The Monitoring Method Application for Vegetation Dynamic Changes Based on TM and ETM$^+$ Images

Sheng Zhan
The Department of Mathematics and Information Science
Tangshan Teacher's College
Tangshan, China
23875654@qq.com

Jingqin MU
The Department of Computer Science
Tangshan Teacher's College
Tangshan, China
mujingqin@163.com

***Abstract*—the paper studies the method application to estimate vegetation pixel by using normalized difference vegetation index and the threshold parameter of the near infrared. It is applied for the experiment of the vegetation extraction in Tangshan city by using TM and ETM$^+$ images. The graph of vegetation information and the graph of vegetation dynamic change were generated according to images in three different periods. It can be concluded that the vegetation coverage area with park has been increased primarily in Tangshan city and the city scale has experienced peripheral expansion in the past 10 years. This method turns out to be correct and effective, as the result is consistent with the actual development of Tangshan city.**

***Index Terms*—TM and ETM$^+$ images; vegetation index; dynamic change.**

I. INTRODUCTION

Urban green space is the key components of urban ecosystem, which has ecological, economic and social attributes. The change of urban green space area directly relates closely to some factors to influence regional environment in climate, hydrology and soil condition. The traditional green survey method that takes filed measurement and estimation requires lots of work which is time-consuming and inaccurate. Remote sensing technology as a kind of comprehensive detection technology can provide effective surface natural process and phenomenon of the macro information, which can help to reveal the dynamic change rule, and forecast the development trend. We may take a certain method and obtain the distribution of urban space structure and the dynamic change quickly and accurately according to the macroscopic properties, multi-phase and multi-band of remote sensing technology. The vegetation index method which is considered to be convenient and accurate parameters has been got a wide range of application [1-2].

This paper explores the methods application for vegetation information extraction and the dynamic change information extraction deeply by examining TM and ETM$^+$ images and applies them to the experiment of the vegetation extraction in Tangshan city effectively.

II. THE PROCESS OF THE VEGETATION INFORMATION EXTRACTION

Since the 1960s, scientists have simulated and extracted all kinds of biological and physical data. A large number of studies have adopted the vegetation index. When computing the vegetation index, the inverse relationship between red and near infrared reflectance of healthy and green vegetation has been used. The research [3] has shown us that making different combination of the red light and near infrared band of remote sensing data turns to be more effective, which may contain ninety percent of vegetation information. Rouse J W, Haas R H, Schell J A [4] put forward the common normalized difference vegetation index (NDVI) in 1974.The formula is

$$NDVI = \frac{\rho_{nir} - \rho_{red}}{\rho_{nir} + \rho_{red}}, \qquad (1)$$

with ρ_{nir} as the value of near infrared band, and ρ_{red} as the value of red band. The NDVI is widely used in the process of processing green vegetation information by using TM image [5].The range of NDVI is between -1 and 1.The more the vegetation information for the pixel, the bigger the value of the NDVI. Therefore, it is necessary to set threshold parameter of pixel value for distinguishing green vegetation information. The threshold is usually more than zero, but the more accurate one must be obtained from the monitoring of the actual landform.

In addition, the NDVI is based on the ration. The research [6] has shown us that for some darker non-vegetation features the NDVI values were higher but the reflectance of near infrared and visible light band are very low. Therefore, the method is improved based on NDVI so as to examine the value of near infrared through additional measurements. If the value of near infrared band is relatively small, even if the value of NDVI meets the requirements, the pixel can not be considered as vegetation one.

In order to analyze the distribution of vegetation information intuitively, the vegetation graph takes binary mode. If the pixel is judged for vegetation, the value on the vegetation will be 1; otherwise the value as 0.This will be used to compute the number of the vegetation pixel and the area of the vegetation.

III. THE PROCESS OF THE VEGETATION DYNAMIC CHANGE EXTRACTION

A. the study district and data set

Several zones such Lunan district and Lubei district of Tangshan city in Hebei province were selected as research objects. The vegetation system consists of five major series including park, square, road green space, residential green space and attached green space, which focuses on green space in five parks.

