Sediment Entrainment, Distal Transport and Deposition by Saline Gravity Currents

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Time: 9:00 – 10:00 AM
Location: 362 Willard Building
Coffee and donuts will be provided

Abstract:
The propagation of bottom gravity currents in lakes, reservoirs, seas, and oceans strongly depends on the interaction with the floor. This interaction is determinant for flow resistance, pressure induced movements of the bed and exchange of dissolved and undissolved species across the benthic layer. Furthermore, it governs processes of entrainment, distal transport and deposition of sediment, with consequences for reservoir sedimentation, submarine cable and pipelines destruction, resuspension of contaminated deposits, and carbon degassing from sediment deposits. Sedimentary basins caused by turbidity currents form some of the world’s most important hydrocarbon reservoirs and the topography of ocean and sea floors is shaped by large-scale gravity currents. In this presentation we address simultaneously the feedback between the hydrodynamics of a gravity current and the geomorphic changes of a mobile bed. Laboratory experiments of saline gravity currents, produced by lock-exchange, flowing over a mobile bed channel reach, are presented. Different initial conditions of the current were tested together with three different grain sizes of the erodible sediment. Results from velocity measurements are combined with the visualization of the sediment movement in the mobile reach and with post-test topographic and photo surveys of the geomorphology modifications of the channel bed. We show that the mean vertical component of the velocity and bed shear stress are highly correlated with the first instants of sediment entrainment. Vertical turbulent velocity is similarly related to entrainment, although with lower correlation values, contributing as well to the sediment movement. Bed shear stress and Reynolds shear stress measured near the bed are correlated with sediment entrainment for longer periods, indicating that these quantities are associated to distal transport as well. Geomorphological changes in the mobile bed are strongly related to the work done by the bed shear stress. On the other hand, we show that the nature of the grain of the mobile bed reach influences the hydrodynamics of the current which means that a feedback mechanisms between both occurs during the passage of the unsteady gravity current. The signature of this geomorphological work, which is visible in the form of longitudinal streaks of accumulated sediment downstream the mobile bed, is related to the flow initial buoyancy and to the size of the mobile bed sediment.
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Biography:
Mário is Professor of Hydraulic Engineering and River Basin Development of the IHE Delft Institute for Water Education in the Netherlands. He was previously professor at the University of Coimbra and at the New University of Lisbon, and recently he was Research and Teaching Associate at the École polytechnique fédérale de Lausanne (EPFL). He graduated from the Technical University of Lisbon as a civil engineer in 1998 and as a MSc. in Hydraulics and Water Resources in 2002. In 2005 he obtained a doctoral degree in sciences at EPFL. His domain of activity includes hydraulic processes within the river basin, more specifically fluvial hydraulics, turbulence in open-channel flows, sediment transport, fluvial geomorphology, non-conventional hydropower production and density currents. He is author of several scientific publications and he gives regularly invited seminars in these fields of research. He was part of the local organizing committees of the River Flow conferences in 2006 and 2014, in Lisbon and Lausanne respectively. He is part of the leading team of the IAHR section Experimental Methods and Instrumentation. He served as hydraulic engineer as private consultant and in engineering companies, having worked in projects of dams, hydropower schemes, river engineering, emergency planning, safety of hydraulics infrastructures, water supply, drainage, rehabilitation of mining sites, and master plans. He is associate editor of Water Resources Research.