International Journal of Applied Earth Observation and Geoinformation 50 (2016) 10–25

Contents lists available at ScienceDirect

International Journal of Applied Earth Observation and Geoinformation

journal homepage: www.elsevier.com/locate/jag

Water-Body types identification in urban areas from radarsat-2 fully polarimetric SAR data

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ARTICLE INFO

Article history:
Received 11 November 2015
Received in revised form 26 February 2016
Accepted 27 February 2016
Available online 11 March 2016

Keywords:
PolSAR
Supervised classification
Water-body extraction
Water-body types identification

ABSTRACT

This paper presents a novel method for supervised water-body extraction and water-body types identification from Radarsat-2 fully polarimetric (FP) synthetic aperture radar (SAR) data in complex urban areas. First, supervised water-body extraction using the Wishart classifier is performed, and the false alarms that are formed in built-up areas are removed using morphological processing methods and spatial contextual information. Then, the support vector machine (SVM), the classification and regression tree (CART), TreeBagger (TB), and random forest (RF) classifiers are introduced for water-body types (rivers, lakes, ponds) identification. In SAR images, certain other objects that are misclassified as water are also considered in water-body types identification. Several shape and polarimetric features of each candidate water-body are used for identification. Radarsat-2 PolSAR data that were acquired over Suzhou city and Dongguan city in China are used to validate the effectiveness of the proposed method, and the experimental results are evaluated at both the object and pixel levels. We compared the water-body types classification results using only shape features and the combination of shape and polarimetric features, the experimental results show that the polarimetric features can eliminate the misclassifications from certain other objects like roads to water areas, and the increasement of classification accuracy embodies at both the object and pixel levels. The experimental results show that the proposed methods can achieve satisfactory accuracies at the object level [89.4% (Suzhou), 95.53% (Dongguan)] and the pixel level [96.22% (Suzhou), 97.95% (Dongguan)] for water-body types classification, respectively.

1. Introduction

Water is one of the most important natural resources and plays an irreplaceable role in human survival and in the ecosystem. In urban areas, many water resources are now facing threats from nutrient enrichment, organic, and inorganic pollution (Palmer et al., 2015). Besides, with the rapid urban expansion and population growth, water resources in urban areas are also gradually decreasing (Niemczynowicz, 2009; Huang et al., 2015). To improve the understanding of physical, chemical, and biological properties of water resources, and to monitor the illegal use and pollution, the demands for precise and real-time water monitoring in large areas are increasing. Some traditional methods including field survey take a long time and suffer from small spatial coverage. On the contrary, remote sensing techniques provide an effective tool for land-use management due to their capabilities for frequent and large-scale observations of the earth. The optical data provide abundant spectral information and a short-revisiting period, which are useful in land-cover/land-use (LCLU) classification. However, optical sensors are limited by the cloud cover. In contrast to optical sensors, SAR avoids the effects of clouds and allows day and night imaging (Lee and Pottier, 2009; Cloude, 2010).

Many scholars have also carried out meaningful work in water management, flood mapping, and water level change detection using SAR data (Hostache et al., 2009; Chen et al., 2010; Giustarini et al., 2013; Zhao et al., 2014; Shareef et al., 2014). Most of these studies have focused on rapid or precise water-body extraction. For example, Giustarini et al. (2013) proposed a change detection approach for automated flood-extent extraction using TerraSAR-X data. Zhao et al. (2014) used the time-series Radarsat-2 PolSAR data to monitor the seasonal inundation in the Erguna floodplain. Moreover, PolSAR data were also used to develop technology for water quality monitoring and evaluation (Chen et al., 2010; Shareef et al., 2014). For better water resources management, we need to know more details (water-body types *etc.*) of water resources rather than their areas. Different water-body types show totally different functions and have different effects on the urban ecology and environments

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http://dx.doi.org/10.1016/j.jag.2016.02.012
0303-2434/

