

PRELIMINARY RESULTS OF ESTIMATING SOIL MOISTURE OVER BARE SOIL USING FULL-POLARIMETRIC ALOS-2 DATA

A. Sekertekin ^{a,*}, A. M. Marangoz ^a, S. Abdikan ^a, M. T. Esetlili ^b

^a BEU, Engineering Faculty, Geomatics Engineering Department 67100 Zonguldak, Turkey - (aliihsan_sekertekin, aycanmarangoz)@hotmail.com, sabdikan@beun.edu.tr

^b EU, Faculty of Agriculture, Department of Soil Science and Plant Nutrition, Izmir, Turkey - tolga.esetlili@ege.edu.tr

GeoAdvances 2016

KEY WORDS: Soil Moisture, Synthetic Aperture Radar (SAR), ALOS-2, Backscattering coefficient (σ^0), Gravimetric Method

ABSTRACT:

Synthetic Aperture Radar (SAR) imaging system is one of the most effective way for Earth observation. The aim of this study is to present the preliminary results about estimating soil moisture using L-band Synthetic Aperture Radar (SAR) data. Full-polarimetric (HH, HV, VV, VH) ALOS-2 data, acquired on 22.04.2016 with the incidence angle of 30.4°, were used in the study. Simultaneously with the SAR acquisition, in-situ soil moisture samples over bare agricultural lands were collected and evaluated using gravimetric method. Backscattering coefficients for all polarizations were obtained and linear regression analysis was carried out with in situ moisture measurements. The best correlation coefficient was observed with VV polarization. Cross-polarized backscattering coefficients were not so sensitive to soil moisture content. In the study, it was observed that soil moisture maps can be retrieved with the accuracy about 14% (RMSE).

1. INTRODUCTION

Soil moisture is a key parameter for many environmental phenomena, especially for meteorological, agricultural and hydrological applications (Verhoest et al., 2008; Ahmad et al., 2011; Lakshmi, 2013). In addition, soil moisture information can be used as an indicator for natural disasters such as flooding and droughts, and for environmental changes, such as dust storms and erosions (Canada Center for Remote Sensing, 2008; Ahmad et al., 2011). Thus, monitoring spatial and temporal variations in soil moisture is of great importance for ecological balance. However, measuring accurate in situ soil moisture is expensive and time-consuming, also to observe temporal changes it requires repetitive measurements periodically.

Remote sensing is an effective technology to understand the behaviour of the world and to evaluate the changes on Earth. Moreover, remote sensing is a potential alternative way for estimating the distribution and quantity of soil moisture at a variety of scales, without expensive, time-consuming and tiring in situ measurements (Kornelsen & Coulibaly, 2013). In recent years, radar remote sensing with different wavelengths is used to monitor spatial and temporal variations in soil moisture. Many studies have been presented to retrieve soil moisture

content from X-band (Aubert et al., 2011; Baghdadi et al., 2011; Zribi et al., 2012; Kseneman et al., 2012; Baghdadi et al., 2012; Kweon et al., 2012; Satalino et al., 2012) and C-band (Gherboudj et al., 2011; Moran et al., 2011; Pasolli et al., 2011; Merzouki et al., 2011; Livens & Verhoest, 2012; Jacome et al., 2013; Wang et al., 2013) SAR images; however, few studies were carried out using L-band (Paloscia et al., 2012; Balenzano et al., 2013) SAR data.

The only current operational high resolution L-band SAR satellite is ALOS-2 and the aim of this study is to investigate the effectiveness of new generation L-band satellite ALOS-2 images on estimating soil moisture content on bare soils.

2. STUDY AREA AND MATERIAL

An agricultural region in Bakircay river basin in Bergama was chosen as study area (Figure 1). Bergama is one of the districts of Izmir province. The study area is located on the northern side of the city Izmir. It is an agricultural region with different kinds of products including cotton, okra, corn, grape, tobacco and olive.

