Proceedings of International Symposium
on

Sensing Soils

School of Agriculture, Meiji University
Kawasaki, Kanagawa 214-8571 Japan

November 3 and 4, 2018

Sponsored by
Organization for International Collaboration
Meiji University

Preface

Soil is a precious natural material that supports all the living creatures on the earth. The United Nation declared 2015 the International Year of Soils to increase awareness and understanding of the importance of soil for food security and essential ecosystem functions. When I was a graduate student of Tottori University in 1985, I happened to read the paper of Dasberg and Dalton (1985) describing that time domain reflectometry measured soil water content and electrical conductivity at the same time. It was my first encounter to TDR and shocked me. I think that applying TDR to measure water content, first introduced by Topp et al. in 1980, totally changed the world of sensing soils. I asked top notch scientists to share their research on sensing soils. I hope that this symposium will be catalysis of collaborative research toward a new horizon of science.

November 3, 2018

Kosuke Noborio

Organization for International Collaboration, Meiji University Presents
International Symposium on
Sensing Soils

#204 room, No. 6 bldg.
School of Agriculture, Meiji University
November 3, 2018

10:00-10:10	Opening, Kosuke Noborio
10:10-10:50	Frost prediction–an AI approach, Liya Ding
10:50-11:30	Using cosmic rays, monitoring networks, and machine learning to unveil mesoscale soil moisture patterns and drivers, Tyson Ochsner
11:30-12:10	Measuring soil physical properties and processes in the near surface soil: A thermo-TDR approach, Tusheng Ren
12:10-13:10	Lunch
13:10-13:50	Measurement of soil thermal conductivity under reduced air pressure, Toshihiko Momose
13:50-14:30	Normalized concept for modelling effective soil thermal conductivity, Hailong He
14:30-15:10	Temperature effect on dielectric moisture sensors: Theory and application, Tadaomi Saito
15:10-15:30	Break
15:30-16:10	Field monitoring system (FMS) with TDT sensors: A case study for recovery of tsunami-affected agricultural fields in Miyagi, Japan, Ieyasu Tokumoto
16:10-16:50	Dual functional DPHP technique–simultaneous determination of thermal properties and matric potential–, Yuki Kojima
16:50-17:30	Discussion

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International Symposium on
土壌と私達の生活

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November 4, 2018

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10:50-11:20 Socially constructed awareness of radioactivity risk: A case study of Iitate Village, Tomoko Ichida
11:20-11:50 Development of science technology communication for outreach projects of agriculture in Fukushima, Ieyasu Tokumoto
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13:00-13:30 火山灰土壌の性質と農業利用の歴史，竹迫紘
13:30-14:00 日本における泥炭地の変遷と開発の歴史，矢崎友嗣
14:00-14:30 砂丘と水文環境：砂と水と生活，齊藤忠臣
14:30-15:00 千里浜にたどり着くはずの砂の行方を追う―砂浜侵食の本質的原因とは何なのか，百瀬年彦
15:00-15:10 おわりに，登尾浩助

Frost prediction — An AI approach

Liya Ding
Meiji University, Japan

Frost is a serious problem for farmers that may occur anywhere in the world. To reduce damage of vegetables and fruits from frost, a reasonably accurate forecast of frost is desired. Behaving as a categorical value, frost makes its forecast a challenging task. Some recent research shows that frost has association with a few factors, including temperature, humidity, and radiation. This preliminary study explores the possibility of frost prediction using artificial intelligence and machine learning techniques through the association of frost and these factors. Several ways of modeling are explored: predictive model based on time series forecast of predictors; predictive model with past factors, constructing decision model using Bayesian networks, descriptive model for association pattern discovery, and hybrid system involving multiple techniques. Each of the models may be expected to bring values to target application but also raise new challenges. The critical issue of uncertainty and the strategy of problem solving are also briefly discussed.

Using cosmic rays, monitoring networks, and machine learning to unveil mesoscale soil moisture patterns and drivers

Tyson Ochsner
Oklahoma State University, U.S.A.

We are constantly surrounded by water held in the soil in constantly changing, intricate spatial patterns, patterns which can strongly influence people and nature and yet are often undetectable by current soil moisture observing systems. These limitations are particularly pronounced at the mesoscale from approximately 1-100 km, where we are only now beginning to develop tools and approaches capable of unveiling these previously unseen patterns. In this talk, I will give an overview of research at Oklahoma State University that is contributing to new observational approaches and new understanding of mesoscale soil moisture patterns and dynamics. Those approaches include: 1) a mobile cosmic-ray neutron detector (rover), 2) high resolution mapping using data from a large-scale monitoring network, and 3) modeling effects of contrasting land covers using machine learning.

Measuring soil physical properties and processes in the near surface soil: A thermo-TDR approach

Tusheng Ren
China Agricultural University, China

The near surface soil is characterized by strong spatial and temporal variabilities in physical structure, properties and processes. There is a need to develop technologies that are able to observe the temperature, water content, solute concentration, thermal properties, and coupled flow processes of heat, water, and solute in the near surface soil, non-destructively and in situ. The thermo-TDR technique provides such an opportunity by sending both electrical and heat pulses into the soil, and then monitor the fates of these signals. The approach has been applied to monitor soil temperature, water content, thermal properties, electrical conductivity, water flux, heat flux, and soil water evaporation. Soil bulk density, air-filled porosity, and degree of saturation are also estimated indirectly from theoretical and empirical relationships. In this presentation, the development, applications, and perspectives of the thermo-TDR method for measuring soil physical properties and processes, under dynamic surface soil conditions, will be presented.

