Soil moisture estimation from Landsat-8 imagery using triangle method in Imphal–Iril river catchment, Manipur, India

Ngangom Robertson* **and Oinam Bakimchandra**
Civil Engineering Department, National Institute of Technology Manipur, Imphal 795 004, India

Soil moisture is an essential indicator for long-term sustainable agriculture. Crop growth and production are highly dependent on cropland soil moisture conditions. The primary goal of this study is to assess surface soil moisture indirectly using satellite-derived temperature vegetation dryness index (TVDI) based on the triangle approach within the Imphal-Iril river catchment. TVDI was derived from the Landsat-8 imagery dataset for three different periods based on normalised difference vegetation index (NDVI) and land surface temperature (LST). Maximum and minimum LST values were calculated to compute TVDI using LST and NDVI. According to the results, NDVI and minimum LST showed a positive correlation, whereas NDVI and maximum LST showed a negative correlation. The TVDI was correlated with *in situ* soil moisture measurements using a regression analysis. Fifty *in situ* soil moisture measurement data were collected for three different periods over the catchment using time domain reflectometry (TDR-300). These ground observation data were used to compute regression parameters and validate the study. The computed soil moisture values were validated against *in situ* volumetric soil moisture measurements. The results were statistically significant, with R^2 values of 0.83, 0.85 and 0.86 for 22 November 2018, 8 December 2018 and 9 January 2019, respectively. The results of this study revealed that TVDI can depict soil moisture variation under various land uses in a region. The study found that settlement areas and higher-elevated hilly regions have lower soil moisture content, whereas agricultural zones in the valley and densely vegetated areas show significantly higher soil moisture levels.

Keywords: Land surface temperature, normalised difference vegetation index, soil moisture, temperature vegetation dryness index, triangle method.

in soil moisture affects terrestrial carbon absorption, an accurate estimate of soil moisture is crucial for analysing the consequences of climate change[4]. Soil moisture serves as a quantitative foundation for developing agricultural socio-political policies to regulate and monitor agricultural production, crop selection, water resource allocation, and irrigation operations[5]. Crop development and yield are influenced by the quantity of soil moisture that a crop can access through precipitation and irrigation in arid and semi-arid regions of the world[6]. Estimating soil moisture is essential for agricultural, meteorological, and water resource management applications[7]. Numerous variables, including soil texture, vegetation, topography, cover crops, irrigation techniques, and depth of the groundwater table, influence the spatial and temporal variability of soil moisture[8,9].

Various environmental studies have emphasised the importance of soil moisture in hydrology, meteorology, agriculture, and climate change[9]. Therefore, it is crucial to keep track of and accurately assess the fluctuations in soil moisture through time and space. The moisture condition of agricultural croplands has been measured using several techniques, including time domain reflectometry (TDR), gravimetric method, frequency domain reflectometry (FDR), neutron probe, and others. Despite its high spatial and temporal variability, *in situ* soil moisture monitoring is not easy over a large area. The results of field observation methods are accurate, but *in situ* point measurements are complex, destructive, cost-intensive, time-consuming, and labour-intensive. It provides information for only a few selected points, but the remote sensing technique measures surface soil moisture for large areas at short intervals of time[10,11]. Soil moisture assessments are now confined to discrete measurements at specific areas because soil moisture is highly changeable both geographically and temporally. The point-based data also do not accurately depict the spatial distribution