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A REVIEW ON STUDY OF TEMPORAL AND SPATIAL VARIATION OF SOIL MOISTURE AND DROUGHT MONITORING

H Nethra[1], D Priyanka[2], Gopi Krishna[3], Keerthana S[4], Dr Abhishek A Pathak[5]

[1,2,3,4]Students BE, Department of Civil Engineering DSCE, Bengaluru, Karnataka, India
[5]Professor, Department of Civil Engineering, DSCE, Bengaluru, Karnataka, India

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Abstract - *Soil-moisture information plays an important role in disaster predictions, environmental monitoring, and hydrological applications. Soil moisture serves a critical role in shaping the ecosystem response to the physical environment. Adequate knowledge of the distribution and linkage of soil moisture to evaporation and transpiration is essential to predicting the reciprocal influence of land surface processes to weather and climate. The purpose of this study is to review and summarize existing literature on soil moisture studies.*

Key Words: Soil moisture, Drought monitoring, Remote sensing, ecosystem, irrigation.

1. INTRODUCTION

1.1 General

The soil moisture content of soil is the quantity of water it contains. A major component of soil hydrology is soil moisture. Soil moisture is an important variable in land surface hydrology. Soil moisture has very important implications for agriculture, ecology, wildlife, and public health and is probably (after precipitation) the most important connection between the hydrological cycle and life-animal, plant, and human. Water content is used in a wide range of scientific and technical areas and is expressed as a ratio, which can range from 0 (completely dry) to the value of the materials' porosity at saturation.

In soil science, hydrology and agricultural sciences, water content has an important role for groundwater recharge, agriculture and soil chemistry. If the moisture content of a soil is optimum for plant growth, plants can readily absorb soil water. Not all the water, held in soil, is available to plants. Much of water remains in the soil as a thin film. Soil water dissolves salts and makes up the soil solution, which is important as medium for supply of nutrients to growing plants. Soil moisture information is valuable to a wide range of government agencies and private companies concerned with weather and climate, runoff potential and flood control, soil erosion and slope failure, reservoir management, geotechnical engineering and water quality.

Despite the importance of soil moisture information, widespread and/or continuous measurement of soil moisture is all but nonexistent. The lack of a convincing approach of global measurement of soil moisture is a serious problem (National Research Council, 1992).Clearly, a need exists for continuous measurements of surface soil moisture with global coverage. Remote sensing of soil moisture from the vantage point of space is advantageous because of its spatial coverage and temporal continuity, but this capability does not yet exist. Research in soil moisture remote sensing began in the mid 1970's shortly after the surge in satellite development. Subsequent research has occurred along many diverse paths. Quantitative measurements of soil moisture in the surface layer of soil have been most successful using passive remote sensing in the microwave region.

1.1 Necessity of soil moisture

Soil moisture serves a critical role in shaping the ecosystem response to the physical environment. Near-surface soil moisture controls the partitioning of available energy at the ground surface into sensible and latent heat exchanges with the atmosphere, thus linking the water and energy balances through the moisture and temperature states of the soil.

Adequate knowledge of the distribution and linkage of soil moisture to evaporation and transpiration is essential to predicting the reciprocal influence of land surface processes to weather and climate.

2. LITERATURE REVIEW

(Kristine M et al. 2008) : This study shows that a GPS receiver collocated with in situ soil moisture sensors shows excellent agreement in measuring near-surface volumetric water content variations. The technique described in this study could be applied to data from existing GPS networks, creating a global GPS soil moisture network. These soil moisture sensors would be valuable for hydrological studies, weather forecasting, and climate monitoring, as well as providing calibration/validation sites for soil moisture satellite missions planned for the next decade

(Venkatesh B et al. 2010) : This study mainly focused on the spatio-temporal variability of soil water potential as it is necessary to characterize the linkages between a region's hydrology, ecology and physiography. In addition

to characterizing the spatial and temporal characteristics of observed soil moisture contents under different land covers, the study also focused on exploring the relationships between soil moisture levels at different depths using correlation analysis. Overall study indicates that while the nature of land cover has an influence on the spatio -temporal variability of soil moisture, other variables related to topography may have a more dominant effect.

(Mohammad Subzar Malik et al. 2014) : They studied and presented on understanding the spatial and temporal variations of soil moisture, which is crucial for the land surface processes and their management. The spatial and temporal variation in soil moisture is resulted by variation in soil texture, vegetation, and topography and groundwater level depth. They have concluded that remote sensing combined with field methods provide distributed soil profile moisture information and it is recommended to carry out detailed research work applying both remote sensing and field measurements for soil moisture estimation.

