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Extraction of Water Information based on RADARSAT SAR and Landsat ETM+

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Abstract

As an important resource，water has a far-reaching impact on various economic activities. In agriculture, water controls the distribution of crops. In this paper, RADARSAT SAR and Landsat ETM+ imagery were used for the extraction of water information. First, radar image was preprocessed by the radar image calibration and filtering. K-T transformation was applied to Landsat ETM+ data for wetness index and NDVI was derived. Finally, the two classification results are compared. The results show that the complementary information of RADARSAT SAR and Landsat ETM+ image can quickly and accurately extract the water information.

Keywords: *RADARSET* SAR; Landsat ETM+; Wetness; NDVI

Introduction

74% of the Earth's surface area is covered by water. Water either as a resource, or as an environmental factor, or the source of flooding are subject to the attention of people particularly. Therefore, extraction of water information has become an important application of Remote Sensing. Satellite remote sensing images, which can be used for rapid and accurate extraction of water information, has become a macro-important means of detecting water resources, water survey and wetland protection. Using satellite remote sensing data to monitor the distribution and changes in water resources, it has been widely used in the last 20 years. Water resources research first need to accurately extract the distribution of water. To address the problem using remote sensing information in extracting the distribution of water, lots of people have done a lot of researches and proposed a number of methods. The most common methods are: spectral analyze technology, (the Maximum likelihood method[1]), single band threshold analyse、ratio technique、segmentation、rate measurement、spectral relationship method and those based on knowledge rules as well as water index method[2]. Remote sensing technology provides the advanced technical means for detecting the spatial distribution of water and other information, It overcomes many shortcomings of traditional manual surveys, such as high cost, time-consuming and influence of many other unknown factors in the field.

Microwave remote sensing has become an international focus of the study of remote sensing technology, for it regardless of the weather factors and has a powerful data acquisition capabilities. Canada's RADARSAT satellite is one of the relatively complete and advanced in radar satellites

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operating today. Its multi-resolution and multi-modal model of coverage provides lots of flexible and efficient application methods for the Earth observation, has been widely used in various fields. This paper attempts to use RADARSAT SAR and Landsat ETM+ image as the basis of complementary information for rapid extraction of water information.

Study Area and Data Sources

The study site is located in Jiangning district, Nanjing, Jiangsu Province (Fig.1). It is located in the economic development zone along the Yangtze River. Specifically, it is located between latitude 31 ° 30 'N and latitude 32 ° 00'N, and longitude from 118 ° 30 'E to 119 ° 25'E . It is a typical southern hilly area and the land use mainly includes irrigation paddy field, dry land and forestry. The study area mainly includes part of Qinhuai River basin and some hills. RADARSAT SAR data and Landsat ETM+ data were used in this study for the extraction of water bodies. RADARSAT-1 SAR C-band (wavelength of 5.6cm) was acquired on August 23, 2001, and Landsat ETM+ imagery on July 17, 2001.

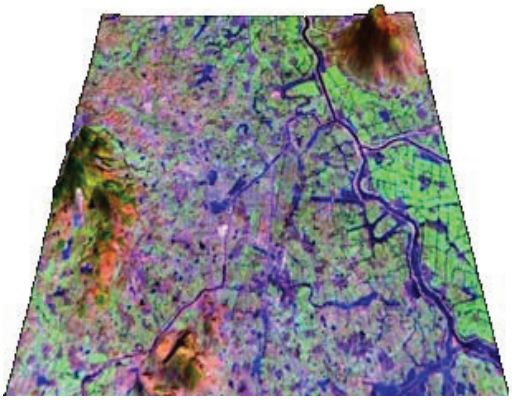


Fig.1 Location of study area

Methods

RADARSAT narrow scanning SAR data on August 23, 2001 provided complete coverage of research area at a nominal post spacing of approximately 50m.

RADARSAT SAR data and optical remote sensing data are very different in imaging mode and mechanism. Moreover, SAR data provide different image features from optical remotely sensed imagery. RADARSAT SAR imagery represents the characteristics of objects on slant imagery and ground imagery. Layover, foreshortening and shadow on imagery make this kind of data more difficult to be processed.

