Civil and Environmental Engineering

Seminar

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Flows in vegetated sea and river currents

ABSTRACT

Jet-like flows, ubiquitous in both atmospheric and oceanic systems, are fundamental to many fluid-dynamic processes. Their interaction with obstacles, such as rigid vegetation, introduces complex flow behaviors that remain underexplored despite their significance in environmental hydraulics. This study presents an analytical model specifically designed to capture the dynamics of jet-like flows in the presence of rigid vegetation. To broaden the model's applicability, additional flow configurations interacting with rigid structures are also examined.

Beyond their influence on localized flow structures, rigid vegetation—such as mangroves—plays a crucial role in coastal protection, serving as a natural barrier against extreme wave events. In recent years, nature-based coastal defense strategies have gained increasing attention, aligning with eco-hydraulic principles. A critical aspect of these strategies is understanding how fluid flows interact with vegetation, affecting both wave transmission and current dynamics.

A key feature of vegetated flows is their ability to dissipate wave energy. This study investigates the attenuation of solitary waves propagating through an array of rigid, emergent, and submerged cylindrical stems over a horizontal seabed. The analysis integrates theoretical modeling, numerical simulations, and controlled laboratory experiments to provide a comprehensive assessment of wave-vegetation interactions.
Theoretical predictions are validated through laboratory experiments, where solitary waves are tested against a background current to mimic realistic oceanic conditions—acknowledging that circulation currents are rarely absent in natural marine environments. The comparison confirms the robustness of the theoretical model and its practical applicability.

Moreover, the study evaluates the bulk drag coefficient for rigid stem arrays, exploring its dependence on key parameters such as stem density, diameter, and submergence ratio. These findings offer deeper insights into fluid-structure interactions in vegetated flows, with significant implications for coastal engineering, eco-hydraulics, and sustainable shoreline protection.

BIO

Michele Mossa (MM) is Full Professor of Hydraulics at the Polytechnic University of Bari and associated with the CNR-IRSA for research collaboration. He is Chair of the Technical Committee on Ecohydraulics of the IAHR (International Association for Hydro-Environment Engineering and Research), was appointed expert member of the ministerial commission for the preparation of the National Research Plan - PNR 2021-2027 for the section "Knowledge and technological innovation and sustainable management of marine ecosystems", is Chief Scientist of the LIC - Coastal Engineering Laboratory of the Polytechnic University of Bari and representative of the Polytechnic University of Bari in the Council of the National Consortium for Marine Sciences (Co.N.I.S.Ma.). MM is person in charge of the international cooperations of the Polytechnic University of Bari with the University of Tennessee (USA), the University of Notre Dame (USA), the Institute of Fluid Mechanics and Heat Transfer, TU Wien, Austria, and the LEGI UMR 5519 CNRS, Universite Grenoble Alpes.
The main research topics of Michele Mossa are relevant with the Environmental and Maritime Hydraulics, examining the mechanisms of waves, sea currents, local erosion phenomena, buoyant and non-buoyant jets issued in steady or wave environment or in crossflow, also with macroroughness at the bottom (ripples or vegetation), channel flows and their local phenomena, such as hydraulic jumps. He is author of 130 papers in journals, 91 book chapters, 59 paper in proceedings of conferences, 12 books, 2 editorship, 2 patents. MM is within the top 2% of scientists of their main subfield discipline (career-long data are updated to end-of-2022 and single recent year data pertain to citations received during calendar year 2022). The list was drafted by researchers from Stanford University: Ioannidis, John P.A. (2023). MM has been invited lecturer in many conferences and principal investigator in many national and international grants. He is associate editor of scientific journals, including Journal of Hydraulic Research (ISSN: 1814-2079), Environmental Fluid Mechanics" (ISSN: 1573-1510), and Scientific Reports (Nature research journal, ISSN 2045-2322). In 2023 MM was awarded as Fellow Member of IAHR (unanimously approved by the IAHR Council). IAHR Fellow Membership is a new distinction introduced in 2023 to recognise IAHR members for their outstanding contributions to hydro-environment engineering and research and to the development of IAHR. Further information is available on the website: https://www.michelemossa.it/en/

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