Advanced machine learning methods for wind erosion monitoring in southern Iran

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Extended abstract

1- Introduction

Wind erosion is one the most important factors of land degradation in the arid and semi-arid areas and it is one the most serious environmental problems in the world. In Fars province, 17 cities are prone to wind erosion and are considered as critical zones of wind erosion. One of the most important factors in soil wind erosion is land use/cover change. Therefore, accurate mapping of land use/cover and wind erosion evidences in arid and semiarid regions is the utmost importance. Moreover, for discrimination of land covers resulting from wind erosion such as sand sheets and Nebka, we need accurate remote sensing methods. In this study, capability of the advanced machine learning techniques on Landsat 7 and 8 imageries in mapping land use/cover related to wind erosion is evaluated.

2- Methodology

The study area is located in the Fars province, in the southern part of Iran, (from 28°07′15″ to 28°13′07″N and 52°07′36″ to 52°23′55″E, covering an area of 17,230 ha), which is considered as the most critical wind erosion area of the province. Landsat 7 (2006) and Landsat 8(2013) images were corrected radiometrically using Dark Object Subtraction method. Although images from USGS website are corrected geometrically, we checked the images using stream and road maps. According to the variations in land use/cover spectral behavior across the study area, it was difficult to define training samples representing thematic classes in a supervised classification procedure. Then different image enhancement techniques were applied. Classification stopped using Support Vector Machine with four different types of kernels including linear, polynomial, Radial Basis Function, sigmoid and Kohonen's Self-Organizing Map neural network. Results were compared with Maximum Likelihood method. Using separability analysis, the best input band combination for classification was selected. The Overall Accuracy and Cohen's Kappa coefficient, derived from the error of matrix which were used for the accuracy assessment of the final maps.

3- Results

Results from accuracy assessment showed that the best map of the land use/cover in the relation to wind erosion was produced using a combination of original and processed bands and RBF vector machine (overall accuracy of 88 and 90.87 percent for L7 and L8, respectively). According to the separability metrics, the near infrared (NIR) and short infrared band (SWIR1), the WDVI, SAVI, LI indices, and processed bands by edge analysis in the aspect of E were finally selected as the best input band combination. The difference between accuracy of this method with

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linear, polynomial, SOM, sigmoid and ML methods were 1.5, 2.9, 8.3, 12.4, and 16.4 percent for L7 and 2.16, 4.16, 6.19, 13.89, and 14.67 percent for L8, respectively. In addition, results indicated that there was a significant change in wind erosion potential and land use/cover in relation to wind erosion in the study area in a short period of time. Rangelands were decreased by 73 percent and 10 percent of these areas are covered by sand sheets. More than half of rangelands were converted to agricultural lands. Insusceptible areas with surface crust or rocks were decreased by 59 and 2.39 percent, respectively.

4- Discussion & Conclusions

The accuracy of classification increased using a combination of processed and original bands in comparison with using original bands alone. This indicates the fact that processing image classification without paying attention to the quality of input bands, will not results in accurate classification map. One of the advantages of active learning algorithm is its less training samples requirement. This is very important for areas which are difficult to have access to them. Although there were not distinct and large sand dunes in the study area like what can be seen in desert areas of Iran, but discrimination of these small sand dune and nebkas were done accurately using the combination of original and processed bands of Landsat imageries and support vector machine methods. Goodarzimehr et al., (2012) also indicated that support vector machine was a better algorithm for discriminating lithology units comparing to maximum likelihood and neural network methods. Sandification was also recognized using remote sensing methods in this study which is one the indices of land degradation and wind erosion. Sand sheets showed and expansion mostly to the southeastern parts. The results indicated the change of rangelands into agricultural lands which will increase wind erosion potential. Low-efficiency irrigation systems combined with an increase in soil loss from arable lands leads to reduction in productivity. This is in line with findings by Minwer Alkharabsheh et al. (2013) who reported the progressive decrease of the agricultural areas and mixed rain-fed areas as the main reason of declining in soil erosion in Jordan. Generally, this study showed the capability of Landsat imageries and support vector machine learning in study of wind erosion potential in arid areas.

Key Words: Wind Erosion, Land use/cover, Landsat, Support Vector Machine.