Monitoring and modelling hydrological fluxes in support of nutrient cycling studies in Amazonian rain forest ecosystems
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5. CALIBRATION OF TDR WATER CONTENT MEASUREMENTS IN THE FOREST FLOOR AND CLAY SOILS IN NORTHWEST AMAZONIAN FORESTS

5.1 ABSTRACT

Time Domain Reflectometry (TDR) was used to investigate the water dynamics in the forest floor and mineral soils in four forest ecosystems in the Middle Caquetá, Colombian Amazonia. Undisturbed samples for gravimetric determination of water content and bulk density were collected from the same sites where TDR measurements were carried out. Volumetric water content of the samples (forest floor and mineral soil) was fitted with linear functions against the refraction index calculated from the TDR travel time measurements. These linear regressions, with an explained variances of 0.94 and 0.88, were compared with results from existing calibration models, indicating that existing calibration parameters either underestimate or overestimate measured water content from the samples. In an attempt to improve the accuracy of the function for the mineral soil, measured bulk densities from the soil samples were used following the procedure indicated by Malicki et al. (1996). Although the results were in close agreement with Malicki’s function, interpretation of parameters with the available data on bulk density rendered a very low explained variance. Therefore, deduced regression parameters of measured water content and the refraction index (forest floor and mineral soil) can be used to translate TDR travel time measurements into volumetric water content.

5.2 INTRODUCTION

Time Domain Reflectometry (TDR) is a well-known and non-destructive method to measure water content in different soil types (Weitz, 1997; Heimovaara et al., 1993; Topp et al., 1980) and in the forest floor (FF) (Schaap et al., 1995). TDR is based on the measurement of the propagation velocity of an electromagnetic pulse along parallel lines. This propagation velocity depends on the soil dielectric permittivity. According to Topp et al. (1980), the dielectric constant (\(K_a\)) strongly depends on the volumetric water content of the soil and it is almost independent of soil texture, density and electrical conductivity of the soil solution. Topp et al. (1980) also found that the apparent dielectric permittivity of clay soils differs from that of sandy soils.

One of the most common calibrations models relates the apparent dielectric permittivity (\(K_a\)) to the volumetric soil water content (Topp et al., 1980). This third order function was derived from soils with water content ranging from 0.1 to 0.5 m\(^3\)m\(^{-3}\) and bulk densities between 1.3 to 1.4 Mg.m\(^{-3}\). Although suitable for sandy soils with low bulk