The Geo-Institute Embankments, Dams and Slopes Technical Committee will live-stream the *session "The Nexus of Embankments, Dams and Slopes and AI: Prediction and Evaluation"* on Monday, December 7, at 11 AM EST. The talks include:

Talk #1: Critical Failure Domain-Informed Smart Sampling for Slope Stability Assessment (presented by Dr. Chao Shi, Ph.D., C.Eng, R.GE – Nanyang Technological University, Singapore)

Slope reliability critically depends on accurately modelling spatially variable soil properties. While borehole sampling provides essential data for modelling soil variability, conventional borehole optimization strategies typically focus on minimizing spatial uncertainty, without accounting for slope failure mechanisms. There is a lack of failure mechanism-informed tools for optimizing borehole locations and number while considering cross-correlated random fields. This lecture introduces a data-driven sampling strategy that integrates multi-task Bayesian compressive sensing (BCS), Karhunen–Loeve expansion, and reliability sensitivity analysis (RSA) to adaptively identify critical failure domains and optimize borehole planning. The framework introduces a nonparametric method for interpolating cross-correlated soil fields, incorporates a spatially continuous mean reliability sensitivity indicator (MRSI) derived from FORM to guide domain identification, and extends the analysis to multi-mode failure mechanisms through multi-point FORM. The optimal borehole locations are adaptively determined based on the principle of a maximum reduction in cumulative MRSI. The proposed method is illustrated through both a simulated example and real-life investigation data.

Talk #2: Probabilistic Prediction of Breach Width from Historical Riverine Levee Overtopping Event Data (Presented by Stefan Flynn, EI, P.E., M.ASCE, U.S. Army Corps of Engineers)

Prediction of levee breach growth after overtopping failure remains highly uncertain due to complex nature of embankment erosion processes. Published embankment breach widening models often rely on narrowly defined parameters and tightly controlled boundary conditions with model validation frequently limited to narrow training datasets due to limited documentation of real-world observations. As a result of this limitation, relatively few models have been rigorously evaluated against the variability and complexity that exists across the potential permutations of levee material type, constructed and natural geometry, and hydraulic loading conditions. This study presents a probabilistic framework for levee breach width prediction that leverages the recently published LLID-OT v1.0.

Talk #3: AI-powered Concrete Dam Monitoring (Presented by Jian Li, Ph.D., P.E., F.ASCE, University of Kansas)

Concrete dams are fundamental to national infrastructure, supporting economic growth, public safety, and resource management through hydroelectric power generation, flood control, and water storage. In the United States, nearly 70% of dams were built over 50 years ago, and many have experienced significant deterioration. The American Society of Civil Engineers (ASCE) assigned U.S. dams a D+ in its most recent infrastructure report card, underscoring the urgent need for effective structural health monitoring to ensure timely maintenance and repair. However, traditional human inspections are costly, time-consuming, and often unreliable. This paper presents a comprehensive concrete dam monitoring framework that integrates 3D photogrammetry, unmanned aerial vehicles (UAVs), and artificial intelligence (AI) to support the creation of digital twins for concrete dams. The framework focuses on efficient training data preparation and learning strategies enabled by human-AI collaboration, curriculum learning, and photorealistic synthetic data generation. It also incorporates deep learning–based pixel-level image localization for change detection and 3D model updating—an essential component of digital twin technology. The proposed framework was applied to two concrete dams in the United States. Results indicate that the framework effectively enabled efficient data generation for training deep neural networks for damage detection and supported accurate localization of inspection images for 3D model updating. Finally, a comprehensive software platform is presented to facilitate visualization, documentation, tracking, reporting, and asset management.

Talk #4: Scientific Machine Learning for Landslide Modeling and Understanding: From Event-Scale Hydromechanical Inference to Long-Term Susceptibility Change (Presented by Te Pei, Ph.D., M.ASCE, Stony Brook University)

Machine learning is increasingly used to model and predict landslides from event inventories and Earth observation data. While these approaches have greatly improved regional-scale landslide assessment, an important next step is to use machine learning not only for prediction, but also to extract process-relevant information from complex geospatial data. This talk presents a scientific machine learning perspective for landslide modeling and understanding across event and long-term scales. The first part focuses on rainfall-induced shallow landslides triggered by a real extreme storm event. By integrating machine learning with landslide physics, an event inventory is used to infer hidden hillslope hydromechanical conditions and help explain why some slopes failed while others remained stable during the storm. The second part examines landslide susceptibility on the northeastern Qinghai-Tibetan Plateau, where rapid environmental change over the past few decades has altered vegetation and surface conditions. Using long-term Earth observation data, the study explores how changing surface conditions influence landslide susceptibility and how these effects vary across complex terrain. Together, these studies show how scientific machine learning can move landslide modeling beyond prediction and mapping toward process interpretation, hypothesis generation, and improved understanding of evolving slope instability.