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STUDY OF DIELECTRIC PROPERTIES OF SOIL

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Abstract: The increasing human population is placing greater pressure on soil and water resources and threatening our ability to produce sufficient food, feed, and fibre. As a result, there is a growing consensus within our global community that the protection of natural resources and implementation of environmentally and economically agriculture practices is of the chief priority. The purpose of soil analysis is to assess the adequacy, surplus or deficiency of available nutrients for crop growth and to monitor change brought about by farming practices. Soil study is an inventory of the properties of the soil such as texture, internal drainage, parent material, depth to groundwater, topography, degree of erosion, stoniness, pH, and salinity and their spatial distribution over a landscape. Each soil type has a set of physical, chemical and mineralogical characteristics. The primary objective of this study is to explore the potential use of electromagnetic characteristics of soils using the Time Domain Reflectometry technique to identify physical properties of soils. To assess trends in soil quality; this technique carefully monitors physical, chemical and biological conditions.

This Paper Focuses on Review of Dielectric Properties of Soil & methods applied by different researchers.

Keywords: Dielectric Properties, Time Domain Reflectometry technique

INTRODUCTION

Soil is essential to human survival. We rely on it for the production of food, fibre, timber and energy crops. Together with climate, the soil determines which crops can be grown, where, and how much they will yield. Soil can be very different from one location to another, but generally consists of Organic and inorganic materials, water and air. The Composition of the soil affects the plants growth. In addition to supporting our agricultural needs, we rely on the soil to regulate the flow of rainwater and to act as a filter for drinking water. With such a tremendously important role, it is imperative that we manage our soils for their long-term productivity, sustainability and health. Soil is a vital part of the natural environment. It is just as important as plants, animals, rocks, landforms, lochs and rivers. It influences the distribution of plant species and provides a habitat for a wide range of organisms. It controls the flow of water and chemical substances between the atmosphere and the earth, and acts as both a source and store for gases (like oxygen and carbon dioxide) in the atmosphere. Soils not only reflect natural processes but also record human activities both at present and in the past. They are therefore part of our cultural heritage.

The majority of measurements of physical, chemical and biological properties of porous materials including soil should be accompanied with the measurement of soil water content and temperature. These parameters determine almost all processes in natural environment. It seems obvious to accompany the sensors for the measurement of soil salinity, oxygenation, content of nutrients, soil water potential, and others with the temperature and moisture sensors having the same measurement volume and performing measurements at the same time. Such a property of porous materials accompanied with moisture is dielectric permittivity. Measurement of soil moisture using time domain reflectometry (TDR) has become increasingly popular because of simplicity of operation, satisfactory accuracy and fast result available, the process of measurement is non-destructive, portable systems are available and the method gives ability for measurement automation and probes multiplexing [1].

RESULTS AND DISCUSSION

Dielectric Materials have many applications ranging from microwave components and subsystems to industrial and manufacturing processes. The precise knowledge of the dielectric properties of soil is very important for industrial as well as scientific microwave applications success.

Soil TDR probes act as a wave-guide .Time Domain Reflectometry technique is designed to measure the dielectric properties of soils. Time Domain Reflectometry (TDR) measure the dielectric constant of the soil .The dielectric constant is the ratio of the permittivity of a substance to free space. Dielectric constant in air is 1, water is 80 and soil is 3 to 4. Therefore any relative change between air, water and soil will change. TDR is used to determine moisture content in soil and porous media. The key to TDR's success is its ability to accurately determine the permittivity (dielectric constant) of a material from wave propagation, and the fact that there is a strong relationship between the permittivity of a material and its water content.

The Portable Dielectric Measurement Kit is a new instrument designed to determine the complex permittivity for a wide range of solid, semi-solid, granular and liquid materials around the ISM frequency of 2.45 GHz. Unlike other instruments, it performs automatically all the necessary control functions, generation and analysis of microwave signals, data processing, dielectric calculation, storage and display of results.

When the electromagnetic waves interact with the soil, from the reflected wave we can reveal the basic information that will be useful for the microwave remote sensing. The dielectric properties of soil are function of its chemical constituents and physical Properties. In a non-homogeneous medium such as soil, the dielectric constant is combination of individual dielectric constant of its constituents such as sand, slit, and clay, organic and inorganic matter. Different Studies predict that the dielectric properties of soil at microwave frequencies are the function of its physical-chemical constituents.

The available macronutrients of Soil show remarkable variation in dielectric properties. Inorganic matter in Soil significantly affects its dielectric properties. These dielectric parameters are useful for researchers in the field of agriculture.

These parameters may Useful to predict soil Fertility [2].

F.N. Dalton and M. Th. Van Genuchten [3] reported the physical principles and use of Time Domain Reflectometry as a new tool for studying water and solute transport in unsaturated soils. Time Domain Reflectometry techniques have great potential for obtaining non-destructive, in –situ measurements of the soil solution concentration during variably unsaturated flow.

Renpeng Chen and Co-authors [4] presents an approach for estimating the apparent dielectric constant from the reflection at the surface of soils by using a model –based inversion method. This approach can be applied to contaminated soils and chemically modified soils that have high electrical conductivities. The dielectric properties of the contaminated soils may be used to detect the migration of the contaminant components in the soils.

Several factors influence dielectric constant measurements, including soil porosity and bulk density, measurement frequency, temperature, water status (bound or free) and dipole moments induced by mineral, water, and air shapes. Water content is inferred from dielectric permittivity of the medium, whereas electrical conductivity is inferred from TDR signal attenuation. Empirical and dielectric mixing models are used to relate water content to measured dielectric permittivity were reported by Scott B. Jones.et.al [5].

It was very clear to Peter and Les [6] that the TDR and Ground Penetrating Radar offered a practical method for measuring soil water content for agricultural applications. D.A. Robinson et.al, [7] summarizes and examines advances that have been made in terms of measuring permittivity and Electrical conductivity also issues such as the effective frequency of the TDR measurement and waveform analysis in dispersive dielectrics. V.J.Shinde and Co- authors [8] reported Moisture content in soil significantly affects its dielectric properties.

CONCLUSIONS

These Dielectric properties may be useful for researchers working in the field of microwave remote sensing. The nation requires undertaking actions to assess and manage the risks produced by soil contaminants. Strict social and environmental standards are needed to identify soil projects that best address the needs of society, the environment, and the economy. Technical measures to maintain the soil standards are necessary for agricultural purposes. Reduction of public health risks from soil contaminants and increased society confidence in the ability of this technique.

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