Civil and Environmental Engineering Seminar

The Sonny Astani Department of Civil & Environmental Engineering presents

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Date: Thursday, August 25, 2022
Time: 2:00 – 3:00 PM
Place: RTH 526

Zoom Meeting:
https://usc.zoom.us/j/98445798429
Meeting ID: 984 4579 8429
Passcode: 960488

"Stochastic assessment of hydrogeological and geochemical variables exhibiting multiscale spatial heterogeneity"

Abstract: A theoretical formulation for the stochastic characterization of spatially distributed variables that are typical of hydrogeological and/or geochemical scenarios manifested on various scales of heterogeneity is introduced. We analyze jointly the probability distribution of a variable of interest, Y, and its associated spatial increments, ΔY, taken between locations separated by any given distance (or lag). The spatial distribution of Y is interpreted through a bi-modal Gaussian mixture model. The modes of the latter correspond to an indicator random variable which in turn is related to the occurrence of different processes and/or geomaterials across the domain of observation. We then derive rigorous formulations for the probability density function (PDF) of spatial increments ΔY. As such, we rely on a joint analysis of the PDF of data and their increments within a unique theoretical framework to ensure consistency between these two types of information. Our modeling approach embeds key features emerging from the analysis of experimental evidences. These include (*i*) a slight to moderate asymmetry in the distribution of Y and (*ii*) the tendency of the PDF of ΔY to evolve with lag. After analyzing the main features of the model and its parameter estimation procedure through a set of synthetic scenarios, we consider two experimental data sets associated with different processes and observation scales. The first data set is a collection of microscale reaction rate maps evaluated from Atomic Force Microscopy imaging of the surface of a calcite crystal in contact with a fluid and subject to dissolution. The second data set is a collection of Darcy-scale air-permeability data acquired on a block of volcanic tuff through minipermeameters associated with various measurement scales. Our results (*a*) reveal a remarkable agreement between sample and modeled statistics of Y and ΔY for both systems and (*b*) show that one can effectively infer distributions of quantities of interest through a joint analysis of measured values and their increments.

Bio: Full Professor of Hydraulic Engineering at Politecnico di Milano since 2003 and Director of the Department of Civil and Environmental Engineering since 2017. Adjunct Professor at the Department of Hydrology and Atmospheric Sciences of the University of Arizona (USA). Main research activity is related to qualitative and quantitative aspects of flow and reactive transport in groundwater systems and underground energy resources. Key roles in EU framework projects (FP5-FP7, H2020: Coordinator, Deputy Coordinator, Project leader, Supervisory Board member, and PI of numerous research projects funded by the

industrial sector). Chair of the Communication Committee of the International Society for Porous Media (Interpore). Chair of the Committee on Groundwater Hydraulics and Management of the International Association for Hydro-Environment Engineering and Research (IAHR). Chief Executive Editor of the Journal Hydrology and Earth System Sciences (EGU) and Associate Editor of the Journals Water Resources Research (AGU) and Stochastic Environmental Research and Risk Assessment. Recipient of the Chaire Gutenberg and Prix Gutenberg 2018 (Award by Cercle Gutenberg and Région Grand-Est, France, for research on Climate change and water cycle in Upper Rhine Basin). Elected member of the European Academy of Sciences and Arts (2021).