A Study on Satellite Images Data for Irrigation Planning Water Requirement

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ABSTRACT

The Wan-Dan working station, PingTung Irrigation Association was selected as the study area. Satellite images of the area were classified by the supervising maximum likelihood classifier method and the unsupervised Iterative Self-Organizing Data Analysis Technique (A) classifier method. Four different satellite images were used in the classification in order to avoid spectral uncertainty of vegetation at the same spot. Crops in the study area were classified into seven classes based on the spectral characteristics and ground experiences. Results indicated that only 1.3% discrepancy between the cultivation area calculated by ground survey and by image classification in the paddy-majority area. The supervised classification method had higher accuracy as shown by the accuracy verification table. This method could assist staffs of Irrigation Association to calculate the water requirement for each crop and make irrigation plan more efficiently and accurately, based on the area of each crop derived from image classification and the growing and cropping pattern.

Keywords : Remote Sensing, Geographic Information System, Unsupervised- Classification, Supervised Classification, Irrigation Water Requirement.

1. INTRODUCTION

It has to put into many manpower and time to investigate crop types, cultivation areas, and cultivation time for drawing up the irrigation scheme. This task process is not economical and waste time, however, the work can be done by remote sensing technology. The remote sensing technology is a technique to get information not touches the body surface. The characters of remote sensing include cover great areas, rapid analysis, multi-time capture images and rapid take amount information.

It is necessary to catch data in short time for effective plan irrigation scheme. The major questions of water allocation are occurred in the irrigation process owing to the investigation inexact and lead to the irrigation plans imprecise. In this study, the remote sensing image in Wan-Dan working station, Pingtung Irrigation Association was used and combined geographic information systems technique to generate a model. The model processed input date, management data, analysis, and output results. According to the output data the association workers can rapid plan irrigation scheme, exactly adjust water allocation, and understand the crop type distribution.

1.1 Study purposes

The spectrum reflection of remote sensing technology was use to classify crop types, then to calculate rice areas and other upland crops areas for establishing irrigation schemes. The purposes of this paper are described as following:

1. To generate the classification method of crop types by using remote sensing technology.
2. To frame the irrigation project by combining the remote sensing and geographic information systems techniques.

1.2 Study area and flow chart

The Wan-Dan working station is one working station of Pingtung Irrigation Association, irrigated area is 1,683 ha and the main crops are rice and bean and other upland crops. The rice areas are 935 ha and other farms are grown bean, sweet potatoes, fruiters, and other upland crops. Because the rice image of remote sensing possesses higher accuracy and the irrigation water resources are easy control and the equipments of conveyance water are perfect in this area, therefore, the Wan-Dan working station was chosen as the study area. The study flow chart was shown in Figure 1-1.

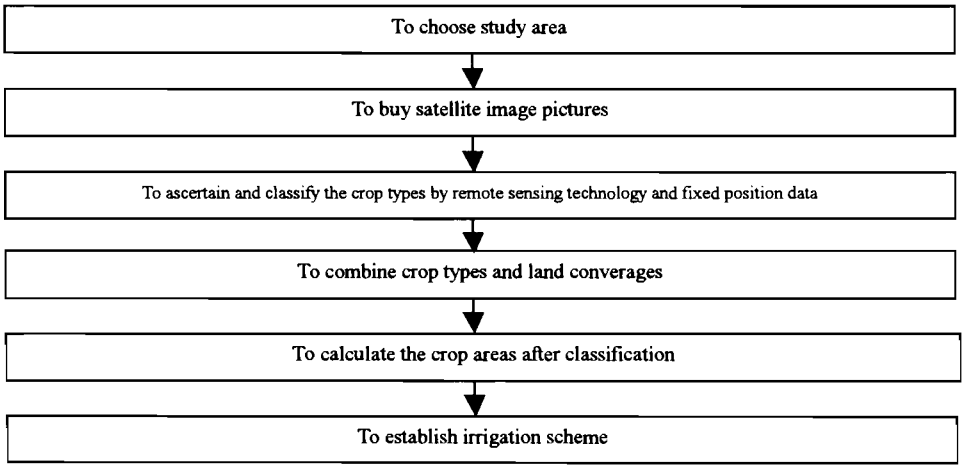

Figure 1-1. The flow chart of research

2. LITERATURE REVIEW

Chen (1989) used SPOT satellite images to estimate the rice areas in Taiwan. The results indicated under the simple land use and clear weather conditions and matched up part aerial photographs or field investigation to take sample that are basis data for classification. The SPOT images were used to estimate rice areas are feasible.