(Aswathi P.V et al. 2018) : They have worked mainly on meteorological and agricultural drought in Maharashtra which monitored using traditional as well as remote sensing methods, by considering meteorological indices and remote sensing based indices. The analysis is done by using two indices namely Standard Precipitation Index and Effective Drought Index. The severity and persistency of meteorological drought are studied using SPI for the period 1901 to 2015. As, accuracy of SPI in detection of sub-monthly drought is limited. Hence, sub-monthly drought is effectively monitored using EDI. They concluded that EDI serves as a better indicator to monitor sub-monthly droughts.

(Borowiki A et al.2016) : He made a study on how soil moisture affects microbiological and biochemical activity of soil. They have made a different tests on different soil samples they have collected the enzymes and micro organism present in soil varies according to the type of soil. He had done the PCA test on different samples which gives information regarding enzymes and counts of micro organisms in soil

(Pavan kumar Sharma et al. 2018) : They have estimated the soil moisture by Remote sensing methods. They have absorbed that soil moisture of a particular region is just temporary, it varies time to time. They have used many point measurement technique for soil moisture estimation. Techniques like gravimetric methods, nuclear methods, scattering, electromagnetic methods, tensiometer techniques. The main advantage of Remote sensing which provides the large area. Soil moisture data and changes of soil moisture from time to time.

(Ravi Kant Chaturvedi et al. 2018) : His study mainly focused on tropical dry forests which contain a huge plant diversity that are highly affected by soil moisture conditions and he concluded that due to climate change the variation of soil moisture conditions, lead to changes in function and structure of the ecosystem, which will favour few species to flourish and also can be a reason for removal of some species

(Yang T et al. 2018) : They have made a study regarding how soil moisture varies with the seasons of the year. In summer the soil moisture is less compared to the winter season as the rainfall in the summer is very less compared to the winter season and they have made the study of soil moisture of different vegetation like in deserts the vegetation is very less so soil moisture is less compared to forest area.

(Ali Akbar Jamali et al. 2019) : His research calculated the soil moisture by using a method called Microwave imagery, which can be considered as a appropriate way to detect and calculate the amount of soil. The SENTINEL-1 with SAR sensor is used for this purpose. The microwaves sent by the satellite to the earth receives the backscatters which is directly related to the soil moisture

(Anuradha Hadgila et al. 2019) : They have mainly studied on cost effective and simple moisture sensor because knowing the exact soil moisture conditions on the fields, the water can be used efficiently by the farmers for growing the crops. Soil moisture content being an important parameter for irrigation, monitoring of the moisture content becomes necessary to overcome the problems like over irrigation and under irrigation which affects the yield and health of the crop. In this paper volumetric based custom-made soil moisture sensor (metal alloy) is compared with the standard commercially available sensor. The sensor is an anti-corrosive material gives comparative results, hence can be used as substitute to commercially available sensor.

(Kishore Pangaluru et al. 2019) : This study investigates the spatial and temporal variability of the soil moisture in India using Advanced Microwave Scanning Radiometer-Earth Observing System (AMSR-E) gridded datasets from June 2002 to April 2017. Significant relationships between soil moisture and different land surface–atmosphere fields (Precipitation, surface air temperature, total cloud cover, and total water storage) were studied, using maximum covariance analysis (MCA) to extract dominant interactions that maximize the covariance between two fields. They studied soil moisture over Asia and Africa, concluding that surface wetness in India contributes to increased rainfall.

(Mohana Prabha G et al. 2019) : They have studied the system which mainly predict the moisture of the soil, humidity and temperature by using the data from the

sensors namely moisture sensor and humidity sensor. The data is collected over the period of time and an algorithm is designed that will alert the farmer with various notification like low moisture level, low mineral level, humidity and temperature. This can be considered as a boon for the farmers to keep track of the contents inside the soil and make prior arrangements on time to keep the soil alive and the plantations as well.

(Loliyana V.D et al. 2019) : The main objective of the study is to develop the less data-intensive distributed physics based hydrological model that will be able to predict the run-off and soil moisture within the Gopalkheda sub-catchment of purna catchment in Maharashtra. They developed a model for computation of runoff and taluka wise soil moisture prediction using MIKE SHE-MIKE 11 coupled model.

(Naresh G. Ganeshia et al. 2020) : The present study describes the role of long-term SM variability on the evolution of extreme temperature conditions over the Indian region. This study presents an analysis of hydrometeorological datasets for the 67-year period (1948–2014) to assess the impact of long- term soil moisture changes on temperature extremes over the Indian region. They analysed regions where the soil moisture-temperature coupling is stronger and subsequently describing the evolution of extreme temperature over the regions, through land surface processes.

3. CONCLUSIONS

Based on the literature, the following were drawn:

1. The spatial distribution, characteristics, and temporal variability of soil moisture on monthly, seasonal, and annual temporal scales using satellite observations are more accurate than the conventional methods of soil moisture measurements.

2. On the basis of the remote sensing methods, estimating soil moisture on bare soil or soil with less vegetation gives more accurate results, as compared to using the methods on a mixture of land-cover soil.

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