1. Radar Data Preprocessing

Firstly, Radar brightness values（β^0）were obtained by calibration and filtering. Then, the study area was cropped out after precisely registration by using ground control points (GCPs) (Fig.2).

2. Extraction of water information

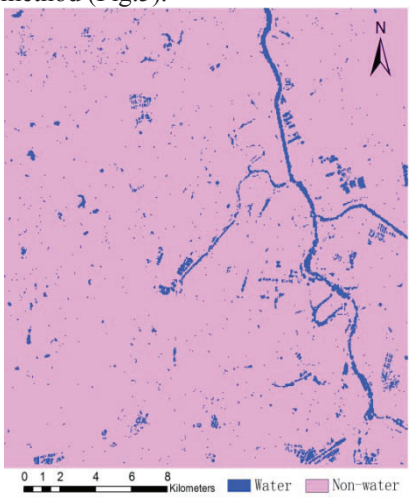
2.1 Extraction of water information based on RADARSAT SAR images.

Water bodies on the radar image are in gray and black, because the smooth water surface produces low backscatter. Therefore, brightness values of water bodies are generally low. The results of analyzing samples show that brightness values of water in the study area are less than – 47. Water bodies and non-water can be effectively distinguished by using decision tree classifier(Fig.4). Finally, the accuracy of the classification results is assessed.

Fig.2 RADARSAT SAR images of the study area ; **Fig.3** False color composite of Landsat ETM+ (543) of the study area

2.2 Extraction of water information based on Landsat ETM+ image.

Firstly, Landsat ETM+ imagery was precisely registered by digital elevation model (DEM) of the study area (Fig.3).Then, the wetness index were acquired by processing the Landsat ETM+ images with Tasseled cap transformation. The Wetness index was used to extract water information. It is found that by using -57, the water can be separated from non-water effectively by using decision tree classification method (Fig.5).



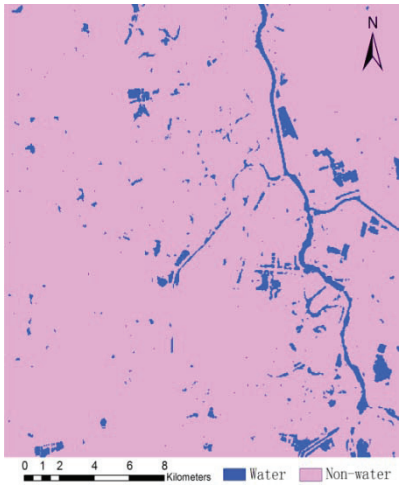


Fig.4. Water extracted by using RADARSAT SAR ; **Fig.5** Water extracted by using Landsat ETM+

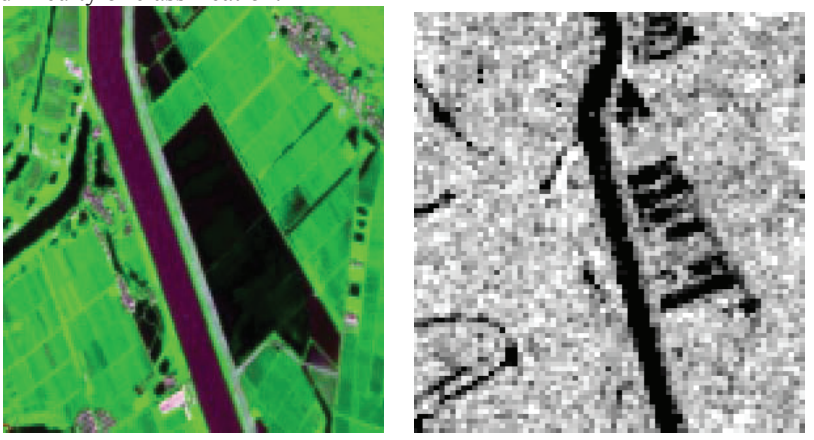
2.3 Combination of the extraction information of SAR imagery and ETM+ imagery

Two extraction results were superimposed. Then, by using high-resolution SPOT images and field survey data, the results of extraction of water bodies were analyzed and validated. Then the differences of the two results derived from SAR data and optical remotely sensed data were explored and compared.

