What sets the size and spacing of tidal channels in a changing climate?

Proposers: Prof. Andrea D'Alpaos and Prof. J. Taylor Perron (MIT)

Summary: Tidal channels carving through salt marshes and tidal flats are ubiquitous and fundamental features of coastal landscapes, significantly influencing their eco-morphodynamic evolution (D'Alpaos et al., 2005). Despite their pivotal role in landscape evolution, tidal channels have been comparatively understudied in relation to their fluvial counterparts, especially concerning their formation, development, and efficiency in governing water and sediment exchange within intertidal areas. Our understanding of these mechanisms remains incomplete, creating an opportunity to apply principles from erosional fluvial networks to the study of tidal channel dynamics. Comprehensive investigations into the **initiation**, **dynamics**, and **efficiency** of tidal channels demand an **interdisciplinary approach**, integrating morphometric analysis from **remote sensing**, **field surveys**, and **mathematical modeling**. Thus far, such interdisciplinary studies are still in their infancy, highlighting a pressing need for further exploration and integration across disciplines to elucidate the complex dynamics of tidal channels and their broader implications for coastal landscape evolution, particularly in the context of climate change.

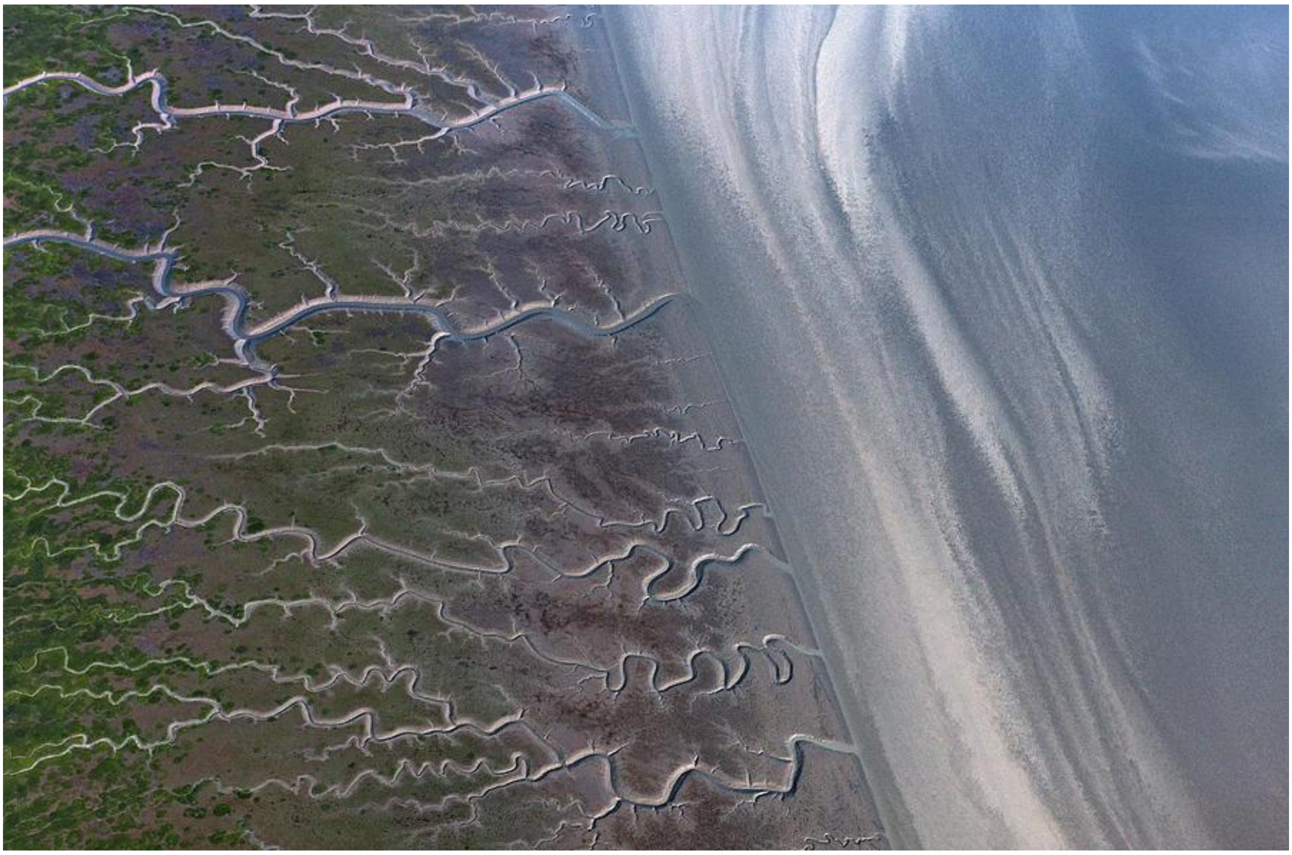

Figure 1. Parallel tidal channel patterns cutting through tidal-flat and slat-marsh surfaces. **What controls the size and spacing of channels like these? How will climate change and human interference affect these patterns?**

Aims of the project. Echoing progress in fluvial geomorphology (Perron et al., 2008), the project aims to explore the processes that control tidal channel network dynamics and morphology through remote sensing and mathematical modelling. The specific goal is to answer two critical questions: "**What controls channel size and spacing in tidal landscapes?" and "How do environmental perturbations affect equilibrium channel patterns?"** Towards this goal the PhD candidate will combine analyses of the planimetric configurations of tidal networks (determined from temporal sequences of high-resolution images) with mathematical and computational modeling that blends approaches previously used to explore tidal network initiation (D'Alpaos et al., 2005) and fluvial landscape evolution (Perron et al., 2008).

Expected outcomes. The results of the research will have significant **theoretical and practical implications**. Tidal channels play a crucial role in the ecology and hydrology of coastal landscapes, making it essential to comprehend their formation and behavior. Factors such as sediment supply and sea level rise can significantly influence these processes, underscoring the importance of studying tidal channels **in the context of changing environmental conditions**. Ultimately, by addressing these critical questions, the project aims to contribute to a deeper understanding of tidal landscape dynamics, which can inform both theoretical advances and practical management strategies, such as salt-marsh restoration.

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References

D'Alpaos, A., S. Lanzoni, M. Marani, S. Fagherazzi, and A. Rinaldo (2005), Tidal network ontogeny: Channel initiation and early development, *J. Geophys. Res.*, 110, F02001, doi:10.1029/2004JF000182.

Perron, J.T., W.E. Dietrich and J.W. Kirchner (2008), Controls on the spacing of first-order valleys. *J. Geophys. Res.*, 113, F04016, doi:10.1029/2007JF000977.

About the Proposers

J. Taylor Perron is the Cecil and Ida Green Professor of Earth, Atmospheric and Planetary Sciences at MIT. His group studies how geology, climate, and life intertwine to shape the surfaces of Earth and other planets. Prof. Perron is a Fellow of the American Geophysical Union and a MacArthur Fellow. He holds an AB in Earth and Planetary Sciences and Archaeology from Harvard University and a PhD in Earth and Planetary Science from the University of California, Berkeley.

Andrea D'Alpaos is Professor of Hydrology at the Department of Geosciences of the University of Padova. His research activity focuses on the biomorphodynamic evolution of coastal and terrestrial landscapes accounting for the effects of the mutual interactions and adjustments between physical and biological processes. His research includes understanding, through field observations, laboratory experiments, and modeling, how biogeomorphic feedbacks contribute to shaping these landscapes and how they drive system response to changes in the environmental forcing and human interferences.