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SCHOOL OF ENVIRONMENTAL SCIENCES

DEPARTMENT OF HYDROLOGY AND WATER RESOURCES

Effects of hydro-meteorological variables, soil physical properties, topography and land use on unsaturated zone soil moisture in Siloam Village, South Africa

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ABSTRACT

This research was focused on investigating the dependence of soil moisture on hydro-meteorological variables, soil physical properties, land use, and topography in the unsaturated zone in Siloam Village. Knowledge of soil moisture in the unsaturated zone is essential in determining recharge, soil moisture availability for agriculture, etc. Soil samples were collected at 3 different sites up to 80 cm and were analyzed in the laboratory for bulk density, porosity, soil texture and hydraulic conductivity. Double ring infiltrometer was used to measure infiltration rate. Soil moisture and temperature data from July 2011 to January 2013, which cover both the dry and wet seasons were measured from 6 different sites using neutron probes. Hydro-meteorological variables such as humidity, solar radiation, rainfall and evapotranspiration were measured from February 2012 to January 2013. The spatial variations of soil moisture were determined by comparing the results from different sites. Average soil moisture from sites with different land use and topography in the study area were compared to determine the influence of land use and topography on soil moisture variations. Soil moisture data from February 2012 to January 2013 was correlated with rainfall, evapotranspiration and soil temperature data for the same period to determine the influence of these variables on soil moisture. Soil temperature was used to show the relationship between soil moisture and solar radiation and soil moisture and humidity since soil temperature has a direct relationship with solar radiation and humidity. Correlation coefficient (R) was used to determine the relationship between soil moisture and each of the above variables.

The study found that soil moisture content increase with depth. Throughout different seasons and at all depths the study showed that increase in temperature was associated with increase in moisture content and a decrease in temperature was associated with reduction in the moisture content and this was due to high, low or no rainfall. In probes 17437, 17433, and 17436 at 80 cm depth, increase in rainfall resulted in increased soil moisture during summer (October 2012- January 2013). During the dry season (April- August 2012), soil moisture was low due to low or no rainfall. Land uses in the study area were more or less the same during dry and wet seasons, and hence land use did not have much influence on soil moisture content. The altitudinal difference between the probes locations ranged from 10 to 20 m and hence topography did not have much influence on soil moisture variation.

Clay and sandy clay soils were dominant in the study area and were susceptible to cracking. The dominant clay soils in all probes sites had low hydraulic conductivity. Due to cracks, the initial infiltration rate for clay and sandy clay soil of the study area were high thereby increasing soil moisture content. R values for temperature and soil moisture ranged from 0.3 to 0.8. Weak positive relationship between soil moisture and evapotranspiration were noted at all six sites with a range of 0.01 to 0.3. Weak to moderate positive relationship between soil moisture and rainfall existed with a coefficient ranging from -0.004 to 0.4 for all sites. The hydro-meteorological parameter that exhibits the strongest relationship to soil moisture is temperature. The soil properties could not be compared to show which parameter exhibited the strongest relationship with soil moisture as the properties are not of the same scale. Continuous monitoring of soil moisture should be done to extend the period used in determining the spatial and temporal variations in the study area.

Key words: hydro-meteorological variable, soil moisture, soil physical properties, unsaturated zone.