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Calibrating and processing SAR images from Sentinel-1 for the purpose of soil moisture extraction

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In this study, preliminary results obtaining using data derived from the C-Band synthetic-aperture radar (SAR) on-board the ESA's Sentinel-1 for the purpose of extracting superficial soil moisture information are presented. The main objective of this work would be the development of a shallow landslide early warning system for Sardinia (Italy), based on remotely-sensed soil moisture data derived from the relationship between the C-band backscattering values and soil water content on unstable slopes. Several important factors led to choosing ESA's Sentinel-1 mission. The mission consists of two twin satellites, namely 1A and B, which share the same sun-synchronous orbit with a 180 [U+F0B0] phase difference and ensures a 6-day repeat cycle. Contextually, the main SAR's acquisition mode (interferometric wide swath) can acquire data with a high spatial resolution (5 m by 20m) in double polarisation (VV and VH), which allows a complete analysis of landslide phenomenon. Lastly, Copernicus program distributes free data, with a 2 hours delay after the acquisition. As pre-processing steps, geometric and radiometric corrections were applied on the raw datasets (for the period 2017-2018), in order to properly georeference the images and to retrieve the backscattering values. Additional statistical analyses are applied to the backscattering values and rainfall information for the same period. Further data processing was based on the implementation of a soil moisture retrieval algorithm based on feed-forward multilayer perceptron (MLP) artificial neural networks (ANNs) with a known number of hidden layers of neurons between the input and output. The ANN approach was chosen since it is characterized by the best balance between the accuracy of the output and the computation time. A very important step is the training of ANN, which is based on the back-propagation rule, and the input dataset is split in three parts for training, testing and validating. Since the study is carried on Sardegna, a test site was chosen in a central part of the island – Mount Guzzini. The datasets for the training step partially include in-situ measurements and remotely-sensed data. On the test site, several ground campaigns were performed, for the training datasets, in order to measure the soil volumetric water content with a TDR probe and the soil surface roughness derived by a photogrammetric approach. The measurements were collected as close as possible, in terms of time, to the satellite overpass. In addition, the backscatter values from Sentinel-1 are used together with the NDVI derived from multiband images of the Sentinel-2 mission. An important factor for the accuracy of the training and the retrieval of the soil moisture is the extent of the datasets, which should encompass a high variety of soil moisture conditions in a considerable time interval. The preliminary results show a good correlation between the applied approach and ground truth observation.