* Corresponding author

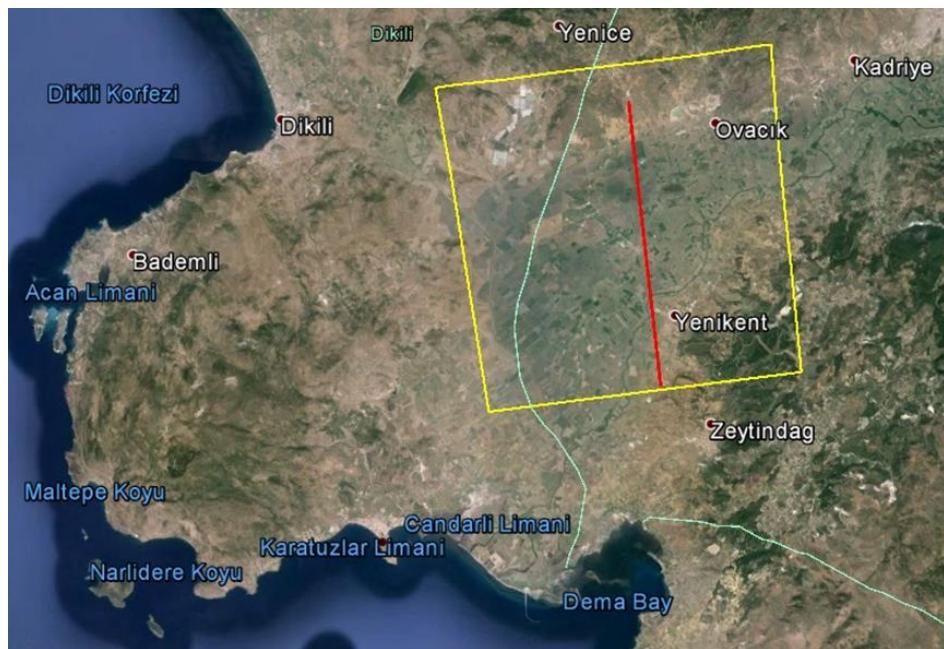


Figure 1. Boundary (yellow frame) of the study area from Google Earth images

In this research, full-polarimetric (HH, HV, VV, VH) ALOS-2 images, acquired on 22.04.2016 with the incidence angle of 30.4°, were utilized to obtain backscattering coefficient. ALOS-2 satellite specifications are presented in Table 1. The images used in this study are acquired as strip map high sensitive mode with 5.1m range and 4.3m azimuth resolution.

SENSOR	SAR
PALSAR-S (Frequency)	L-band (1.2 GHz band)
OBSERVATION MODE	Spotlight Resolution: 1x3m Swath:25 km
	Strip Map Resolution: 3-10m Swath:50-70 km
	ScanSAR Resolution: 60-100m Swath:350 km
DESIGN LIFE	5 years (target: 7 years)
SATELLITE MASS	Approx. 2100 kg
MISSION DATA TRANSMISSION	Direct transmission, via data relay satellite
LAUNCH DATE	24 May 2014
LAUNCH VEHICLE	H-IIA launch vehicle No.24

Table 1. ALOS-2 Satellite specifications

3. METHODOLOGY

Simultaneously with ALOS-2 acquisition, in situ soil moisture measurements have been carried out over 41 bare agricultural fields. Only one sample was collected from each field. It represents whole field because the fields are not irrigated. After collecting samples, soil moisture content was determined for each field using gravimetric method.

The workflow diagram of the study is presented in Figure 2. Firstly, raw ALOS-2 data were geometrically corrected and then radiometric calibration (sigmanought conversion) for all polarizations was implemented. After the radiometric calibration, the images were subsetted so as to include the study area. For each agricultural site, mean linear backscattering coefficients were extracted by means of spatial analysis and each linear backscattering coefficient was converted to decibel

(dB). Finally, Backscattering coefficients in dB and gravimetric soil moisture content for each site were utilized in linear regression analyses.

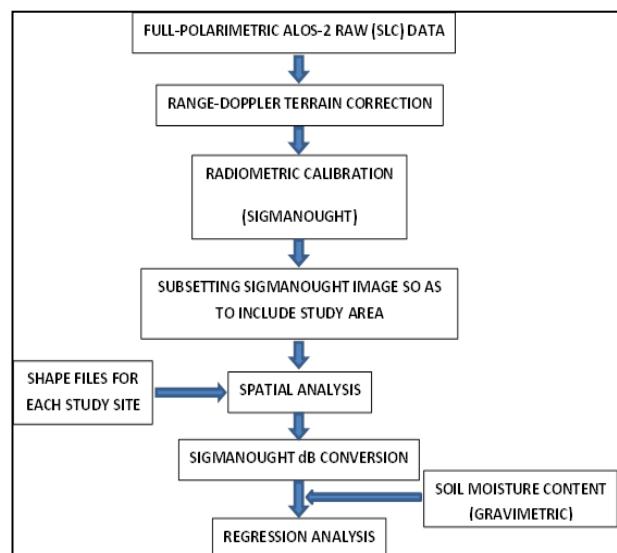


Figure 2. Workflow diagram of the study

4. RESULTS

The results of the linear regression analyses are presented in Figure 3. As it is clear from the Figure 3, backscattering coefficients in VV and HH polarization presents best results for our study sites. Cross-polarized backscattering coefficients are not so sensitive to soil moisture content as well as co-polarized backscattering coefficients. In addition, accuracy assessment in VV polarization was obtained 14% RMSE.