Measurement of soil thermal conductivity under reduced air pressure

Toshihiko Momose
Ishikawa Prefectural University, Japan

Most people think that the ability of soil to transfer heat is much lower than metals. However, if soil is moderately moistened and is exposed to reduced air pressure, its thermal conductivity increases dramatically becoming equivalent with metals such as stainless-steel. This presentation explains two key aspects on my research for over twenty years: (1) two methods for measuring the thermal conductivity of soil under reduced air pressure, a transient heat-probe technique and a steady-state technique, (2) mechanisms of the dramatic increase in the soil thermal conductivity under reduced air pressure. This presentation will also try to broaden your knowledge on soil: It can be a raw material of heat transport apparatus.

Normalized concept for modelling effective soil thermal conductivity

Hailong He
Northwest A&F University, China
Meiji University, Japan

Effective soil thermal conductivity (λ_{eff}) describes the ability of a multiphase soil to transmit heat by conduction under unit temperature gradient. Among the many soil thermal conductivity models, models based on the normalized concept are most often developed and utilized for accurate estimates of soil thermal conductivity. However, at present no systematic study has been performed to investigate the origin and evolution of the normalized thermal conductivity, nor to evaluate their performance with large datasets. A total of 38 normalized thermal conductivity models were critically reviewed and their relationships were clearly outlined, and their performance was evaluated by categories according to model characteristics. Our analysis demonstrated the key roles of the quartz content, solid thermal conductivity, and choice of the Kersten functions on the model applicability and accuracy of estimating λ_{eff}. The models of He et al. (2017), Lu and Dong (2015), Markle et al. (2006), and Kasubuchi et al. (2007) are the best performed models with fitting parameters, approaches to calculate these parameters are required so they could be easily applied. Future studies on parametrization of currently well performed models for wider and more accurate application, development of soil thermal conductivity database for model evaluation and calibration purpose, and connecting soil thermal conductivity models to hydraulic properties are recommended.

Temperature effect on dielectric moisture sensors: Theory and application

Tadaomi Saito
Tottori University, Japan

Dielectric moisture sensors have been widely used for non-destructive monitoring of volumetric soil water content. However, the output of such sensors are usually affected by soil type, salinity and temperature. In this presentation, I introduce recent research activities on temperature effect on dielectric moisture sensors. The presentation is divided into four parts. Part (i) is about theoretical background and four mechanisms of temperature effect. Part (ii) is about empirical calibration method of temperature effect through laboratory experiments. In part (iii), calibration method using time series field data (without conducting laboratory experiments) is introduced. Finally, application of calibration method to filed data and monitoring of stem water content is introduced in part (iv).

Field monitoring system (FMS) with TDT sensors: A case study for recovery of tsunami-affected agricultural fields in Miyagi, Japan

Ieyasu Tokumoto
Saga University, Japan

Soil moisture and salinity remote sensing technology can facilitate recovery of agricultural production on damaged lands. We developed a soil moisture and salinity Field Monitoring System (FMS) incorporating with three main components: a field router (FR), data logger, and soil/meteorological sensors. The FR collects data measured by the in-situ sensors and sends it to the data server over the Internet. The FR mainly consists of a micro-PC, 3G/GSM USB modem, webcam, and battery in a waterproof dust-tight box. The FR consumes little power (6 W solar panel), is easy to set up, and transmits data inexpensively over a cellular mobile line. With the FMS we monitored soil moisture, electric conductivity (EC), groundwater level in Miyagi that were inundated with sea water by the tsunami after the 2011 Tohoku earthquake, Japan. The FEM performed adequately to monitor desalinization process for determination of irrigation leaching periods. Thus, the utilization of FMS is expected to provide positive feedback for the recovery of agricultural production.

Dual functional DPHP technique–Simultaneous determination of thermal properties and matric potential–

Yuki Kojima
Gifu University, Japan

Dual probe heat pulse (DPHP) is a technique which can simultaneously determine soil thermal properties. In this study, the DPHP sensor was improved to determine soil matric potential (ψ) and the thermal properties. The new DPHP sensor has two 80 mm stainless tubes, which one embeds a heater wire and the other embeds two thermistors. The thermistors are located at 20 mm and 60 mm away from the root of the tubes. The 40 mm from the root of the tubes is covered by a porous medium made of Kaolinite so that the new sensor measures thermal properties of soil and the porous medium. The thermal properties of the porous medium is converted to the ψ from a preliminarily obtained relationship. The volumetric heat capacity of soil is converted to volumetric water content (VWC) so that the new sensor can simultaneously determine ψ and VWC, i.e., in-situ water retention characteristics. The performance of the new sensor was evaluated in laboratory. The new sensor can determine ψ from 20 to 30,000 kPa. The accuracy of the sensor for determining ψ was 15% and that for VWC was 6%. The new sensor can contribute to a variety of studies associated with heat and water transfer in vadose zone.

明治大学国際連携本部後援
国際シンポジウム

Sensing Soils

日時：2018年11月3日（土）10：00-17：30
場所：明治大学生田キャンパス
農学部6号館204教室（無料・一般公開）

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問合せ：農学部農学科　登尾浩助
044-934-7156, noboriok@meiji.ac.jp

明治大学国際連携本部後援
国際シンポジウム

土壌と私達の生活
–Sensing Soils–

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044-934-7156, noboriok@meiji.ac.jp