The Study of Automatically Extracting Water Information in City Zone Based On SPOT5 Image

Cao Kai
Department Of Urban And Resource,
Nanjing University,
Nanjing, Jiangsu CHINA
(caokaisqtv@gmail.com)

Jiang Nan
Nanjing Institute of Geography and Limnology, ,
Chinese Academy of Sciences
Nanjing, Jiangsu , China

***Abstract*—This article look the main city zones as the research area. and study the method of extracting water information in SPOT5 image. We choose the SPOT5 as the research data. We can get the water and shadow information from the image by setting the divided line in band SWIR. By using the spectrum characteristic, the space characteristic and time characteristic, such as index of shape, The decision tree model of automatically extracting water information in city zone from SPOT5 image to get the water information from the area can be set up. For estimating the precision of the model, the model and supervised classification method in the whole area and in some special zone that has much building shadow are compared. The result tells that in the whole area there is some improvement between the model and supervised classification method, it's about 2.5%; especially in the special zone there is large improvement, it reaches to 11.6%. Beside that the model is good in transplanting , maybe the divided line is different.**

Keywords- *SPOT5 Image ; Water in City Zone; The Shadow of Buildings ;The Shadow of Terrain; Decision Tree*

I. INTRODUCTION

The methods of taking use of remote sensing to automatically extracting water information have developed a lot in the past tens of years in and abroad.

In China, Mr Pei zhiyuan took use of NOAA images to study the large field of blood disaster. Zhou Chenghu and Du Yunyan brought forward the method of how to extract water information from the AVHRR images using the characteristics of spectrum, and the model has been used broadly. Aiming at the shadow of the terrain , Du Jinkang who was from Nanjing University put forward the method that can remove the shadow of the terrain, and some scientists brought out the method of using DEM to solve the shadow problems[1][2][3].

In foreign countries , Shil took use of the Landsat MSS to extract the water information ,he thought density slice method in one band (band 7) was only lower than the supervised method using the band 5 and band 7 by 3%.Barton took use of the band 4 of AVHRR image to explore the temperature to supervise the blood day and night[4][5].

In a word ,the main methods of extracting water information are divided line method, difference method ,ratio method, spectrum method and the method of basing on knowledge such as the index of shape .But the most obvious problem is the way how to recognize the water information in city zone ,the methods above can not solve the mixture of the water information and the shadow of the buildings in city zone. This article have studied the method how to extract the water information based on SPOT5 image ,and builds the decision tree model of automatically extracting water information. The model have solved the problem of the mixture of water and the buildings' shadow.

II. INTRODUCTION TO THE RESEARCH AREA

The research area –Nanjing is located in the southern part of Jiangsu Province. It is also situated in 31°14′-32°36′N, 118°47′-119°14E. The climate there is belong to north subtropic monsoon climate area. It is very hot in summer and cold in winter. The spring and autumn are too short, the average temperature is 16° C. The main direction of the wind is northeast in winter and southwest in summer.

The article looks the main city zone of Nanjing as the main research area. It includes Gulou Section,Jianye Section,Yuhuatai Section,Qinhuai Section,Baixia Section,Xuanwu Section.The main water information include part of Changjiang River ,Qinhuai River ,Xuanwu Lake .Mochou Lake and some small reservoirs .The main mountains include Purple Mountain. The main remote sensing datum is SPOT5 image in 2000.The resolution of multiply bands is 10 m, and the Pan band is 2.5 m.

III. THE ERECTION OF THE MODEL HOW TO EXTRACTING WATER INFORMATION IN CITY ZONE BASED ON SPOT5 IMAGE

A. The analysis of the characteristic of the spectrum about water information

In infrared bands, the water can absorb more energy than the visible light bands. Although the water is very shallow, the water can also absorb most of the energy in NIR and MIR bands. That means water can reflect little energy in NIR and MIR .But vegetable and soil absorb less energy and reflect more energy in these bands. All of these show that water is different from other things in the two bands. We can find the characteristic in the SPOT5 images. So if we can define the proper divided line in SWIR .we can differ water from other

things .But in some city zone, there are many mountains and high buildings ,and these shadow will affect the water recognition .In the images the shadow and water have the same characteristic. If we only use the divided line method , we can also extract the shadow information just as water from the image when we want to extract the water information .It will affect the precision of the water information extraction.

