

Developing a Novel Soil Moisture Content Index under the Effects of Droughts Using Deep Learning Techniques

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Abstract

Soil moisture is important for the survival of plants and living organisms in the soil. It plays an important role in the movements of minerals and nutrients in the soil surface. Additionally, it is important in understanding the land surface processes such as soil erosion, evaporation, soil topography and runoff generation [2]. However, the availability of water has been greatly affected by prolonged and often occurring drought events caused by rapid changes in the climatic conditions, Land Use and Land Cover (LULC) and socio-economic systems in ecosystems. This has led to loss of crop

harvest and vegetation, causing loss of human lives, death of livestock and wildlife. This study seeks to develop a novel soil moisture content index under the influence of droughts. The novel index could be used to detect and monitor soil moisture and form an early warning system in arid and semi-arid ecosystems. Muringato basin located in the Upper Tana River basin in Nyeri County in Kenya will be used as the test site. Recurrent Neural Network-Long Short-Term Memory (RNN-LSTM) deep learning algorithm will be utilised to develop the index through linear and non-linear regression, fitting, iterations and adjustments. The algorithm is preferred due to its ability to handle both non-linear and linear data depicting seasonality and cyclic nature, multiple variable consideration and provide reliable results [1]. The input variables will be Biophysical Composition Index (BCI), Topographic Wetness Index (TWI), Solar Incidence Angle Index (SIAI), Bareness Index (BI), Normalized Difference Vegetation Index (NDVI), and a multiple combined drought index made up of the Standardized Precipitation Index (SPI), Streamflow Drought Index (SDI), Evaporative Stress Index (ESI), and Waters Supply Capacity Index (WSCl) [1], [3]. The expected results will be a comprehensive soil moisture index capable of giving reliable soil moisture simulations especially in dry environments. The novel soil moisture content index will be of benefit to the local community and the scientific world as it will foster droughts monitoring, inform policies and measures towards food security and irrigation. Additionally, it presents a perfect application of the artificial intelligence in environment monitoring and conservation.

Keywords: drought, recurrent neural network-long short term memory (RNN-LSTM), soil moisture index