CASE SCHOOL OF ENGINEERING
CASE WESTERN RESERVE UNIVERSITY

Civil and Environmental Engineering Department Seminar

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Date: Friday December 2nd, 2022, 12:45 – 2:00 PM

Location: Bingham Bldg., Room 140

Remote Access Here

Using Satellite Soil Moisture Data for the Prediction of Landslides

Abstract: The study presented herein investigates the feasibility of refining satellite-based root zone soil moisture estimates and subsequent use of these refined estimates in landslide slope stability analyses. The satellite products investigated throughout this study were that of the National Aeronautics and Space Administration (NASA) Soil Moisture Active Passive (SMAP) satellite mission 9-km Level 4 Root Zone Soil Moisture (L4_SM) and 9-km Level 3 Enhanced Surface Moisture (SPL3SMP_E) products. Throughout this work, refinement of satellite-based moisture estimates refers to increasing the resolution of the L4_SM product through various downscaling routines, locally calibrating the L4_SM product to that of a particular in-situ site(s), and a reduction in bias observed between SPL3SMP_E estimates when compared to that of in-situ surface moisture estimates. This study implemented the following refinement methods upon the investigated SMAP datasets: (i) Random forest machine learning and (ii) Soil Evaporative Efficiency, which were both downscaling methods used to refine L4_SM data from 9 km to 1 km, (iii) Localized calibration of L4_SM data which made use of regressive approaches to calibrate 9 km L4_SM to that of in-situ soil moisture sites, and (iv) An Ensemble Kalman Filter assimilation routine that was used to remove estimated biases between SPL3SMP_E and in-situ surface moisture measurements. These bias reduced estimates were then assimilated into the Soil Moisture Analytical Relationship (SMAR) infiltration model to estimate root zone soil moisture via bias reduced SPL3SMP_E. After the refinement methods were conducted upon the respective SMAP products, the refined products were then used to detect incipient failure conditions at known landslide locations. The investigated landslide locations were the Big Sur landslide in California, the Rattlesnake Hills in Washington, and various landslides throughout Eastern Kentucky. It was observed that these stability models, derived from inclusion of refined SMAP estimates, performed well at predicting either incipient failure or strength weakening conditions. It was the intent of this study to first, show various methodologies for refining SMAP soil moisture estimates, and then to show the feasibility of using these refined estimates to detect incipient landslide conditions.

Speaker Bio: Dr. L. Sebastian Bryson is the current Hardin-Drnevich-Huang Professor of Civil Engineering in the Department of Civil Engineering with a joint appointment in the Department of Earth and Environmental Sciences at the University of Kentucky. Dr. Bryson is also the current Department Chair for the Department of Civil Engineering. Dr. Bryson's research interest focuses on applied geotechnics and includes field instrumentation and monitoring of constructed facilities, in-situ response of earth structures, performance prediction of supported excavations, and in-situ and laboratory testing of soils. Current research projects include: landslide geohazard assessment and prediction, deformation-based design methodology, and multi-hazard response of infrastructure systems. Dr Bryson was named a Fellow by the ASCE Board of Direction in the Fall of 2021. Also, in 2021 Dr. Bryson received certification as Diplomate Geotechnical Engineer (D.GE) by the Academy of Geo-Professionals (AGP) of ASCE in recognition for his specialized knowledge and skills, professional ethics, commitment to lifelong learning, and continued professional development in the field of geotechnical engineering. Dr Bryson received his Ph.D. from Northwestern University, his Master of Engineering degree from Howard University, and his Bachelor of Science degree from the Florida A and M University/Florida State University College of Engineering. Dr. Bryson teaches undergraduate courses in Foundation Engineering and Introduction to Research. He also teaches graduate courses in Advanced Soil Mechanics, Advanced Foundation Engineering, and Stability of Earth Slopes. Dr. Bryson is a registered professional engineer in the states of Kentucky, Wisconsin, Illinois, Ohio, Michigan, Indiana.