Understanding the Turbulence Dynamics in Environmental Flows with Complex Roughness

Akshay Patil (Post-doctoral Researcher)
3D Geoinformation Research Group, Delft University of Technology, The Netherlands

The need to better understand the hydrodynamic response over complex roughness/bathymetry has only grown over the past decade. This is especially true for environmental flows where equilibrium conditions rarely exist making these systems especially interesting from a fundamental fluid dynamics perspective. In this talk, I will discuss two environmental fluid mechanics problems that have inspired me in the recent past. Specifically, I will talk about

1. Coastal Ocean Bottom Boundary Layer Dynamics
2. Urban Fluid Dynamics

Coastal bottom boundary layers play an active role in supporting a wide variety of important ecological, aquatic, and anthropogenic economic activities. These boundary layer flows are primarily driven by turbulent currents and oscillatory wave motion that interact over naturally rough bottom bathymetry. Thus, it is essential to understand and model these wave-current interactions to accurately predict the long-term fate of the coastal environment. Here I will detail some insights on the various combinations of these driving forces and boundary conditions; and more importantly, how they set the scene for a non-trivial flow response both at the large and the small scales of interest.

In the second part of my talk, I will briefly discuss some of the more recent developments we have made in urban fluid dynamics primarily using Reynolds-Averaged Navier-Stokes (RANS) frameworks. Here the focus will be mainly on urban air mobility and its applications/implications on how best to use the RANS framework to make meaningful predictions. I will also talk briefly about some of the exciting things that I am looking forward to exploring in the field of urban fluid dynamics as there are more parallels between the coastal ocean world and the urban built environment.