In order to analyse the traits of the water and other things in SPOT5 images, here we can choose 7classical types of things: Changjiang River water, inland water(except Changjiang River water and other water),roads, buildings,buildings shadow, vegetable, terrain shadow (because there are large differences between Changjiang River water and the inland water, the shadow of buildings and the shadow of the terrain and vegetable ,we divide the four types of things).We choose 100 to 200 examples respectively for each type of things ,and take use of the average values to set up the Figure1 as follows:

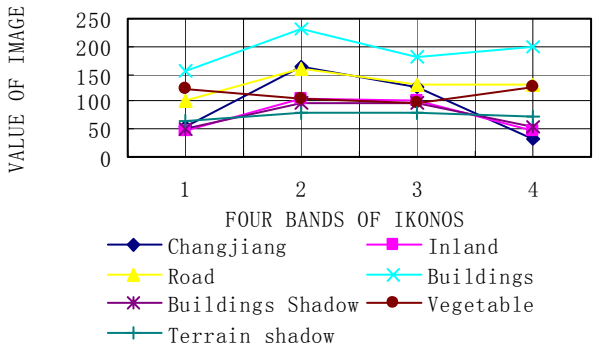

Figure1: Spectral curves of typical things in SPOT5

From the figure1 ,we can see that in the band 1 and 4,the radiation values of Changjiang River water ,inland water ,buildings shadow and terrain shadow are very low .we can distinguish water and shadow with other things in band 4.Inside the four types of things, Changjiang River water is different with inland water in spectral cures. Although they are the same in band 1and band 4, they are different in band 2 and band 3.In the same way ,although buildings shadow is as same as terrain shadow in band 1 and 4, we also can find the differences in band2 and band 3.We can use band 2 to divide the two things. So ,we can divide Changjiang River water ,inland water ,buildings shadow and terrain shadow respectively.

The Figure2 can be gotten by taking use of the distinguished function analysis. In the distinguished scatter spot plot, the relativity during the seven types of things is very low. The obvious mixture here is between inland water and the buildings shadow ,and it indicate that it is not enough to use the only spectral characteristic to extract water information automatically. The article take use of the spectral characteristic and the spatial characteristic to build the model of extracting water information in city zones to solve the problem.

(Figure2 is as follows:)

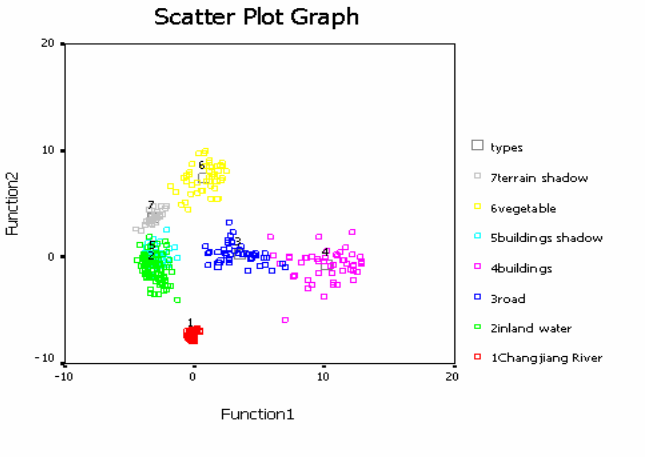

Figure2: Distinguished scatter spot plot

B. *The spatial characteristic analysis of the water information in SPOT5 images*

The main spatial characteristics include size, shape, texture and position. There are different spatial traits in different types of water ,such as rivers ,reservoirs, lakes, ponds and pounds. The shape of these waters is different .The river is like a line. The reservoir usually has a line border at one side of it. The lake's area is more large. The ponds and pounds are usually quadrangle. We can use these knowledge of the water information to differentiate these types of water.

