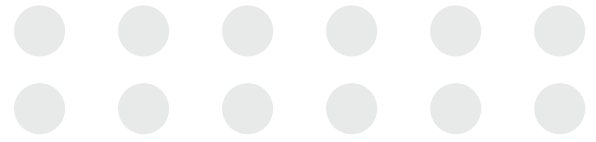




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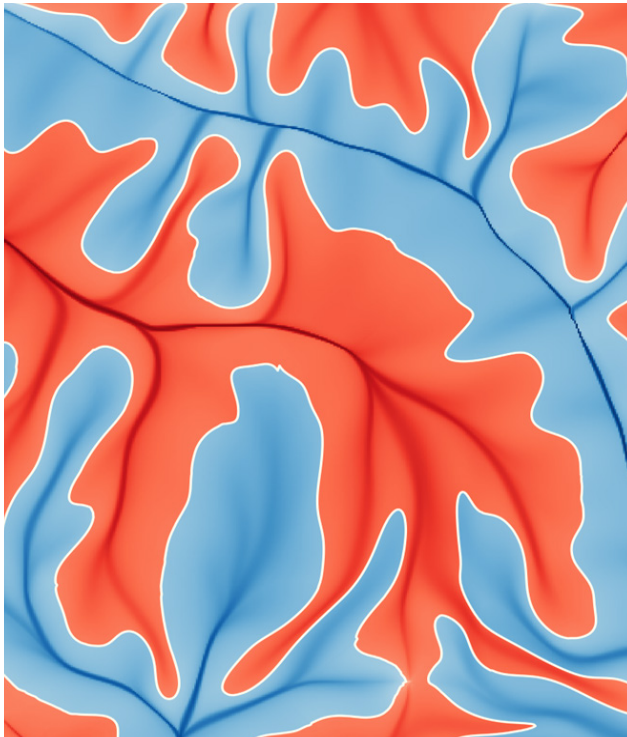
Department of Environment,
Land and Infrastructure
Engineering



SELF-SIMILARITY AND VANISHING DIFFUSION IN FLUVIAL LANDSCAPES: FROM CHANNELIZATION INSTABILITY TO OPTIMAL BRANCHED TRANSPORT AND VASCULARIZATION

PROF. AMILCARE PORPORATO
PRINCETON UNIVERSITY (APORPORA@PRINCETON.EDU)

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Ridge and valley duality in landscapes linked to supply and drainage networks.

ABSTRACT:

Natural landscapes often exhibit universal scaling laws and self-similar behavior with intricate ridge and valley networks. We present and analyze a minimalist landscape evolution model (LEM) with specific focus on the specific contributing area equation. Its scaling properties unveil the existence of distinct dynamic regimes (e.g., unchanneled, transitional with valley formation, and statistically self-similar fractal regime). When fluvial erosion dominates over the smoothing tendency of diffusion, the self-similar regime becomes independent of the exact balance between erosion and soil diffusion. Even in its vanishing limit, diffusion remains crucial, localized at the valley and ridge singularities, where abrupt slope changes occur (as in shock waves). We draw a parallelism between the landscape self-similarity and the self-similarity of fully developed turbulent flows and discuss novel challenges for numerical simulations. We conclude by exploring links to optimal transport, and extensions to supply and drainage networks and 3D vascularization.

BIO

Amilcare Porporato is the Thomas J. Wu '94 Professor at Princeton University, in the department of Civil and Environmental Engineering and the High Meadows Environmental Institute. His research focuses on the quantitative description and prediction of the complex dynamics of the terrestrial water cycle, with special interest in the impact of the hydrologic cycle on temporal and spatial variability of ecosystem processes (eco-hydrology) and the related energy, carbon, and nutrient cycles. He uses both theoretical and experimental approaches to isolate and describe the dominant dynamical components of these physical and biological interactions. Because of the inherent interdisciplinarity of such problems, his research methods draw from fluid mechanics, soil physics, plant physiology, statistical physics, nonlinear dynamics, non-equilibrium thermodynamics, and complex system science.

