STUDY ON INFORMATION EXTRACTION OF RAPE ACREAGE BASED ON TM REMOTE SENSING IMAGE

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ABSTRACT

China's rape acreage and total output of rapeseeds ranks among the top in the world, accounting for more than 30% of the world's total rape acreage and output of rapeseeds. This paper takes Landsat TM as the main data source in conducting the study of extracting rape acreage information in the Shou County, Anhui Province. Through analysis and calculations of phenological diversity, spectral discrimination, etc. of various main vegetations, with remote sensing image in each growth stages of rape within the studied area, this paper concludes that the optimal time period for information extraction of rape acreage based on TM image is the flowering period for rape. This paper adopts confusion matrix calculation to compare non-supervised and supervised classification methods in extracting rape acreage information using remote sensing image. The results show that the classification results of Mahalanobis Distance method and Isodate non-supervised classification method yielded relatively good results. In which, the Isodate non-supervised classification method combined with human visual inspection can extract the rape planting area information with higher precision and efficiency. The study shows that the method by utilizing TM remote sensing data to extract information of rape acreage can get a relatively satisfactory result. We believe the rape acreage remote sensing identification technology can provide a scientific reference to the understanding of China's rape planting situation.

***Index Terms*—**Rape Acreage, information extracting, TM Remote Sensing Image, J-M calculation

1. INTRODUCTION

Remote sensing technology can gain data for a large coverage of land at different time resolutions and space resolutions, and objectively reflect the actual conditions. The results of information extracted can eliminate human interference, and is both scientific and objective. Not only does it timely obtain the distribution pattern of crops with remote sensing image, but also make comparisons with the planting and growth situation of the crops in past years to dynamically monitor planting area and output of crops [1].

In China, agricultural application of remote sensing technology began in late the 1970s. After years of experience, this technology has currently reached the goal of commercialized operations in nationwide agricultural resources, main crops, and remote sensing monitoring of agricultural natural disasters [2-3]. During the "11th Five-Year Plan", the National 863 Program conducted remote sensing measurements for planting acreage and the yield estimation system for four good crops in major grain producing areas [4]. More and more departments at different levels have conducted remote sensing monitoring on wheat, rice, corn, and other field crops but seldom studied rape. This study takes Shou County, Anhui Province as a case study and TM remote sensing image as the main data source in exploring remote sensing identification of rape acreage.

2. RESEARCH AREA AND RESEARCH METHODS

2.1. Research Area

Anhui Province is located in the southeastern part of China and lies between longitude 114°54′ to 119°37′ E and latitude 29°41′ to 34°38′ N. The planting area and output of rapes of Anhui Province has been the top in the country. Basically, the acreage of rapes in the province over the years has been kept at around 933,300 hectares, accounting for about 75% of the planting area of oil crops in the whole province. According to crop values, rapes ranks third, only next to grains and vegetables. The production of rapes has been the main route for increasing income of farmers, and is also an important part of Anhui Province's agricultural restructuring [5].

2.2. Data Acquisition

Most of the planting area of the winter rape in China is located in the south with frequent cloudy and rainy days. The acquisition rate of the remote sensing data is very low in the growing period of crops. Therefore, it is relatively difficult to acquire high resolution images within the optimal identification time period that meets the requirements of remote sensing information extraction.

Table 3-1 Growth stage of rapes in Anhui Province

Growth stage	Early September to early October	In the middle of October to early November	The middle of November to late January	Early February to the middle of March	In late march to early April	In the middle of April to early May	In the middle of May to late May
Rapes	Sowing	Transplanting	Seedling	Peduncle-growing	Initial flowering	Final flowering	Mature

Table 3-2 Main land use types and rape J-M distance

TM time phase	Dec. 10, 2008	Jan. 11, 2009	Feb. 12, 2009	Apr. 1, 2009	May 3, 2009
Growth stage	Seedling stage	Over-wintering stage	Peduncle-growing stage	Initial flowering stage	Final flowering - maturity stage
Winter wheat	1.8229	0.9625	1.8901	2.0000	1.9451
Building	1.9999	1.9999	2.0000	2.0000	2.0000
Water body	1.9997	1.9998	2.0000	2.0000	2.0000
Forest land	1.9995	1.9394	1.9999	2.0000	1.9664
Other crops	1.9990	1.9790	2.0000	2.0000	1.8955

Rapes in Anhui are planted every year from September to May of the following year, going through stages such as, sowing, germinating, seedling, peduncle-growing, flowering, and developing mature pods (table3-1).In accordance to the situation of the growth stage of rapes in Anhui Province and collection of remote sensing image, this study selects TM images from five periods: December 10, 2008, January 11, 2009, February 12, 2009, April 1, 2009 and May 3, 2009 to conduct its analysis.

2.3. Research Methods

Spectral difference between rapes and other crops in the same period is the basis of extracting rape information with remote sensing. The more obvious the spectral difference is, the more easily rapes are identified and thus, the higher the precision. So, the selection of the optimal identification time period should be based on changes of the spectral difference between rapes and other crops in their growth period, the optimal period is when the spectral difference is the most obvious. J-M distance solves the problem brought about when the mean difference of the normalized distance is 0, and needs not to assume a normal distribution for land feature, possessing relatively good versatility[6]. Therefore, this paper adopts the J-M distance as the standard of measuring the spectral separability among class features.

The J-M calculation formula is:

$$J_{ij} = \{\int_x [\sqrt{p(X/w_i)} - \sqrt{p(X/w_j)}]^2 dX\}^{1/2}$$

In this formula, J_{ij} is the separable distance of the i^{th} type; X is the random variable; w is the type to be classified; p is the prior probability of the type.

