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Monitoring and Classifying Land-cover in Teheran, Iran by Satellite Remote Sensing

Member ○Homa Zakeri[*1] Member Fumio Yamazaki[*2]

Urban Planning Remote Sensing Land-cover
PALSAR-2 GLCM SAR

1. Background and Purpose

Land-cover monitoring of urban areas provide vital information for environmental science, seismic risk assessment, urban management, and regional planning. It is important to update land-cover maps which could help governments to prepare for emergency monitoring of cities, especially for natural hazards (Brando, 2003). Remote sensing technology is a fundamental tool to obtain significant information from ground surface regarding land-cover classification. Thus, satellite imagery can be used for analyzing land-cover changes. Consequently, Synthetic Aperture Radar (SAR) sensors can extract object's characteristics based on its backscattering echo independent of weather condition and time (Rogan, 2004). Yamazaki & Liu (2014) performed a study on urban change monitoring using SAR imagery. Zakeri et al. (2016) showed that SAR images would provide precise information on land-cover classification of urban areas.

This study aims to apply texture measures to ALOS-2 PALSAR-2 images for supervised classification of Tehran, Iran using the Support Vector Machine (SVM) algorithm.

2. Study Area and Data Set

The study area of this research is Tehran, the capital city of Iran, which is a part of the Tehran metropolitan area located at longitude: 51° 25' 17.44" E and latitude: 35° 41' 39.80" N as shown in **Figure 1**. The population of the city had slightly increased from 6,058,207 in 1986 to 6,758,845 in 1996, but it rose significantly to 12,183,391 by 2011. Therefore the city needed more facilities for the residents. Due to this matter, several land-covers and land-uses emerged or changed into different ones.

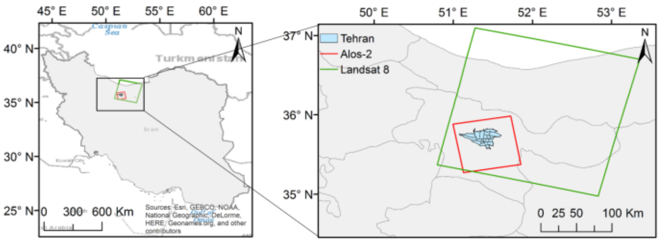

Figure 1. Location of Tehran and coverage of satellite images used in this study, including ALOS-2 (red frame) on October 14, 2015; Landsat-8 (green frame) on May 7, 2015.

The data employed in this research, as depicted in **Figure 1**, were taken by ALOS-2 PALSAR-2, operated by Japan Aerospace Exploration Agency (JAXA), and Landsat-8 satellite of National Aeronautics and Space Administration (NASA). The ALOS-2 image taken on October 14, 2015 has HH and HV polarizations, with incident angle of 40.56º at the center of the image and the spatial-resolution of 6.2 m. The Landsat-8 image acquired on May 7, 2015 has a panchromatic band with 15-m resolution and 11 multi-spectral bands with 30-m resolution.

3. Methodology

The methodology consists of five steps: pre-processing, texture analysis, Principal Component Analysis (PCA), supervised classification, and accuracy assessment. The set of polarized (HH, HV) of ALOS-2 PALSAR-2 as shown in **Figure 2** was applied in this framework and the result was evaluated comparing with the Landsat-8 image shown in **Figure 3**. The pre-processing of ALOS-2 images includes radiometric calibration, geometric correction, and speckle Lee filter with window size 3x3. Besides, the pre-processing of the Landsat-8 image contains radiometric calibration and pan-sharpening. After pre-processing steps, the Gray Level Co-occurrence Matrix (GLCM), which is one of the most powerful texture measures for land-cover monitoring (Haralick, 1973), was used in this study. Eight textural features: *Angular Second Moment*, *Contrast*, *Correlation*, *Homogeneity*, *Variance*, *Mean*, *Entropy* in angle 0º, distance 1, window size 11x11 and quantization level of 64, were performed in order to evaluate its performance for land-cover classification.