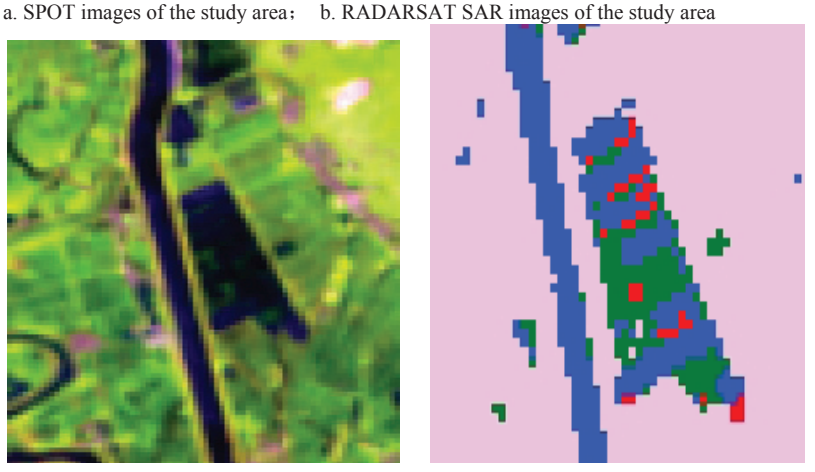
Results and Analysis

High-resolution SPOT images and statistical information were used to determine if the water information significantly extracted from the RADARSAT SAR images and Landsat ETM+ images. Research has demonstrated that RADARSAT SAR imagery can be used to accurately extract water information with an accuracy of 83%. The classification accuracy of the water information based on Landsat ETM+ images was 79%. Studies show that the use of a single type of data for extraction of water information has low classification accuracy and it cannot meet the requirement.

Field investigation of the study area shows that there is a lot of vegetation growing on the water surface (Fig.6a). In addition, many dams, fences and other artificial construction objects were located in the shrimp ponds. A variety of features distributing in water bodies make it difficult to interpret. This brought about the difficulty of classification.



a. SPOT images of the study area； b. RADARSAT SAR images of the study area



c. Landsat ETM+ images of the study area; d.Water information images of the study area

Fig.6 Aquatic vegetation in different images

Unlike water bodies, the brightness values of vegetation on the water on SAR imagery were much higher than those of water. So they can be easily divided into non-water bodies by mistake (Fig.6b). The radar is sensitive to the open water. By using RADARSAT SAR images, open water information can extracted effectively, even many small water bodies such as small ponds.

The survey found that many emergent plants growing in ponds as well as along rivers (Fig.6c). They are easy to be confused with the water with great wetness values due to their proximity to open water areas. In addition，the narrow dams in the open area were divided into water bodies by mistake, because of the surrounding water body. Meanwhile, the study also found that Landsat ETM+ images are not sensitive to the small water bodies and they can be easily classified by mistake as those types of surrounding features. As a result, many of the small water bodies are omitted when using the Landsat ETM+ images for the extraction of water information.

In short, complementary information of RADARSAT SAR images and Landsat ETM+ images of can be used effectively to extract water information. The open water areas and small water bodies can be extracted using RADARSAT SAR images more effectively. The dams and fences and other artificial construction in the shrimp ponds can be effectively separated from water for them high brightness values. Wetness and NDVI can be used effectively for the extraction of water bodies on Landsat ETM+ data (Fig.6d). The accuracy of classification by using two the complementary information of RADARSAT SAR images and Landsat ETM+ reaches 94.7%. This is a fast and more accurate way for extracting water bodies.