The report of Agricultural Engineering Research Center (2000) indicated that combined geographic information system technique and irrigation data could promote the efficiency of water management.

Su et al. (1999) applied geographic information system and the relative maps of irrigation association to build a water management model, which could raise the efficiency of agricultural water management.

3.THEORY

The remote sensing uses the spectral ranges of electromagnetic wave is ultraviolet-visible light-ultra red-microwave, where ultraviolet-far infrared (0.3~15.0μm) is called photopia wave band. Some things have to understand before using remote sensing to decide and classify include (1) the resolution of image: including spatial resolution, spectral resolution, and temporal resolution; (2) the spectral reflection characters of body surface: fundamental spectral reflection characters of body surface and the difference of spectral reflection owing to time and location change.

The multiple view methods were success used to take information during past time. The methods include multi-stage sensing in different altitude, multi-spectral sensing in different band, and multi-temporal sensing in different time at same location. According to these techniques the remote sensing image would accurately determined.

In this study, the satellite pictures taken from space remote sensing were the major information. The satellite pictures were SPOT images that bought from Space Remote Sensing Center, National Central University. The pictures include Wan-Dan area, Pingtung County, which level degree is level 10 and resolution is 12.5m×12.5m.

Any body has the ability and character of emitting, absorbing and reflecting electric wave. Figure 3-1 showed the standard wave reflected rate curves. The wavelength of spectral reflected rate less than 0.7μm is uncovered land > green vegetation > water body. The wavelength range is located in the first and second bands of SPOT. In contrary, the wavelength of spectral reflected rate locates in 0.7μm ~ 1.25μm is green vegetation > uncovered land > water body. The wavelength range is located in the third band of SPOT.

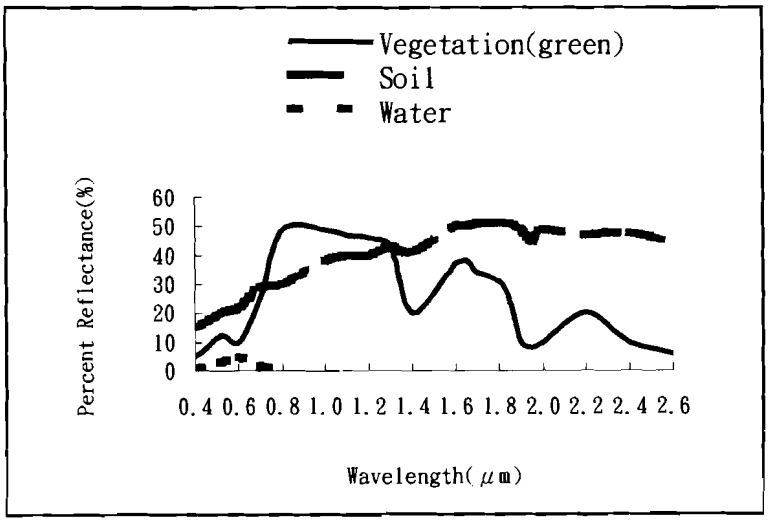

Figure 3-1 The standard wave reflected rate curves

4. INVESTIGATION AND VERIFICATION

4.1 Brief introduction to study area

The irrigation area of Wan-Dan working station (Fig. 4-1) is located in Wan-Dan and Shi-Yuan villages. Figure 4-2 is the irrigated district of Wan-Dan working station. East of the district are Tungkang Creek and the east are Kaoping Creek. The major irrigation ditches are Wan-Dan ditch and Shi-Yuan ditch. The Wan-Dan ditch flow through Wan-Dan and Shi-Yuan villages and length is 5965 m and the irrigated areas are 1,683 ha. Table 4-1 indicates the average areas of major crops in Wan-Dan working station during recently years.

