THE UNIVERSITY OF HONG KONG

DEPARTMENT OF CIVIL ENGINEERING

SEMINAR

Physically Based Lagrangian Stochastic Modeling of Sediment Transport in Turbulent Flows

Professor Christina Tsai
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Date: September 15, 2026 (Tuesday)
Time: 11:00 a.m. – 12:00 noon
Venue: Room 612B, 6/F Haking Wong Building, The University of Hong Kong

Abstract
Sediment transport in turbulent flows involves complex interactions across a wide range of spatial and temporal scales. Turbulence-driven particle motion, entrainment, suspension, and particle–boundary interactions can produce highly intermittent and nonlinear transport behavior that is not fully resolved by conventional deterministic or time-averaged formulations. This seminar presents physically based Lagrangian stochastic approaches for examining these processes, with particular attention to turbulent memory, intermittent near-bed forcing, and sediment particle response.

We develop an embedded Ornstein-Uhlenbeck (EOU) particle-tracking model to represent temporally correlated turbulent velocity fluctuations and their effects on sediment motion. The embedded structure preserves large-scale temporal memory while regularizing high-frequency fluctuations, allowing particle acceleration and near-bed forcing to be represented within a Lagrangian force-balance framework. The model links sweep and ejection events to sediment entrainment and vertical motion and examines how particle size and relaxation time affect particle trajectories.

For sediment motion near the threshold of entrainment, the Stochastic Impulse Event Generator (SIEG) provides a probabilistic description of turbulence-driven bedload transport. Rather than relying solely on time-averaged bed shear stress, the impulse-based formulation considers both the intensity and duration of turbulent events responsible for particle entrainment. This allows the intermittent nature of near-threshold sediment motion to be incorporated directly into a probabilistic description of entrainment and deposition.

These stochastic approaches link turbulent memory, intermittent forcing, particle dynamics, and entrainment across different time scales. The emphasis on individual particle trajectories and transitions between different states of motion provides a physically based connection between particle-scale dynamics and larger-scale sediment transport behavior.

About the Speaker

Christina W. Tsai, Ph.D. is a Distinguished Professor in the Department of Civil Engineering at National Taiwan University. She received her Ph.D. in Civil and Environmental Engineering and M.S. degrees in Civil and Environmental Engineering and Applied Mathematics from the University of Illinois Urbana-Champaign. Prior to joining NTU, she was a tenured faculty member at the University at Buffalo, State University of New York.

Professor Tsai's research focuses on stochastic hydraulics and sediment transport, fluvial hydrodynamics, hydrometeorological extremes, uncertainty analysis, and risk assessment. Her work has contributed to advancing stochastic approaches for understanding sediment particle transport in turbulent flows and to developing quantitative methods for characterizing and predicting hydrometeorological extremes and their associated risks. Her research program has been continuously supported by competitive funding from the U.S. National Science Foundation (NSF) and Taiwan's National Science and Technology Council (NSTC).

Her research and professional contributions have received recognition in both the United States and Taiwan. She is a recipient of the **U.S. National Science Foundation CAREER Award** and a **two-time recipient of Taiwan's NSTC Outstanding Research Award**. She also received the **ASCE** *Journal of Hydrologic Engineering* **Best Associate Editor Award in 2022** and the **Best Technical Paper Award in 2025.** Professor Tsai currently serves as **Editor-in-Chief of the** *Journal of Hydrology: Regional Studies* and holds a leadership role in the **ASCE Environmental & Water Resources Institute's Hydraulics and Waterways Council.**

- ALL ARE WELCOME -

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