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Role of Microwave Remote Sensing Dielectric Behavior of Soil: A Need of an Hour

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Abstract:

An attempt has been made to focus on role of microwave remote sensing dielectric behaviour of soil by the author. Soil has several properties such a textural analysis particle density, dry bulk density, total wet bulk density, specific volume, porosity, soil water volume ratio, degree of saturation, air filled porosity, total porosity, soil structure, soil colour consisting, soil plasticity, soil compaction, soil crusting hydration, swelling, specific surface soil conditions soil water energetics total soil water, potential, gravitational potential, pressure potential, submergence potential osmotic potential, soil moisture potential, differential water capacity, flow of water hydraulic conductivity permeability and fluidity, soil water diffusivity infiltration redistribution of soil moisture, soil water balance evaporation ground water drain solute transport

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diffusion hydrodynamics dispersions soil air, soil aeration, dynamics of soil air, management, soil temperature, thermal properties of soil, heat transfer to soil, soil rheology, apart from these chemical properties are also very important. There is vital role of such parameter for dielectric behaviour of soil.

Keywords: Dielectric behaviour, porosity, bulk density, soil moisture, soil temperature, evaporation

Introduction:

We born, live and die on earth. The role of soil is part and part for human being with the applied approach soil is analyzed by microwave remote sensing technique. Actually, soil is abundant intrinsic properties and what is physics in soil it has been collaborated. Soil physics deals with physical properties of soil as well as with the measurement, prediction and control of the physical processes. As physics deal with the form and interrelation of matter and energy, so soil physics deal with the state and moment of matter and with the fluxer and transformation of energy in soil. Soil is compressed as a complex system i.e. heterogeneous polyphasic disperse and porous, consisting of solid, liquid and gaseous phase among with solid phase constituting the soil matrix is made up mineral and organic component of the soil determines the geometric characteristics of the pore space in which weather and air are transmitted and retained the liquid phase consist of soil water which always contains dissolved substances after called soil solution and the gaseous phase is the soil atmosphere it contains also soil air with higher carbon-dioxide concentration relative to atmospheric air the disperse nature of the soil and its consequent interfacial activity give rip to such phenomena as absorption of water and chemicals, ion exchange adhesion, swelling and shrinking dispersion and fluctuation on well as capillary. Microwave remote sensing contributes a lot of application in the field of dielectric behavior of soil. Soil and agriculture are two parts of a coin. Agriculture is the backbone of the economy of most of nations. In India, agriculture is the most important and extensive land use activity. Remote sensing techniques are widely used in agriculture and agronomy. These techniques are necessary to monitoring agriculture activities. First of all, agricultural production follows a seasonal pattern related to the biological life style of crops. The production depends secondly on the physical land space as well as climate driving variables and agricultural management practices. All these variables are highly variant in space and time. More ever as productivity can change with in

short time periods due to un-fortune growing condition, agricultural monitoring system. Many times, remote sensing can significantly contribute to provide a timely and accurate picture of agriculture sector.

Different properties of soil like physical, chemical and electrical changes with presence of inorganic and organic material. The knowledge of these properties is beneficial to crop and agricultural production. It has been seen that

1. Dielectric behaviour can be used to predict soil fertility and health.
2. There is also role of temperature in agriculture productivity.
3. Dielectric constant predicts the fertility of soil. So dielectric constant of non irrigated and irrigated soil varies in their characteristics.
4. Proper monitoring of sensor for microwave remote sensing, the accuracy of dielectric constant helps a lot of.
5. Moisture content of soil is also responsible for physical, chemical and electrical properties.
6. Knowledge of all concern parameters such as physico-chemical, electrical and geographical properties are beneficial for progressive farmer and scientists who are working in the field of microwave remote sensing.