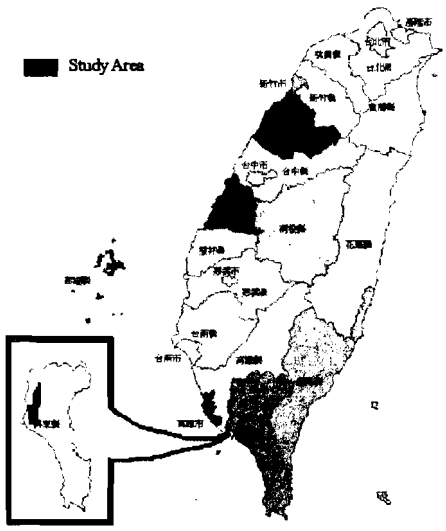

Figure 4-1 Location of study area, Taiwan

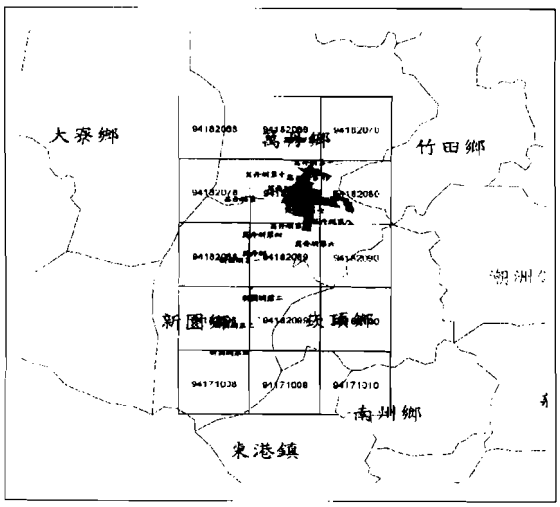

Figure 4-2 The irrigated district of Wan-Dan working station

Table 4-1 the average areas of major crops in Wan-Dan working station during recently years Unit : ha

Ditch name	Period	Rice	Fruiter	Fish farm	Bean	Sweet corn	Sugar cane	Banana	Others	Total
Wan-Dan	First	770	155	25	50	10	19	30	228	1287
	Second	762	140	25	20	5	19	40	276	1287
	Average	766	147.5	25	35	7.5	19	35	252	1287
	Inter-crop		25	25	1065	35	19	40	78	1287
Shi-Yuan	First	172	44	35	40	10	1	50	104	456
	Second	166	44	35	35	5	3	55	113	456
	Average	169	44	35	37.5	7.5	2	52.5	109	456
	Inter-crop		14	35	253	40	3	55	56	456

Table 4-1 indicated the major crop in the district was rice, two periods every year and part farms were single period and another period were grown bean and other upland crops.

4.2 The satellite images of study area

The land covers in Wan-Dan working station were classified as water body, rice, bean, fruiter, sugar cane, building, and other crops. For increasing the decision accuracy, many period pictures (March, August, October, and November 2001) were taken to analyze the spectral reflection. In addition, the images of first period were used as supervised classification and unsupervised classification to decide the accuracy of classification area.

The SPOT image does not possess coordinates, the process by the ERDAS IMAGINE software as following:

1. To import the initial file and transfer into image file.
2. To set the coordinates into the image file, then the file can be used by GIS.

4.3 Land use classification by satellite pictures

According to the previous process steps to deal with the image files, then classify the land use base on the ISODATA classification method. Figure 4-3 showed the classification results of land use in Wan-Dan district.