Besides ,the DEM could be used to simulate the shadow of the terrain in order to help eliminate the shadow information from the water information.

C. *The decsion tree model of automatically extracting water information in city zone*

From the analysis, the decision tree model can be set up just as follows:

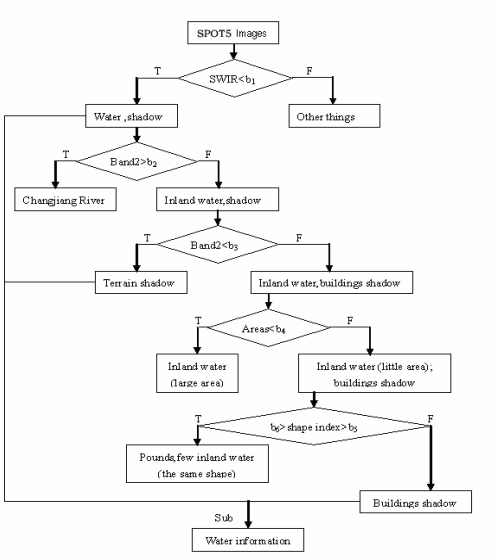

Figure 3:The final model of decision tree

b1~b6 are the divided lines from the spectral characteristics and knowledge ,and the methods to determine the divided line are the same. The model is easy to transplant .But, aim at different images , there are different divided lines just gotten by some statistic methods.

Based on the decision tree model, there are several steps in the study process:

1) The extraction of the water and shadow

In SWIR band, the DN of water is lower than other things .We can find that there are respectively two tops between water and other things by study the histogram. The bottom DN is 66.In order to divide the water and other things adequately ,we choose 81 as the divided line.

We overlay the water graph to the composed picture by SWIR,B1,B2,and the result shows that all the water information has extracted ,but there are also little buildings shadow and terrain shadow.

2) The extraction of the Changjiang River water

Combining with the differences in band2 and band3 during Changjiang River ,inland water and shadow ,we can use the divided line method to extract the Changjiang River water information. Based on statistic knowledge, we define the conditions of Changjiang River water:①DN4<81;②DN2>150.

Comparing the result with the initial image ,the Changjiang River water has been extracted fully. There is no other things in the result.(Figure4)

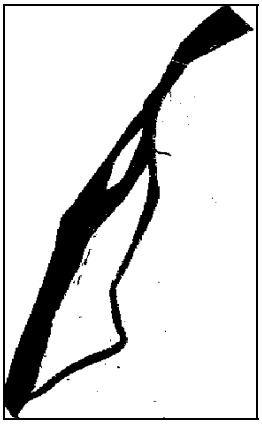

Figure4: Extraction of Changjiang River

3) Extraction of the terrain shadow

Although the terrain shadow is the same as other things' shadow in band 1 and band 4,but in the band2,the DNs of the terrain shadow are fully lower than 87 and the DNs of the other shadow and water information are entirely higher than 91.So we can extract the terrain shadow by these conditions ① DN4<81;②DN2<88.

Compared to the initial image, we can see that all the shadow in the image has been extracted, and there is no other things in the result. The shadow of the mountain has been fully extracted , just as follows:

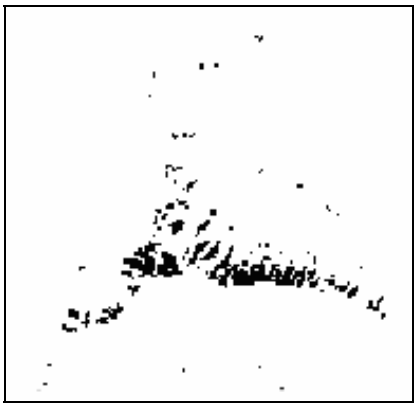

Figure5:Extraction of terrain shadow

4) The separation of the inland water and the shadow of the buildings.

