

APPLIED MATHEMATICS SEMINAR

Hack's Law, Erosion, and Optimal Transport: Developing Mathematical Models and Computational Methods

ABSTRACT:

Hack's Law says that the length of the main river in a river basin scales with the area of the river basin to the power 0.58, thereby prompting speculation on whether there exist optimality principles governing natural processes like channel formation. Identification of such principles and their continued mathematical development could lead to the formulation of a theoretical framework which supports study not only of fluvial landscape evolution, but other geomorphological processes as well. Erosion is nature's process of "moving dirt." In 1781, Monge initiated the theory of optimal transport with the question, "Given a pile of sand and a pit of equal volume, how can one optimally transport the sand into the pit?" Building on earlier work by Birnir, Merchant, Smith, Cattán, and Rowlett, we aim to extend optimal transport theory to develop mathematical models and computational methods for studying erosion. Via optimal transport theory, we prove the existence of unique global weak solutions to equations describing the sediment flow in the evolution of fluvial land surfaces, with constant water depth. While an earlier existence theory result by Birnir and Landry demonstrates that the slopes, or gradients of the surface, are moved optimally, our current work proves that erosion does what Monge proposed: move sediment optimally from the mountainside to the river. This is joint work with Bjorn Birnir.



SPEAKER:

Dr. Therese Basa Landry

UC Santa Barbara

Biography:

Dr. Therese Basa Landry is a UC President's Postdoctoral Fellow at the University of California, Santa Barbara. Previously, she was a Visiting Scholar at the Center for Complex and Nonlinear Science at the University of California, Santa Barbara. From January 2022 through December 2025, Dr. Landry was a Visiting Assistant Professor at the University of California, Santa Barbara. She was a Postdoctoral Fellow in the Non-Commutative Optimal Transport Program at the Institute for Pure and Applied Mathematics (IPAM). She was also a Postdoctoral Fellow in the Thematic Program on Nonsmooth Riemannian and Lorentzian Geometry at the Fields Institute, as well as the Analysis and Geometry of Random Spaces Program at the Mathematical Sciences Research Institute (MSRI, now the Simons Laufer Mathematical Sciences Institute). Part of the funding for Dr. Landry's fellowship at the Fields Institute was provided by George Elliott's NSERC grant. Dr. Landry earned a PhD in noncommutative fractal geometry from the University of California, Riverside, under the direction of Michel Lapidus.

October 22, 2026
SSB 120
3:00-4:30pm

CONTACT:
Prof. Chrysoula Tsogka
ctsogka@ucmerced.edu