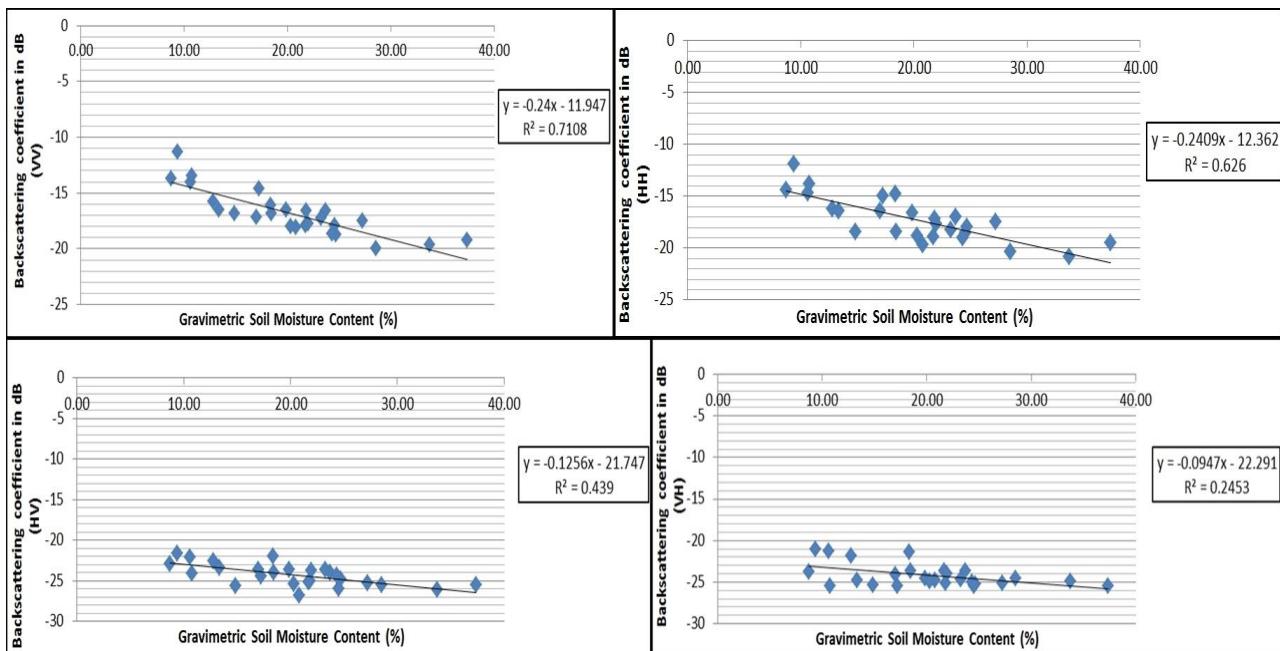


Figure 3. The results of the linear regression analyses

5. CONCLUSION

In this study, the potential of ALOS-2 data for estimating soil moisture content over bare agricultural fields was examined. For this purpose, Full-polarimetric data acquired on 22 April 2016 with the incidence angle 30.4° were utilized and simultaneously with the SAR acquisition in situ soil moisture measurements were carried out using gravimetric method. Linear regression analysis was performed between backscattering coefficients of SAR images and ground soil moisture measurements. Obtained results showed that co-polarized backscattering coefficient is more sensitive to soil moisture content than the cross-polarized backscattering coefficient over bare soils for our case study. It is clear from this research that L-band SAR images have potential for soil moisture mapping on a large scale. As a future work, another surface parameter surface roughness will be included to the study and it will be investigated how it has influence on estimating soil moisture with SAR data.

ACKNOWLEDGEMENTS

Full-polarimetric ALOS-2 satellite images have been provided by Bulet Ecevit University scientific research project: 2015-47912266-04.

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