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Gravel, cobbles and boulders Percentage mapping using Close-Range Photogrammetry (Case Study: The Tehran-Karaj Plain)

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Introduction: Gravel, cobbles and boulders as erodible parameters play significant role to control wind erosion. Therefore, our understandings of gravel, cobbles and boulders percentage variations help to analyze events in the landscape. Close-range photogrammetry as an accurate measurement tool based on photos analysis has been extraordinary improved in recent years and its usage is rapidly growing in environmental analyses. It seems that close range photogrammetry in mapping and measuring the shapes and surfaces have a great potential. Currently close range photogrammetry is mostly used for preparation of Digital Elevation Model (DEM) and Digital Terrain Model (DTM). Now, high resolution DEMS only can be created using 3D Laser Scanner and close range photogrammetry. Despite having a considerable potential, close range photogrammetry has been rarely used in quantitative natural resource studies. In the current assessment, we examined the ability of close range photogrammetry for a quantitative parameter (i.e. percentage of gravel, cobbles and boulder).

Materials and Methods: In this study, we tried to used the close range photogrammetry and assess its performance to estimate the percentage of gravel, cobbles and boulders. For this purpose, a specific quadrat was designed for close range photogrammetry and the required photography tools and techniques were determined. In order to prepare the mapping of gravel, cobbles and boulders percentage, a sampling plan using OLI data was designed for the plain of Tehran-Karaj and photography was performed accordingly. Photos were processed using the PhotoScan software and Orthophotos and Digital Terrain Models were then created. The photos were classified by two methods: 1- Decision Tree Analysis using Digital Terrain Models that it was done using the ERDAS IMAGINE 2015 software; 2- Object-based Classification using Orthophotos and Digital Terrain Models that the eCognition Developer 9 software was used. Gravel, cobbles and boulders percentage of each quadrat was estimated based on more accurate method and used as the dependent variable for modeling process. To model gravel, cobbles and boulders percentage, OLI data was firstly preprocessed to extract reflectance of the bands and then spectral indices were used. Geometric correction and radiometric correction using ATCOR3 were carried out in preprocessing phase and spectral indices of soil characterize were used to enhance the image. Finally, the reflectance of the bands and the spectral indices were used to create a multiple regression model using IBM SPSS Statistics 22 software.

Results and Discussion: The results showed that the Close Range Photogrammetry software (PhotoScan) is able to fix the distortion in photos well. One-dimensional relief displacement error was removed by PhotoScan. Interior and exterior orientation was done very well using the software and measurements which were calibrated by it. High quality Ortho-Photos and high resolution Digital Terrain Models were created using PhotoScan.

Classification by Decision Tree Analysis using Digital Terrain Models was done by the ERDAS IMAGINE 2015 software. First-order and Second-order polynomial interpolation was applied to Digital Terrain Models and the uniform surfaces were created. Two surfaces (original one created by PhotoScan and Interpolated Surface) were then compared and the gravel, cobbles and boulders parts were separated using some thresholds. The results indicated that this method can create the gravel, cobbles and boulders map rapidly but the accuracy is moderate.

Comparing with Decision Tree Analysis, Object-based Classification by the eCognition Developer 9 software which uses Orthophotos and Digital Terrain Models was more accurate. However, the latter was time-consuming as it is needed to be done manually in many different steps and there were many options to be created for final layer.

Automatic linear modeling in IBM SPSS Statistics 22 software was used to create multiple regression model and Iron Oxide and Inferred indices and reflectance of the bands 1, 2, 3 and 7 of OLI Sensor were selected by the software. The coefficient of determination of the model was more than 0.9 showing the good potential of the

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close-range photogrammetry. This model was used to create maps of percentage and the final map was in full compliance with the field observations.

Conclusions: Our results showed that the Close Range Photogrammetry has a vast potential and it can be an important tool in the environmental studies in the future.

Keywords: eCognition, Specific Quadrat for Photogrammetry, Decision Tree Analysis, Object-based Classification, PhotoScan