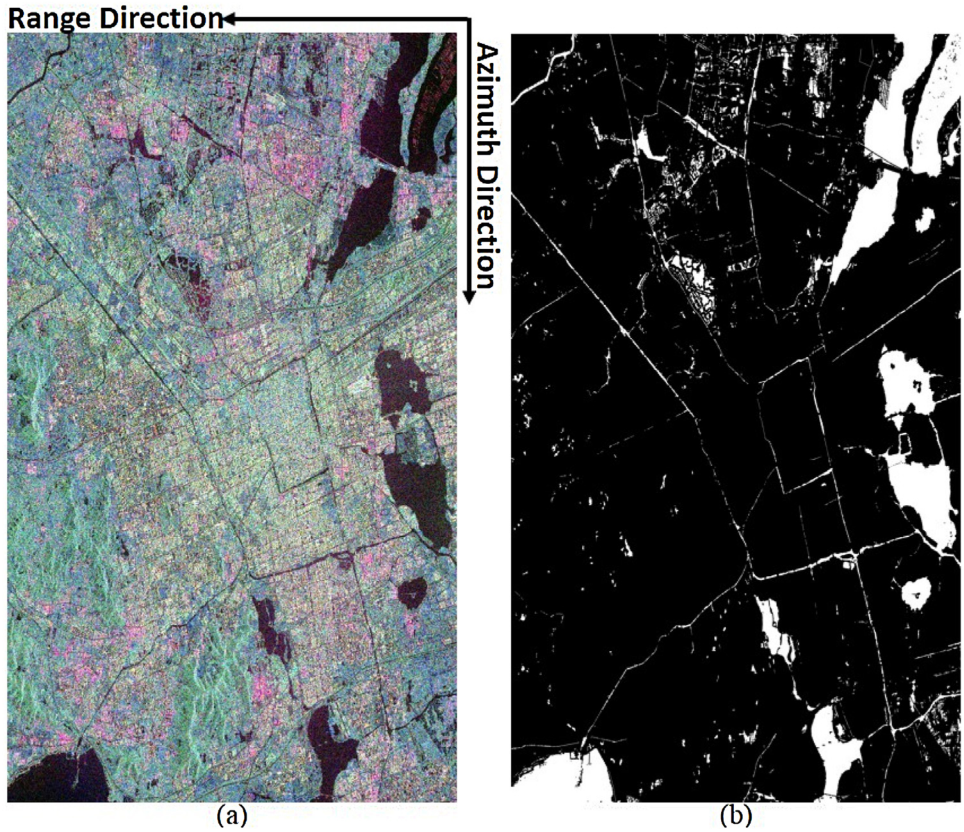

Fig. 1. (a) Pauli image of the study site (Suzhou); and (b) the reference data of water-body areas (colored in white).

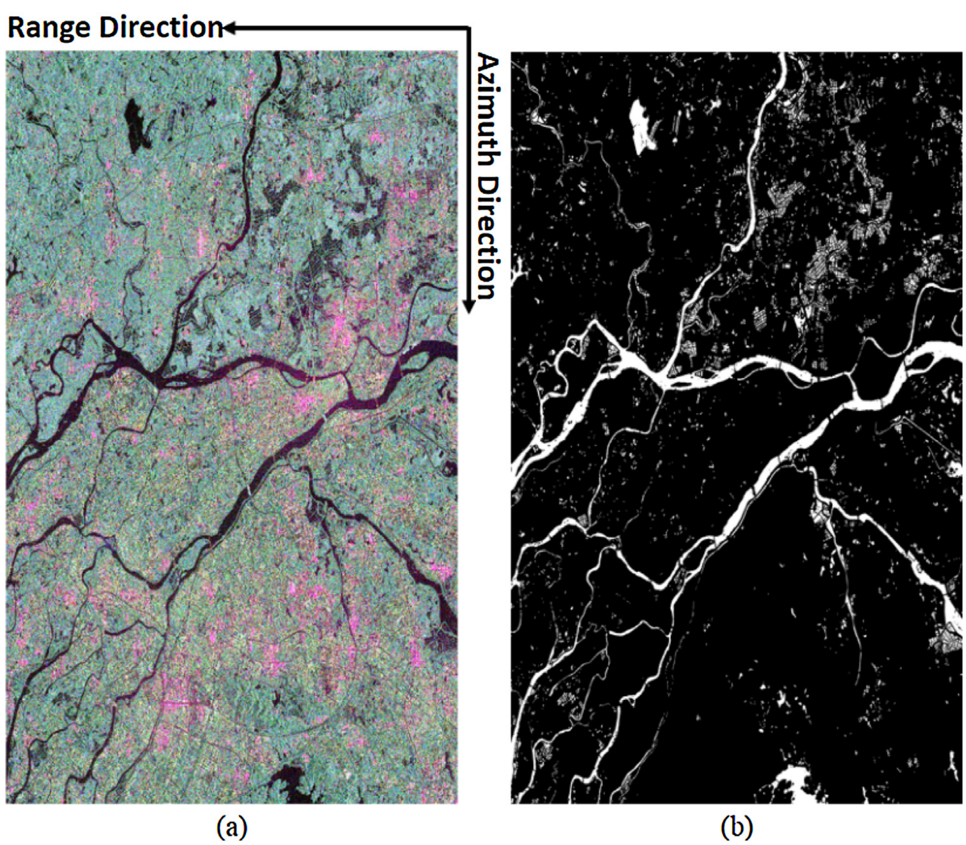

Fig. 2. (a) Pauli image of the study site (Dongguan); and (b) the reference data of water-body areas.