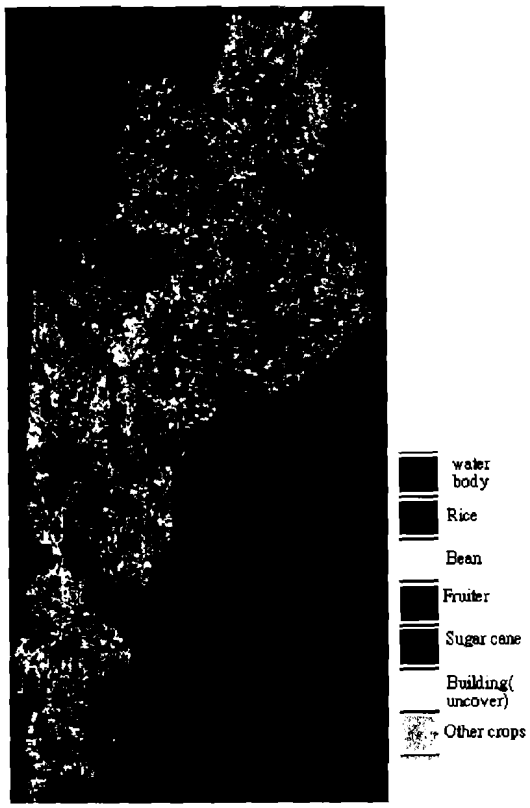

Figure 4-3 The classification results of land use in Wan-Dan district.

The accuracy evaluation is an index to present the satisfied degree of classification result. Therefore, the error matrix can obtain the product precision and user precision of classified evaluation index. The real information was taken by GPS in April was listed in Table 4-2. The unsupervised classification method was used to classify the land use and plug in the investigated data was showed in Figure 4-4. These data were used to compare with the image file, and then the classified accuracy degree was found. Table 4-3 revealed the classified evaluation index of land use classification. The product precision of rice is 83% and great than other crops, because the spectral reflect of rice has more response on near ultra red. The accuracy evaluation of sugar cane was zero, because the sugar cane farms are out of the Wan-Dan irrigation region. Therefore, the total accuracy, average accuracy, and $\hat{k}$ index were affected by sugar cane response.

Table 4-2 Investigation data of land use

	Land use	point
1	Water body	14
2	Rice	23
3	Bean	11
4	Fruiter	18
5	Sugar cane	0
6	Building (uncover)	6
7	Other crops	17

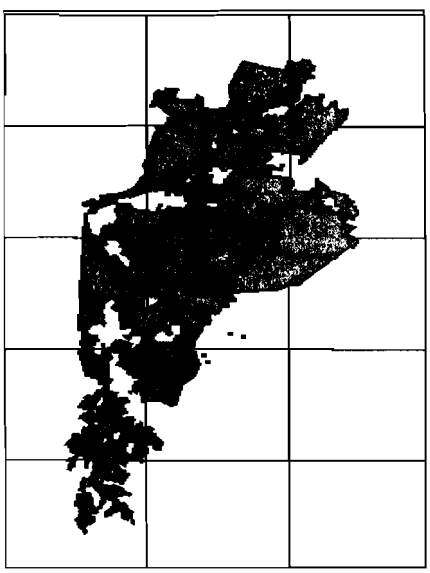

Figure 4-4 Location of investigation site

Table 4-3 Classified precision index by unsupervised classification method

	Results of classification									
	Kind	Water body	Rice	Bean	Fruiter	Sugar cane	Unuse	Other crops	total	product precision
Verify data	Water body	8	2	0	1	0	3	0	14	57%
	Rice	0	19	0	2	0	1	1	23	83%
	Bean	1	3	6	0	0	0	1	11	55%
	Fruiter	1	4	0	11	0	1	1	18	61%
	Sugar cane	0	0	0	0	0	0	0	0	
	Unuse	0	1	0	1	0	4	0	6	66%
	Other crops	0	3	0	3	0	0	11	17	65%
	total	10	32	6	18	0	9	14	89	
	User precision	80%	60%	100%	61%		44%	79%		
Total precision : 66% average precision : 55%										
$\hat{k}$ index : 0.577										

Figure 4-5 showed the classification results of land use by unsupervised classification method using single satellite image of first period in this study. The image was classified into seven categories base on the spectral reflection, then spread different color for each category.

