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Summary of Thermo–Time Domain Reflectometry Method: Advances in Monitoring In Situ Soil Bulk Density

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Abstract

Soil bulk density (ρ_b) is a key indicator of soil compaction and soil health that relates to water infiltration, plant rooting depth, nutrient availability, and soil microbial activity. Under field conditions, ρ_b usually varies with time and depth because of agronomic practices, root growth, and environmental processes (e.g., rainfall events, wetting/drying, and freezing/thawing). The traditional technique (i.e., the coring method) for determining ρ_b has the problems of destructive sampling, labor intensive, and is unable to capture the spatial and temporal variations. In a chapter of the recent Methods of Soil Analysis book, we present a review of the theory, instrumentation, and procedures of the thermo–time domain reflectometry (thermo-TDR) technique for monitoring in situ ρ_b (Lu et al., 2017).

Disciplines

Agronomy and Crop Sciences | Soil Science

Comments

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Methods Summary

Summary of Thermo–Time Domain Reflectometry Method: Advances in Monitoring In Situ Soil Bulk Density

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Soil bulk density (ρ_b) is a key indicator of soil compaction and soil health that relates to water infiltration, plant rooting depth, nutrient availability, and soil microbial activity. Under field conditions, ρ_b usually varies with time and depth because of agronomic practices, root growth, and environmental processes (e.g., rainfall events, wetting/drying, and freezing/thawing). The traditional technique (i.e., the coring method) for determining ρ_b has the problems of destructive sampling, labor intensive, and is unable to capture the spatial and temporal variations. In a chapter of the recent Methods of Soil Analysis book, we present a review of the theory, instrumentation, and procedures of the thermo–time domain reflectometry (thermo-TDR) technique for monitoring in situ ρ_b (Lu et al., 2017).

A thermo-TDR sensor (Fig. 1) measures soil thermal properties and water content (θ) concurrently by integrating the functions of the heat-pulse and TDR sensors. The method employs available models that relate heat capacity (C) or thermal conductivity (λ) to soil texture, θ, and ρ_b. With the prior information of sand/clay fractions and specific heat of soil solids, ρ_b is estimated inversely from θ and C or λ measurements made with thermo-TDR sensors. Laboratory and field tests have shown that the relative errors in ρ_b estimates are generally within 10%. The new method provides in situ and continuous ρ_b measurements with no calibration requirement, thus offers the potential for studying coupled heat and water processes in deformable soils where ρ_b changes with time and depth.

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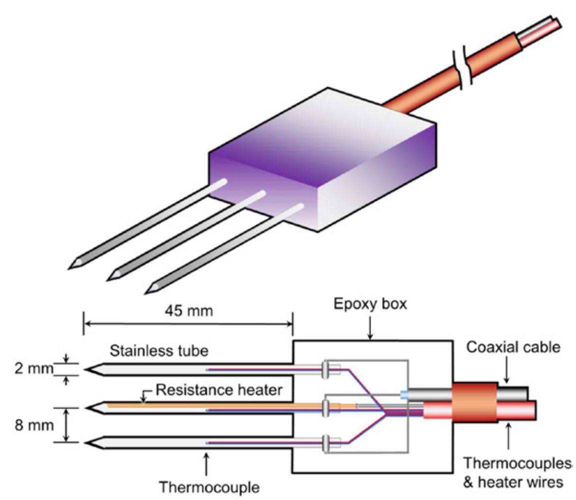

Fig. 1. Schematic view of the configuration for the Liu et al. (2008) thermo-TDR sensor. The drawings are not to scale.

Core Ideas

- **Thermo-TDR technology is used for obtaining soil bulk density.**
- **Soil water content and thermal properties are monitored simultaneously.**
- **Bulk density is estimated by using thermal property models.**

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