Spatial Estimation of soil roughness and moisture from Sentinel-1 backscatter over Yanco sites: Artificial Neural Network, and Fractal

Ju Hyoung, Lee*

Abstract

European Space Agency's Sentinel-1 has an improved spatial and temporal resolution, as compared to previous satellite data such as Envisat Advanced SAR (ASAR) or Advanced Scatterometer (ASCAT). Thus, the assumption used for low-resolution retrieval algorithms used by ENVISAT ASAR or ASCAT is not applicable to Sentinel-1, because a higher degree of land surface heterogeneity should be considered for retrieval. The assumption of homogeneity over land surface is not valid any more.

In this study, considering that soil roughness is one of the key parameters sensitive to soil moisture retrievals, various approaches are discussed. First, soil roughness is spatially inverted from Sentinel-1 backscattering over Yanco sites in Australia. Based upon this, Artificial Neural Networks data (feedforward multiplayer perception, MLP, Levenberg-Marquadt algorithm) are compared with Fractal approach (brownian fractal, Hurst exponent of 0.5). When using ANNs, training data are achieved from theoretical forward scattering models, Integral Equation Model (IEM). and Sentinel-1 measurements. The network is trained by 20 neurons and one hidden layer, and one input layer. On the other hand, fractal surface roughness is generated by fitting 1D power spectrum model with roughness spectra. Fractal roughness profile is produced by a stochastic process describing probability between two points, and Hurst exponent, as well as rms heights (a standard deviation of surface height).

Main interest of this study is to estimate a spatial variability of roughness without the need of local measurements. This non-local approach is significant, because we operationally have to be independent from local stations, due to its few spatial coverage at the global level. More fundamentally, SAR roughness is much different from local measurements, Remote sensing data are influenced by incidence angle, large scale topography, or a mixing regime of sensors, although probe deployed in the field indicate point data. Finally, demerit and merit of these approaches will be discussed.

Keywords : SAR soil moisture, geomorphology, Artificial Neural Networks, Fractal, non-local approach

* Research Professor, Research Institute for Mega Construction, Korea Univ., E-mail : jhlee7@korea.ac.kr