There are two conditions to separate the inland water and the buildings shadow: ①DN4<81;②150>DN2>88.

By the function –FLICKER(a module of ERDAS),we can find that there are no other things except the inland water and buildings shadow, but there are also some little spots which is less than 4 pixel. In figure5, the white things are inland water and buildings shadow, Changjiang River water and the terrain shadow have been eliminated.

5) The separation of inland water and buildings shadow by the spatial characteristics of water and shadow.

The spatial characteristics includes size, shape ,texture and position, we take use of the size(area) and position to solve the problem here.

a)Extraction of water by the area trait. Generally speaking, the area of the building shadow is less than inland water although there are few exceptions(pounds).As a whole, the object above the value of area should be the inland water. Based on this idea , the statistic knowledge and experiences, we determine the 21800m^2 as the divided line. So, we can eliminate much water information whose area are larger.

b)Extraction of water by the shape trait. In the rest of the image information ,there are all the buildings shadow and some water information which have the same acreage as the buildings shadow. From the shape angle,these water information are basically circular, semicircular or shaped complicatedly . There are few pounds here which is foursquare, and the buildings shadow are mainly parallelogram. So here the shape information of the shadow and inland water can be used to separate the shadow information.

Determine the shape index: $M = \sqrt{A} / P$ [8],M is the shape index; A is the area of the object; P is the perimeter. The M of roundness is the largest(>0.25),the second is square(M=0.25),the third is rectangle(m<0.25),The more complex ,the less the M will be .

In this study, the shape of the shadow is usually normal ,and the shadow of the water is rounded or semicircular or the complex shape. There are only the pounds in the left part of the image which have the alike area and the alike shape as the

buildings shadow. So here we could firstly extract the buildings shadow and pounds. One condition:0.23>M>0.13.

From the result image ,we have extracted all the buildings shadow and the pounds ,but there is also few extracted inland water just has the alike shape of the pound .

6) The separation of the pounds ,water which have the same shape with the pounds and the buildings shadow.

From the result of the statistics, the DNs of the pounds and the water have the same shape with the pounds are lower than the DNs of the buildings shadow.So we also can take use of the spectral characteristics and the statistics to extracting the pure buildings shadow. We take 100 as the divided line to separate.

Contrast to the initial image, the buildings shadow can be extracted entirely, and there is only a little inland water.

7) The pure water information could be gotten after the subtraction of the entire information.

We can use the water and shadow information from the first step which subtract the terrain shadow and the building shadow to get the final water information.

IV. CONCLUSION

We take the result from the model to overlay to the initial image, and compare the result with the image interpreted by human being. By the necessary analysis, we can make a conclusion that the entire effect of the model is good, especially the method of eliminating the buildings shadow.

For objective precision evaluation ,firstly ,we compare the precision of model to the precision of supervised classification; after that we choose the special part of area which is full of buildings shadow to compare the precision of the model to supervised classification., 1000 examples have been chose to analyse. The result tells us that to the whole research area, the precision of the model reach to 94.8%, which is more than 92.3%of supervised classification by 2.5%, to the special research area full of shadow, the precision of the model reach to 93.6%,which is more than 82% of supervised classification by 11.6%. After inspection to the image, the mistakes are mainly located in the border between the water and inland. This is mainly because of the similarity of the spectral characteristics of the buildings shadow and the inland water and the defection of the spatial method. According to this, we could use the spatial and time characteristics to get a improvement in the model in the future.

ACKNOWLEDGMENT

The study attributes to the excellent work of the team in Chinese Academy of Sciences and Nanjing University. Especially thanks to Professor Jiang Nan and Dr. Lv Heng for their contribution in collection of the necessary data.

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