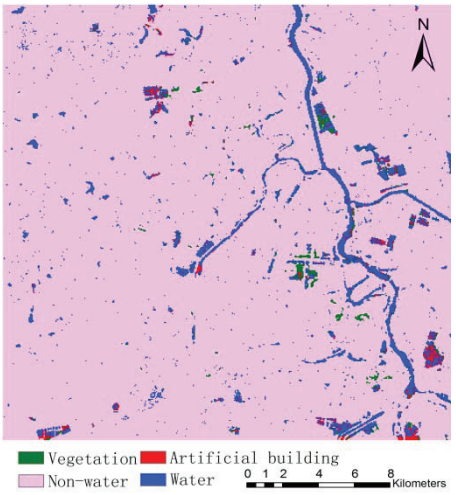


Fig.7 Water information of Jiangning

Conclusions

This paper using RADARSAT SAR images and Landsat ETM+ images respectively to extracted water information in the study area Jiangning,Nanjing. Research shows that the open water areas and a large number of small water bodies in the study area can be effectively extracted from RADARSAT SAR images. Meanwhile, the vegetation and water bodies can be effectively separated by using wetness index and vegetation index NDVI) transformed from Landsat ETM+ dates. The results of this research indicate that the complementary information of these two different types of images can be used to detect the open water and small ponds effectively. At the same time, vegetation growing on the water surface and dams in the breeding area can also be separated quickly.

This study demonstrates that the complementary information of RADARSAT SAR images and Landsat ETM+ images can achieve semi-automatic and rapid extraction of water information. It is convenient for

quick, simple and accurate extraction of information on a wide range of water.

Acknowledgments

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References

[1] QIN Qiming, YUAN Yinhuan, LU Rongjian: The recognition of various types of water bodies on satellite image[J]. Geographical Research, 2001, 20(1):62-67.

[2] CHEN Huafang, WANG Jinliang, CHEN Zhong, YANG Liu, XI Wujun: Comparison of Water Extraction Methods in Mountainous Plateau Region from TM Image[J]. Remote Sensing Technology and Application, 2004,19(6):479-483.

[3] LIU Xin, Cao Xiaoqing: Study on the Method of Picking-up Water Surface Area in The Three Gorges Reservoir Based on RADARSAT[J]. Environment and Ecology in the Three Gorges,2008(2),17-20.

[4] DU Ming yi, WU Wenbo,GUO Dazhi: Research on Multi-Source Geographic Information Based Classification of Desertification[J]. Journal of Image and Graphics, 2002，7（7）：740-743.

[5] ZHU Shaowen, HU Hongyin; WANG Quande, ZHANG Dabin, HUANG Hao, LU Yuchang: Technique and Development of Decision Tree Mining[J]. COMPUTER ENGINEERING, 2000，26（10）：1-3，25.

[6] WANG Zhoulong, FENG Xuezhi, ZHANG Anding, WANG Dapeng: Feature Research on Jiangning Land Use Change with Spatial Analysis[J]. Journal of Agricultural Mechanization Research, 2007(7):80~88.

[7] Feng Xuezhi, Wang zhoulong, Liu Xiaomei ,Wang Lei: The study of dynamic change of the land using in JiangNing[J]. JIANG SU SURVEYING AND MAPPING ,1999,22(4):3-4.

[8] DU Jinkang, HUANG Yong sheng, FENG Xue zhi, WANG Zhou long: Study on Water Bodies Extraction and Classification from SPOT Image[J] . Journal of Remote Sensing,2001，5（3）：214~219.

[9] PEI Tao, ZHOU Cheng-hu, LUO Jian-cheng; HAN Zhi-jun, WANG Min, QIN Cheng-zhi; CAI Qiang: Review on the Proceedings of Spatial Data Mining Research[J]. Journal of Image and Graphics, 2001，6（9）：854-859.

[10] Bolstad Paul V & Lillesand T M: Rule-based cassification models：flexible integration of satellite imagery and thematic spatial data[J]. Photogrametric Engineering & Remote Sensing， 1992，58（7）：965～971.

[11] DU Ming-yi,WU Wen-bo , GUO Da-zh: Research on Multi-Source Geographic Information Based Classification of Desertification[J]. Journal of Image and Graphics, 2002，7（7）：740-743.

[12] LUO Jian|cheng, YANG Yan: Remote Sensing Intelligentized Geo-Analysis[J]. REMOTE SENSING TECHNOLOGY AND APPLICATION, 2000，15（3）：199-204.

[13] YANG Cun jian, ZHOU Cheng hu: Investigation on Classification of Remote Sensing Image on Basis of Knowledge[J]. Geography and Territorial Research, 2001，17（1）：72-77

[14] Lucas L & Janssen F: Integrating topographic data with remote sensing for land-cover classification[J]. Photogrammetric Engineering & Remote Sensing，1990，56（11）：1503-1506.