Images in three periods from 1999 to 2009 were collected. One was the ETM^+ remote sensing image on August 11, 1999.The other two were TM images on July 26, 2006 and September 15, 2009.The periods of three images are near, so the vegetation growth situation was comparable. As the color of them was uniform, together with perfect weather condition in Tangshan, the images were suitable for the vegetation dynamic change monitoring in Tangshan. There are seven bands for TM image. The TM1 to TM5 and TM7 range resolution for 30 meter with TM6 (thermal infrared) band for 120 meter. There are eight bands for ETM^+ image. The ETM^+1 to ETM^+5 and ETM^+7 ranges resolution for 30 meter, ETM^+6 ranges resolution for 60 meter with ETM^+8 for 15 meter.TM4,3,2 and $ETM^+4,3,2$ were used in the study. Because their multi-band characteristics, TM and ETM^+ images have been applied widely in urban planning, architecture, land utilization, resource management, agriculture research, environmental monitoring and information extraction. TM image is the first choice for researchers because of its low price.

B. the preprocessing of images

To analyze vegetation dynamic changes, it is necessary to make geometric registration for three images. Take the image on July 21, 2006 as fiducial one. The other two images are made geometric registration with the first image. After registration, the resolution of images is 30 meter. If the images are not covered by cloud, the atmospheric correction can be omitted. If the cloud of image was obvious, the atmospheric correction must be made.

C. the application of the vegetation information extraction

It is no unified conclusion to set the threshold value of NDVI parameter. Therefore we took the experimental method and comparison to modify the threshold parameters. The vegetation pixel was so red that the vegetation pixel was clearly when false color image was composite with TM4 as red band, TM3 as green band and TM2 as blue band. We selected randomly pixels in NDVI images in 2009 and compared with the actual landscape in Tangshan city. The parameter of NDVI was selected with 0.09 finally. When the TM4 band image, the NDVI image and the composite image were displayed and compared on the screen at the same time, for the value of NDVI of red vegetation pixel in composite image was bigger than 0.09, furthermore the value of the relative pixel in near infrared band was always more than 40.Therefore, the threshold parameter of near infrared band was set with 40.

In order to facilitate the programming, the lines and samples of the selection area were 1000 pixels corresponding to the NDVI image respectively. In Fig.1,the white part is the vegetation such as farmland and urban green space.

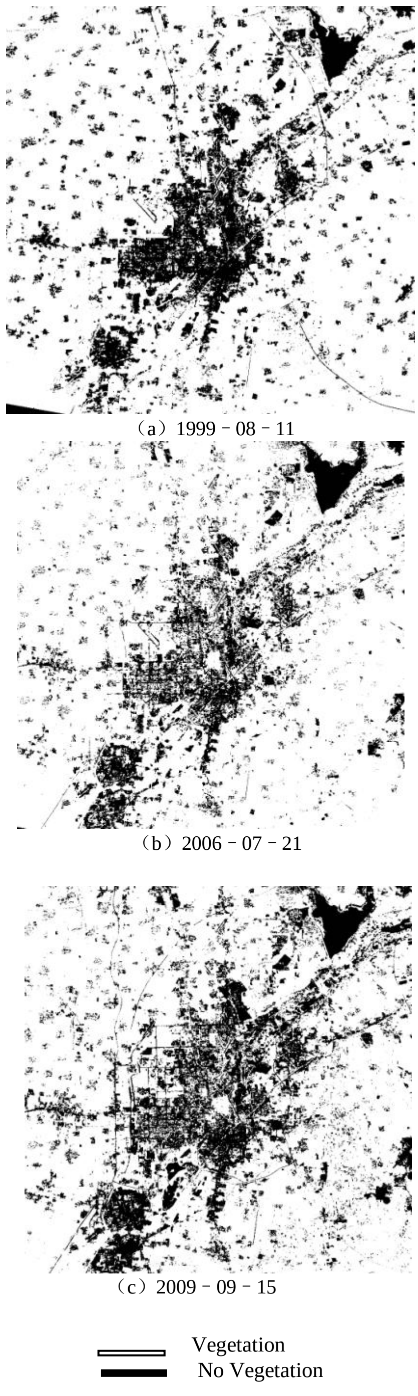

Fig. 1. Vegetation information in Tangshan in three periods

D. The generation of vegetation dynamic change graph

In order to analyze vegetation changes in Tangshan more intuitively and enhance the comparison effect for the three periods of vegetation distribution, the three periods of

TABLE I. STATISTICS OF THE VEGETATION PIXELS AND AREAS IN TANGSHAN (INCLUDING SUBURB FARMLAND)

Date	The Numer of Pixels	Area(Square Meter)	Percent of Area(%)
1999-08-11	820982	738883800	82.1
2006-07-21	843758	759382200	84.3
2009-09-15	772593	69533700	77.3

vegetation information graphs were composite with the graph in 2009 as red band, the graph in 2006 as green band and the graph in 1999 as blue band. From the false color composite graph in Fig.2, it is clear to analyze the vegetation dynamic changes in Tangshan between 1999 and 2009.

