Short communication

Temporal and spatial estimation of soil moisture using RISAT-1 in semi-arid tropics of India

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Soil moisture is an essential climate variable of major importance for land–atmosphere interactions and global hydrology in rainfed areas. The spatial and temporal variability of soil moisture at scales from small catchments to large river basins is important in the understanding of subsurface - land surface - atmospheric interactions as well as, drought analysis, crop yield forecasting, irrigation planning etc. Microwave bands have proven particularly interesting for this purpose because the soil dielectric constant at these frequencies exhibits a noticeable dependence on the moisture content of the observed bodies (Ulaby *et al.,* 1981, 1982 and Srivastava, 2006). Information on soil moisture before sowing and up to establishing of crop cover is very essential thus serves as a surrogate indicator of general plant health. Vegetation cover is the most important factor that influences the retrieval of soil moisture from MW RS. Previous studies (Neusch and Sties 1999; Sikdar and Cumming 2004) revealed that radar signals of C-band are not significantly affected if vegetation has < 0.4 NDVI value. RISAT-1 is India's first microwave remote sensing satellite carrying aSAR payload operating in the C-band (5.35 GHz). FRS image (spatial resolution of 3 m) and MRS image (spatial resolution of 25m) acquired at circular and Dual polarization have been used for the retrieval of soil moisture in and around Hayatnagar Research Farm of CRIDA situated in Hayatnagar village, Rangareddy district of Telangana. RISAT-1 works well in all weather conditions. The overall aim of the study is to retrieve soil moisture both spatially and temporally based on RISAT-1 SAR data to improve understanding of the hydrological behavior of soil and to derive a correction factor for it.

The experiment was carried out at Hayatnagar Research Farm (17°19'52.549"-17° 21'42.986" N and 78°35'03.295"-78°36'46.990" E). The mean annual rainfall is 764 mm and during the time of field data collection the humidity of that area was very low with no rainfall and vegetation. For ground truthing, the samples were collected from agriculture field with no crop stand. There was almost no rainfall during the data collection period. Minimum Sampling Unit Size (in m^2) for RISAT-1 SAR (For an error of 5% on the signal amplitude at 90% confidence interval) for FRS-1 mode of RISAT-1 as suggested by Patel and Srivastava (2013). 134 Soil samples (excluding few samples which were showing extreme values) were analyzed for soil moisture and basic physico-chemical properties. Thematic base maps for the Study area were also prepared for the study area in ArcGis 10.0. Gravimetric soil moisture (SM_G) value was obtained from laboratory analysis, which was converted to volumetric soil moisture (SM_V) by multiplying bulk density (BD).

$$SM_V = SM_G * BD$$

Data procured and processing

RISAT-1 microwave data has been procured from NRSC (National Remote Sensing Centre), Hyderabad for the dates 21st and 23rd March 2014 (FRS under - Circular Polarization), dates - 10th and 12th May 2014 (MRS under - Circular Polarization), dates -3rd November and 21st December 2014 (FRS under - Dual Polarization) and dates - 12th September 2014 (MRS under - Dual Polarization). For the study, software including SARC-View, ENVI 4.3, and ERDAS Imagine were used to process the acquired data. Surface Roughness, Backscatter co-efficient and Dielectric constant (ε was used for estimating SM using Topp model Rawat *et al.,* 2018) were calculated (Thanabalan, 2018; Srinivasa, 2013, Tahnabalan, 2018; Hallikainen, 1985) and the soil moisture determination using RISAT-1 Microwave data was done using a methodology developed given in the flowchart given below (Fig.1). The surface texture indicates that sandy loam and sandy (sand 70-85 %) clay (clay 10-15 %) loam soils are occurring in 33% and 32 % area respectively followed by loamy sand (28%). The subsurface soils are somewhat heavier than the surface layers.

RISAT-1 data analysis

Selection of polarization and resolution which is best suited for soil moisture estimation in the study area after radiometric calibration, backscatter values were compared for different images. FRS 21st March MW data with angle 23