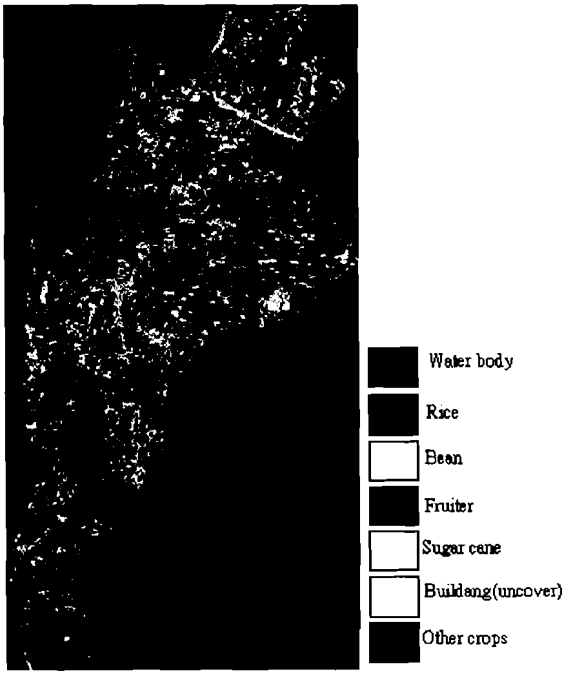

Figure 4-5 The classification results of land use by unsupervised classification method

Figure 4-6 showed the classification results of land use by supervised classification method using single satellite image of first period in this study. The crop types were plugged in to image process software, then compute the statistical value for each category base on the investigation data and then classified the unknown site.

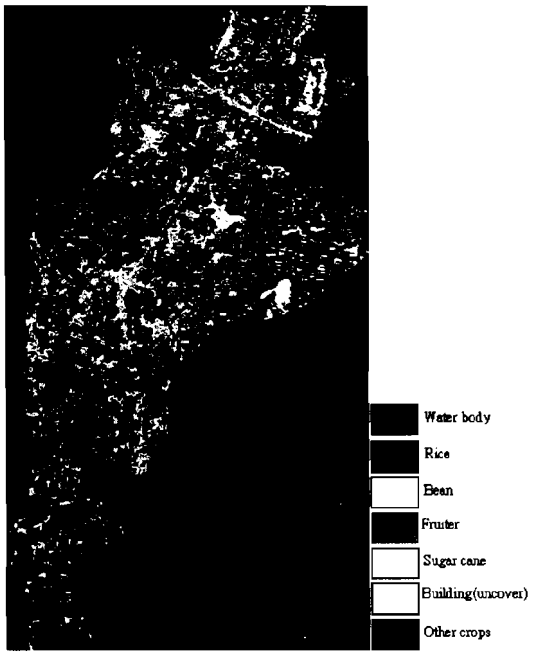

Figure 4-6 The classification results of land use by supervised classification method

4.4 Classified results of land use by satellite pictures

The plant areas of major crops in Wan-Dan working station were listed in Table 4-4. These data were used to verify the classified results. Table 4-5 indicated the classified area of land use for each category by unsupervised classification method in the four periods and the classified results in the single period was listed in Table 4-6. Table 4-7 indicated the inaccuracy rate of area compared between supervised and unsupervised methods in the single period. According to the analysis showed that the classified results could provide farm use information for establishing the irrigation scheme.