IV. THE ANALYSIS OF THE RESULT

From Fig.1, changes in vegetation cover information in the three periods can be seen roughly. In order to study the change further, the number, the area and the percent of green space pixel were calculated in table 1.

It can be seen From table 1 that before 2009,due to the rapid expansion of the city, a large number of farmland were occupied, which resulted in the loss of vegetation in Tangshan city , however, the increase and decrease in the local areas can not been obtained from table 1. Therefore the more specific analysis can be seen from the vegetation dynamic change graph.

From the fig.2, vegetation distribution in the surrounding area of urban district has followed a declining trend. It is shown that the city size has been expanded due to peripheral development and the vegetation has been decreased in the past 10 years. However, the vegetation distribution in the urban internal area can be seen in fig 2 , and especially the obvious increase from 2006 to 2009 .It is also shown that the protection of the internal vegetation is good(especially the vegetation in 2009 and 2006 and the vegetation in 2009 only).

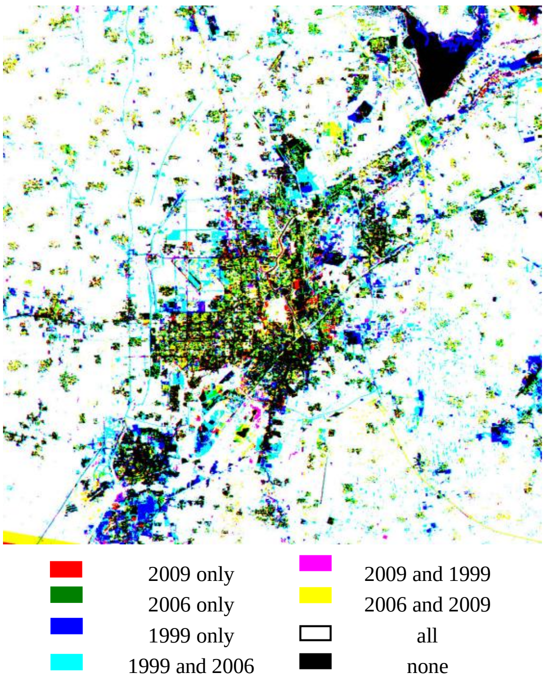

Fig.2. Change of dynamic information of the vegetation distribution in Tangshan during 1999–2009

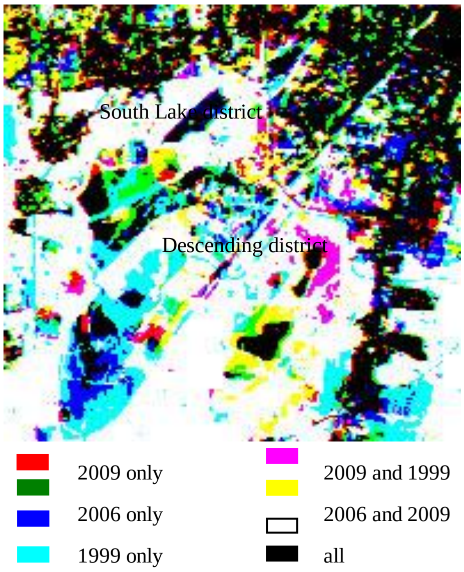

Fig.3 Dynamic change of the vegetation distribution in South Lake area

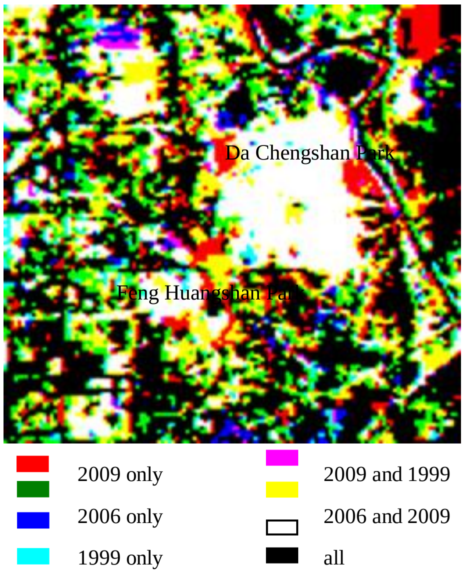

Fig.4 Change of dynamic information of the vegetation distribution in typical greening area of Tangshan

Take the South Lake area shown by Fig.3 and the typical greening area including Da Chengshan Park shown by Fig.4 for examples to illustrate deeply.