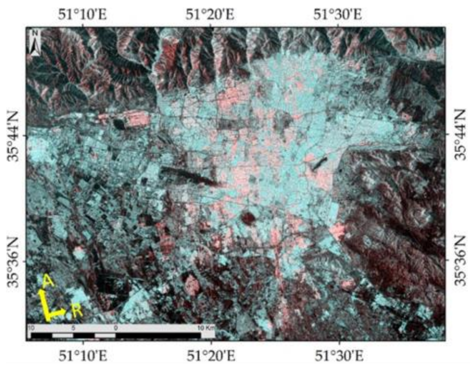

Figure 2. Color composite of the dual polarization ALOS-2 image (RGB: HH, HV, HV).

Then, in order to reduce the dimensionality, the principal component analysis (PCA) was performed independently for each set (HH or HV) of texture features. Thus three first

*1 Homa ZAKERI; *2 Fumio YAMAZAKI

components were selected due to containing the almost 99 percentage of the variation of the eight original input variables and they were used for the next stage.

Supervised classification is a training based methodology, which classifies similar image pixel values to training samples in a confined number of classes. Thus, training samples must be selected based on a homogenous group of image pixels to provide the best separability of them. After the inspection of Tehran city, five land-cover classes were defined as shown in **Figure 3**: bare land, vegetation, built-up type 1 (BT1), built-up type 2 (BT2), and built-up type 3 (BT3). BT1 is composed of highly dense residential areas with old buildings of mostly 2 stories along narrow streets and roads. BT2 is composed of moderately dense residential areas of mostly oriented parallel to a block of buildings, consisting of approximately 4-6 stories. BT3 includes individual buildings with 4-12 stories with wider streets than other types around and plenty of vegetation surrounded. For each of these 5 land cover classes, three training samples were selected as shown in **Figure 3**. Then SVM algorithm was used for classifying the study area.

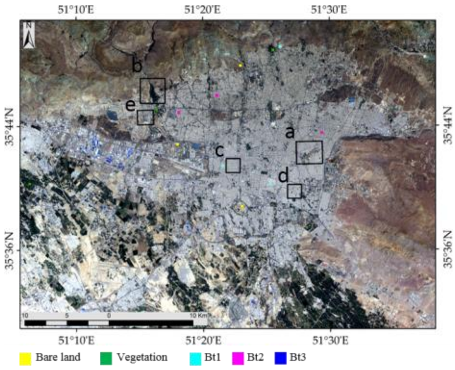

Figure 3. Training polygons used for supervised classification, shown on the Landsat-8 image. The black frames represent the location of the sample areas for land-cover classification.

4. Result and Discussion

In order to evaluate the performance of texture measures in SVM classification of Tehran, accuracy assessment was conducted by preparing the confusion matrix using ground truth data. The result shows improvement of overall accuracy from 57% to 89% for input data without or with texture measures (window size 11). **Figure 4** shows the classification results for the five land-covers. The location of classification samples were also shown on Landsat-8 image in **Figure 3**. Comparing the sample areas in the classification result with the Landsat-8 image showed that all the five land-cover classes were classified correctly.

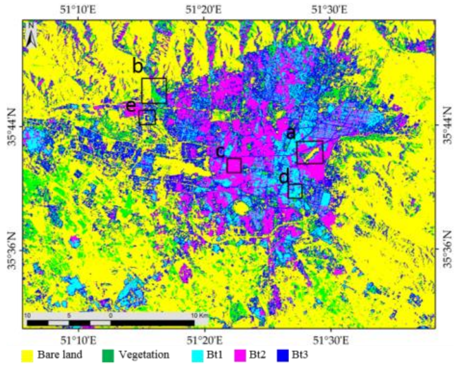

Figure 4. Classification result of the ALOS-2 image by SVM. The black squares represent the location of land-cover classification sample areas.

5. Conclusions

In this study, the GLCM texture measures were applied to evaluate its potential use for improving supervised classification of SAR intensity images for urban areas. For this purpose, Tehran, Iran was selected as the study area because of its fast expansion, which results in significant land-cover changes. The supervised classification results with texture measures were found to be superior to the one without textures in selected land-cover classes. Checking the confusion matrix of the result shows significant improvement of overall accuracy from 57% to 89% for the input data without or with texture measures, respectively.

Acknowledgment

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*1 千葉大学大学院工学研究科　博士後期課程
*2 千葉大学大学院工学研究院　教授・工博

*1 Graduate Student, Graduate School of Engineering, Chiba University.
*2 Professor, Graduate School of Engineering, Chiba University, Dr. Eng.