Soil has several properties such a textural analysis particle density, dry bulk density, total wet bulk density, specific volume, porosity, soil water volume ratio, degree of saturation, air filled porosity, total porosity, soil structure, soil colour consisting, soil plasticity, soil compaction, soil crusting hydration, swelling, specific surface soil conditions soil water energetics total soil water, potential, gravitational potential, pressure potential, submergence potential, osmotic potential, soil moisture potential, differential water capacity, flow of water hydraulic conductivity permeability and fluidity, soil water diffusivity infiltration redistribution of soil moisture, soil water balance evaporation ground water drain solute transport diffusion hydrodynamics dispersions soil air, soil aeration, dynamics of soil air, soil aeration, management, soil temperature, thermal properties of soil, heat transfer to soil, soil rheology, apart from these chemical properties are also very important. Worldwide pioneer and research are doing research work in the field of microwave

dielectric behavior of soil remote sensing techniques are widely used in agriculture and agronomy. The properties of dielectric material commonly permittivity and generally stimulated as a function of frequency and are known as dielectric spectroscopy or impedance spectroscopy. Permittivity volume is an vital tool to understand compressive characteristic of material at high frequencies. India is a agriculture based country geographical climate effect the production of agriculture in respect of food grains. Indian is divided in the six parts on the basis of climate. Chhattisgarh is humid subtropical. The dielectric behavior of soil has dependence on the soil constitution (Patel- Lakhapati, Jaiswal Sweta and Shrivastav A.K., Book 2021).

Theoretical Consideration:

Recent development in the field of remote sensing geographic information system and global system technology has special advantage in term of generating state of the at informatics. The information enables us to provide valuable scientific into the factor contributing to the low productivity of soil resource with is turn wood from the essential ingredient to evolve the effective strongest for optimal use of resource to enhance the productivity. Theory and principal are very important basic process of remote sensing are given us

- Energy source (sun are transmitter)
- Transmissions of energy from source to object
- Energy interaction with object surface
- Transmission of energy to sensor
- Scattering and absorption by atmosphere
- Detection measurement and output sensor

With the help of appropriate formulae, the concerned parameter have been calculated.

Mean Particle Density: ρ_s is defined as

$$\rho_s = M_s / V_s$$

Where M_s = Mass of soil solid

V_s = Volume of the soil solid

It has been that in most mineral soils the mean density of the particles is about 2.6-2.7 gm/cm³. The presence of iron oxide increases the average value of mean particle density whereas presence of any organic matter lowers it sometimes.

Dry Bulk Density:

The dry bulk density f_b expresses mass of dry soil per unit total volume (solid and pores together)

$$\rho_b = M_s/V_t = M_s/V_s + V_a + V_w$$

Where V_t = Total volume of the representative soil body

M_s = Mass of the soil solid

V_s = Volume of the soil solid

V_a = Volume of air

V_w = Volume of water

Clearly, f_b is always smaller than mean particle density (f_s) and if pores constitute half the volume is half of f_b viz 1.3 - 1.35 gm/cm³. In sandy soils can be as high as 1.6 where as in aggregated loams and in clay soils it can be as low 1.1 gm/cm³. The bulk density is affected by the structure of the soil that is its looseness or degree of compaction as well as by its swelling and shrinkage characteristics where are dependent upon clay contact and wetness.

Total Wet Bulk Density:

Total wet bulk density (f_t) express the total mass of wet soils per unit volume.

$$\rho_t = M_t/V_t = M_s + M_w/V_s + V_a + V_w$$

Where M_t = Total mass

M_w = Mass of water

Porosity:

The porosity (f) is an index of the relative pore volume in the soil. Its volume generally lie in the range of 0.3 - 0.6 (30% - 60%). Coarse textured soil to

be less porous than fine texture soils through mean size of individual porous in greater in former than in the latter in clays soil the porosity is high variable as the soil alternating swells and shrinks aggregates, disperses, compact and cracks. Although the term porosity refers to the volume fraction of pores, but the value should be equal on an average to the real porosity as well as to the average linear porosity. A real porosity is the fraction of pores in the measurements. Cross sectional area where as average linear porosity in the fractional length of pores along a straight line passing through the soil in any direction.

$$f = V_f / V_t = (V_a + V_w) / (V_s + V_a + V_w)$$

Where V_f = Volume of pores.