From the fig.3, the changes of vegetation distribution in South Lake ecological area are significant during three periods. It is shown that the urban development has changed a lot in the past ten years in South Lake area; therefore the changes of the areas of vegetation are obvious. Because the South Lake area was the subsidence area of the coal mining and was stacked production and living garbage from Lubei and Lunan district and formed the rubbish mountain in the south of Tangshan city. For the pass few years, the governance of Tangshan mining coal subsidence has been carried out. Especially since 2008, Tangshan launched the construction projects of central urban ecological park in South Lake and implemented sequences of a number of infrastructure projects such as the South Lake expansion and landscaping, road, public plaza etc.Those projects made South Lake ecological construction speed up further.

From the fig.4, the largest white area stands for Da Chengshan Park and the Feng Huangshan Park which is local at the closely south of Da Chengshan. Around the park from 2006 to 2009 new vegetation is apparent. It is illustrated that park green area is increasing in 2006-2009.those phenomena are fit with the measures effect of urban greening such as downtown area greening, planning to build green, three-dimensional green and park greening in Tanshan city. Liner red area on the right side of the figure is the green belts along the coast of Douhe stream. It is correspond with the actual construction forming the green Douhe gallery and green net through south and north urban district. The large red area on the upper right corner of figure is the industrial green belt. It is correspond with implementing industrial zone courtyard greening stand and outside protection greening in 2008.

In addition, we take the NDVI method with not including near infrared parameter to make experiment. The comparison result is shown in Tab.2.With the NDVI method three values during three years are more than the corresponding values. However the data with NDVI and near infrared parameter method is more accordant with the practice of the city. So using NDVI threshold and near infrared parameter together is more accurate.

TABLE II. THE COMPARISTION OF THE GREEN SPACE PIXELS FOR TWO METHOEDS

Date	NDVI and near infrared parameter method	NDVI method
1999-08-11	820982	821804
2006-07-21	843758	850888
2009-09-15	772593	785056

In conclusion, in recent years Tangshan city put a new premium on the greening work, therefore road greening, park greening and transformation and the construction of the south lake are prominent, and the urban green space area is increasing year by year. However, due to the expansion of the city, the farmland area also suffered reduction. The conclusions from table 1 and fig.2 are consistent with the actual situation of green space construction in Tangshan from 1999 to 2009.

V. CONCLUSION

In the paper the vegetation information graph by using the normalized vegetation index and threshold parameters of the near infrared band goes with the dynamic change graph generated from 1999 to 2009 in Tangshan city. The result is consistent with the actual development situation of green space in Tangshan .It is shown that the method is effective and also embodies fully the remote sensing technology to be effective, intuitive and accurate in the vegetation information extraction. There are some pixels with error when selecting the parameter of NDVI with experimentation. It is concerned that the resolution of TM and ETM^+ is limited and some pixels are mixed. How to determine the pixel with error remains to be further study.

ACKNOWLEDGMENT

The paper was supported by the Tangshan Science and Technology Study Project (11150202A-4), and received guidance and help by the professor Guoqing Yao in School of Information Engineering of China University of Geosciences .Thanks to them sincerely.

REFERENCES

[1] Yu M Y, Cui J, Xu Q X, et al. The Monitoring and Analysis of Green Cover in LongKou City Based On the Remote Sensing Technology[J].Journal of Shandong Jianzhu University, 2007(1):85-88

[2] Wang X D, He H, Hou D, et al. Vegetation Cover Change Detection in the Cropping Area Based on TM Image[J].Remote Sensing for Land and Resources, 2012 (2):92-97

[3] Boffat A S. Resurgent Forest Can Be Greenhouse Gas Sponges[J].Science, 1997(277) : 315-316.

[4] Rouse J W, Haas R H, Schell J A. Monitoring Vegetation Systems in the Great Plains with ERTS[J].3rd Earth Resource Technology Satellite (ERTS) Symposium,1974(1)48:62

[5] Trishchenko A P, Cihlar J, Li Z. Effects of Spectral Response Function on Surface Reflectance and NDVI Measured with Moderate Resolution Satellite Sense[J].Remote Sensing of Environment,2002(81):1-18

[6] Huang Y. TM Image Based Research of Extraction Technique of Greenbelt Information [J].West-China Exploration Engineering, 2008(3) : 64-66