Table 4-4 The plant areas of major crops in Wan-Dan working station

	Crop category	area
1	Rice	935
2	Bean	73
3	Fruiter	293
4	Sugar cane	21
5	Other crops	361
total		1683

Table 4-5 The classified area of land use for each category by unsupervised classification method in the four periods

	Crop category	Classified area	Investigation area	Inaccuracy rate
1	Rice	845	935	0.096
2	Bean	113	73	0.354
3	Fruiter	301	293	0.027
4	Sugar cane	14	21	0.333
5	Other crops	396	361	0.088
Total		1669	1683	0.008

Table 5-6 The classified area of land use for each category by unsupervised classification method in the single periods

	Crop category	Classified area	Investigation area	Inaccuracy rate
1	Rice	980	935	0.046
2	Bean	106	73	0.311
3	Fruiter	327	293	0.104
4	Sugar cane	34	21	0.382
5	Other crops	517	361	0.302
Total		1964	1683	0.143

5. BUILDING AND APPLICATION OF DATABASE

The flow chart of consumptive use calculation is showed in Figure 5-1. In this study, the major factors of computing irrigation requirement include evapotranspiration, leakage, effective rainfall, and irrigation for land preparation. The computation model of irrigation requirement was developed base on present irrigation type, plant growing condition, soil texture, and weather condition.

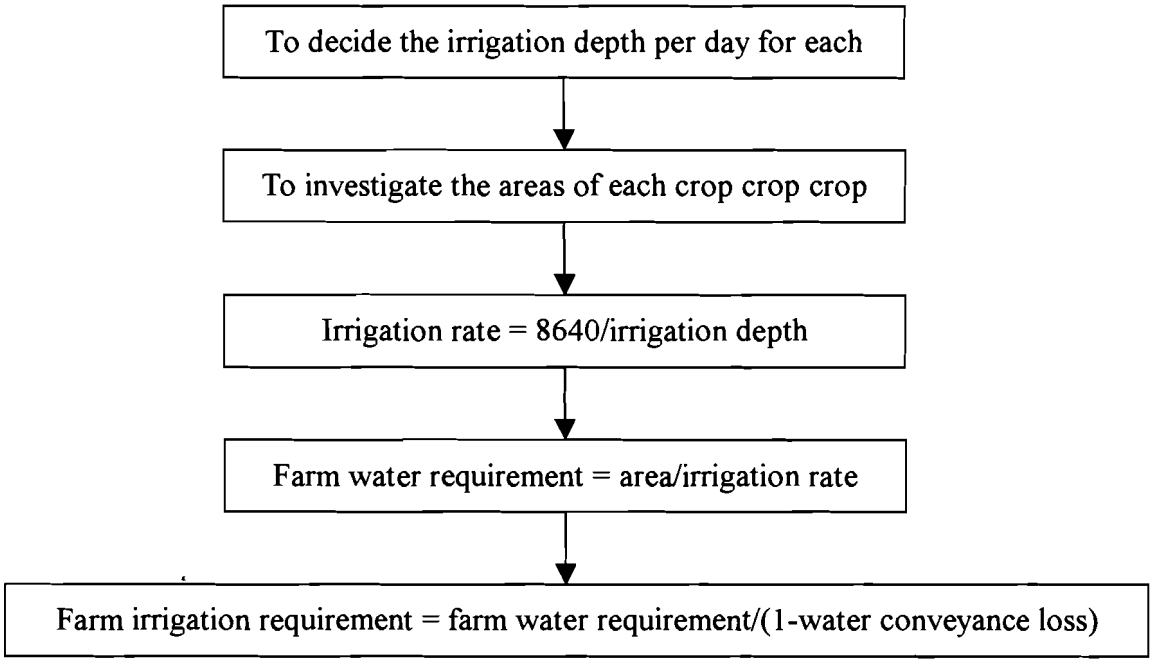

Figure 5-1 The flow chart of consumptive use calculation

6. CONCLUSIONS

6.1 The reflection intensity of different band can use to classify the crop type. In this paper, the maximum likelihood classification method and ISODATA cluster detection method were used to classification land use. The results showed that the previous method was better than later method.

6.2 They are some confuses region among chaff and fruiter, and rice and building during the classification process. The problems can be corrected by field experience and field investigation data.

6.3 The unsupervised classification of single period image cannot often cleanly decide the type because the reflection bands are close between different crops. Therefore, the multiple period images are suggested to help the shortage information.

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