Void Ratio:

The void ratio is also an index indicating the fractional volume of soil pores. The advantage of this index over the porosity (f) is that a change in pore volume changes the numerator alone where as a change in pore volume in term of porosity changes both the numerator and denominator of the defining equation. Void ratio is generally preferred index in soil engineering and mechanics as a porosity is the preferred as the agriculture soil physics. In general (e) varies between 0.3 and 2.0

$$e = V_a + V_w / V_s = V_f / V_t - V_f$$

Air Filled Porosity:

The air-filled porosity (f_a) is given by

$$f_a = V_a / V_t = V_a / V_s + V_a / V_w$$

This is a measure of the relative air content of the soil and as such is an important creation of soil aeration the index is related negatively to the degree of saturation (s)

$$f_a = f - s$$

Total Porosity:

Porosity of a soil sample in the volume where is occupied by air and water mathematically it is the ratio of volume of pore space to total volume of soil. Porosity is a governed by the arrangement or orientation of the solid particles. Total porosity gives us idea only about the total storage capacity of the soil for fluids or gases. It is the volume percentage of the total soil bulk not occupied by the solid particles and is expressed as,

$$\% \text{ pore space} = [100 - D_b / D_p \times 100]$$

$$\text{Where } D_p = W_s / V_s$$

$$D_b = W_s / V_s + V_p$$

$$W_s = \text{Weight of soil solids}$$

$$V_p = \text{Volume of pores}$$

$$V_s = \text{Volume of solids}$$

$$V_s + V_p = \text{Total soil volume}$$

$$D_p = \text{Particle density}$$

$$D_b = \text{Bulk density}$$

Stokes' Law:

A particles falling in a vacuum will encounter no resistance, as it is accelerated by gravity and hence its velocity increases as it fall. A particle falling in a fluid in the other hand will encounter a friction resistance proportional to the product of its radius, velocity and to the velocity of fluid. The resisting force or the viscous drag due to the friction was shown by Stoke,

$$F = 6\pi\eta r v$$

$$\text{Where } \eta = \text{Viscosity of the fluid}$$

$$r = \text{Radius of the particle}$$

$$v = \text{Velocity of the particle}$$

Initially as the particle begins to fall its velocity increases. Eventually a point is reached at which the increasing resistance force equals the constant downward force, and the particle then continues to fall without acceleration at a constant velocity, known as transmitted velocity V_t .

Dielectric Constant:

The technique used in dielectric constant measurement program was the infinite sample method. A X-band microwave bench with a slotted section and crystal detector were used for the measurement of VSWR and shift of minima is needed in this technique.

The complex dielectric constant (ϵ)

$$\epsilon = \epsilon' - j\epsilon''$$

Or
$$\epsilon = \left[1 / 1 + \left(\frac{\lambda_c}{\lambda_g} \right)^2 + 1 / 1 + \left(\frac{\lambda_g}{\lambda_c} \right)^2 \right] \left[\frac{R - j \tan \{k(D - D_R)\}}{1 - j_R \tan \{k(D - D_R)\}} \right]$$

λ_c = Cut off wave length

λ_g = Guide wave length

K = Propagation constant = $2\pi/\lambda_0$

R = Voltage standing wave ratio (VSINR)

D = Position of first minima with sample connected

D_R = Position of first minima without sample connected

Result and Discussion:

The soil behavior depends most only the properties of the primary particles constituting soil mass but also the pattern in which these particles exist in soil any distinct groups of soil particle is a known as a soil aggregate. The key parameter which plays pivotal role for agricultural production. Aggregate stability is an important property of productive soils. It serves as an index of soil quality; water stability is a measure of volume ability of soil to water erosion and soil crusting. It has been found that agricultural practices lead to poor aggregate stability in soils.

Intensive soil disturbance and tillage operations may enhance breakdown of soil organic matter disrupt the existing soil aggregate cropping, grazing or other productions systems that leave soil bare and expose it to the physical impact of raindrops or wind blow soil particles. There is vital role of such parameter for dielectric behaviour of soil.

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