The discrimination standard is as follows: when $0.0<J_{ij}<1.0$, the spectural separability does not exist between the two types; when $1.0<J_{ij}<1.9$, some spectral separability exists between the two types, with overlap to a great extent however, can easily result in spectral confusion; when $1.9<J_{ij}<2.0$, excellent spectural separability exists between the two types [7].

Based on the determination of the optimal time period for rape acreage extraction, this paper, using various methods, conducted tests of automatic information extraction for TM images on April 1st, 2009, It conducted extraction precision evaluations using the confusion matrix, with the ground data as verification, and finally achieves a remote sensing extraction method for rape acreage information that is applicable to the studied area.

3. RESULTS AND ANALYSIS

3.1. Selection Of Optimal Time Period For Extraction Of Rape Acreage Using Remote Sensing

This paper selected rape, wheat, buildings, forest land and other crop areas as contrasting samples, using field investigation date of field crops, and conducted the spectral separability calculations for TM images of five scenes, using the envi4.6 software.

As seen from Table 3-2, the smaller separability distance with the rape is winter wheat. On the other hand, buildings, water, etc., can be well separated from the rape spectrum. According to the J-M distance calculations for TM remote sensing image in a single time period, the optimal time period for remote sensing identification of rapes in Shou County, Anhui Province is in early April.

Table 3-3 Comparison of confusion matrix among various classification methods

Classification theory and method	Omission	Rape	Excess	Excess rate %	Omission rate %
Mahalanobis Distance	4	116	1	0.84	3.36
Maximum Likelihood	15	113	9	7.56	12.71
Minimum Distance	32	97	10	8.40	26.89
Isodate	5	115	2	1.68	4.20

In early April, rape enters their flowering stage, winter wheat enters their jointing stage, and the coverage of farmland surface vegetation rapidly increases, in the same period, forest land enters its sprouting stage and has good spectral separability.

3.2. Results For Remote Sensing Extraction Of Rape Acreage

In order to better extract rape acreage [8], this paper respectively adopts the Mahalanobis Distance, Maximum Likelihood, Minimum Distance and Isodate Classification to conduct its remote sensing classification for the TM remote sensing images on April, 1, 2009.

As seen from the Table3-3, the Minimum Distance has relatively severe omission; only 97 pixels in 119 pixels are classified as rape, with omission rate of 26.89%. The classification effects of Mahalanobis Distance and Isodate Classification seem to be ideal. The initial category number directly affects the precision of extracting rape acreage when using the Isodate Classification, and after the study, initial category numbers ranging from 30 to 40 in the flat area where rapes are largely distributed can meet the extraction requirement; initial category numbers ranging from 50 to 60 in the hilly areas where rapes are distributed in small parts are more appropriate. When setting initial category numbers, a lack of numbers will cause apparent confusion in the image; while excess thereof will cause the phenomenon of large tiny spots, and thereby bringing certain interference to the category judgment.

In the process of supervised classification, the selection of the training field consumes a lot of time because every category needs to select a training field independently. Thus, for the same amount of time given, the results of unsupervised classification were better. Moreover, the comparative results of unsupervised classification were better than that of supervised classification in areas with complex land surface and scattered spots, featuring high efficiency and easily mastered standards. Although it can proceed through automated computer classification, it cannot go without the human visual inspection. It is found through comparison of statistical data that precision of extraction results rectified through human visual inspection improves notably (Figure 1.).

4. DISCUSSION

This paper studies the extraction of rape acreage using TM data in optimal time periods. Due to the restriction of image data source, this paper cannot cover the entire growth stage of rapes. According to the existing analysis results and phenological characteristics, the authors believe that early April is the optimal period for remote sensing monitoring of rapes, but the results still need to be verified with a more complete time series remote sensing data. Mahalanobis Distance and Isodate Classification can both conduct the extraction of remote sensing information of rape acreage with high precision; the extraction methods with man-machine interacting can use field information as support, making full use of expert experience and ensuring better precision for extraction results; while the automatic unsupervised classification by computer can better improve the work efficiency.

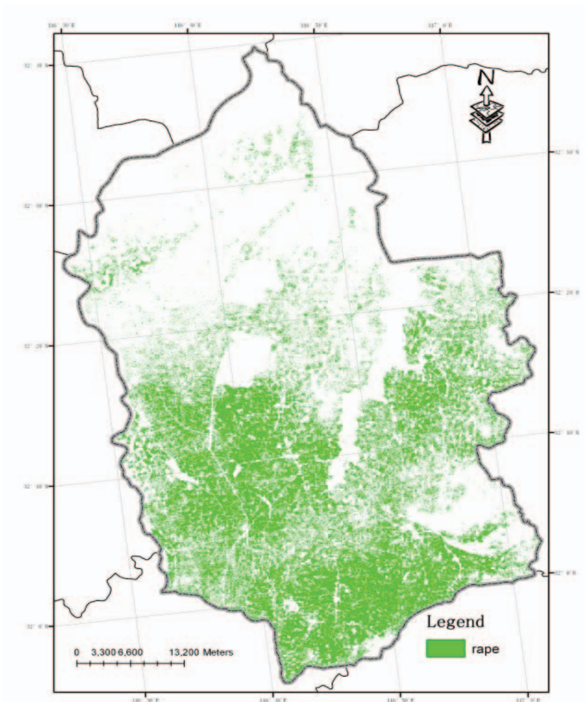

Figure1. Distribution of rape in Shou County

5. ACKNOWLEDGMENTS

This project was supported by the National Natural Science Foundation of China (41001246);by the International S&T Cooperation Projects of China (2010DFB10030)

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