 2, 3, 4, 5, 7) plus DTM, TM plus aspect data, TM plus slope data, or TM plus DTM/aspect/slope data.
- **Comparison:** Analyze the results of all the classification and compare their effects.

3. RESULTS AND DISCUSSIONS

Area summary reports of all the classification are listed in table 2.The total of the study area is 162000 hectares.

The results show that the improvement resulted from the incorporating of DTM and related data is not significant. Some improvement does happen in the results. The result for category 3 is favorable. The improvement, however, is much significant

[1] The swamp classification scheme and its description are prepared by the Wetland Resources Inventory team, Chengdu Subcenter of Agricultural Remote Sensing, China.

when viewing the swamp land category as a whole. The best of these is the combination of Landsat TM plus the DTM itself.
In comparison of the classified image and the visual interpretation map, the effect of the DTM may be enhanced if some more contours be digitized. This is because the area is relatively less undulated and the hills are not very high. Insufficient contours may result in the ignorance of landform changes. On the other hand, the change do happen at the slopes where the DTM represents its condition well.

Table 2. Summary Area Reports of the Classification Practices (Units: Hectares)

Method	1[1]	2	3	4	5	6	7	8
TM+Aspect	3257.910	1623.150	8078.850	15990.750	21226.860	111822.480		
TM+DTM	3379.860	1380.510	6357.510	18980.820	40242.150	91659.150		
TM+All	3306.510	1334.340	8025.480	21655.710	38848.860	88829.100		
TM+Slope	3370.140	1529.640	9307.710	18126.000	19263.780	110402.730		
Visual	4995.900	12484.080	9630.900	14821.650	19077.750	100004.760	81.000	903.960
TM	3232.170	1622.700	7849.890	14944.950	19514.880	114835.410		

4. CONCLUSIONS

The incorporation of DTM and derived data has some favorable effects on the classification of wetland resources. This may be because there is a certain correlation between the occurrence of wetland and the slope and elevation. Preliminary study in Rouergai plateau does not show a significant improvement on each individual category but as a whole. It may be the results of insufficient accuracy of DTM construction, due to inadequate height data in building DTM. Better results are expected when more accurate DTM is available and some sort of "if-what" logic is implemented.

REFERENCES

Chai, X. et al 1962, Formation and Classification of Peat Sources in Rouergai Plateau. In Chinese. JOURNAL OF GEOGRAPHY.

Fan S. 1987 Application of Remote Sensing in Investigation of Peat Resources in Rouergai. In Chinese with English abstract. ACTA GEOLOGICA SINICA. (3):274-283.

Yang, F., 1988, Evaluation of Peat Swamp Resources in Rouergai Pateau. In Chinese. DEVELOPMENT AND PROTECTION OF RESOURCES, 4(2).

Sheng, G. 1992 Peatland Classification and Peat Deposit in Rouergai Plateau. JOURNAL OF NATURAL RESOURCES. 7(4):334-346.

Shi, C. et al 1989 Application of Satellite Remote Sensing Techniques in Investigation and Monitoring of Pastoral Land Resources. In Chinese. TECHNOLOGY DEVELOPMENT IN REMOTE SENSING.

Yu, G. and C. Shi 1992 Application of Satellite Remote Sensing Techniques in Investigation of Swamp in Rouergai Plateau. In Chinese. In: Chinse Society of Geography 1992 MOUNTAIN DEVELOPMENT AND DISASTER PROTECTION IN THE YANGTZE RIVER REACH. CHENGDU: Chengdu Mapping Press. P197-202.

Yu, G. and M. Yan 1997 Swamp Resources Inventory System. In Chinese. In: Lu D. et al (editors) 1997 APPLICATION OF REMOTE SENSING TECHNIQUES IN AGRICULTURE. Beijing: Qinghua University Press. P49-54.

[1] These are category related to the above classification scheme.