Compression Waves and Positive Surges in Open Channels and Geophysical Applications: Tidal Bores and Tsunami Bores

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Abstract

A compression wave or positive surge is a hydrodynamic shock on an open channel. Geophysical applications encompass tidal bores and tsunami bores in rivers. A tidal bore (mascaret) is a series of waves propagating upstream as the tidal flow turns to rising in a river mouth during the early flood tide. The application of continuity and momentum principles gives a complete solution of the ratio of the conjugate cross-section areas as a function of the upstream Froude number. Theoretical considerations are developed based upon the equations of conservation of mass and momentum. Physically the tidal bore propagation induces a massive mixing of the natural system. Prototype observations highlighted that the tidal bore passage is associated with large fluctuations in water depth and instantaneous velocity components. Both experimental and numerical studies indicated the production of large coherent structures advected behind the tidal bore. The presence of such large-scale coherent structures indicated that a great amount of sediment materials could be placed into suspension and transported by the flood tide flow in a natural system. Future research into tidal bores should combine computational calculations combined with ad-hoc laboratory measurements, and it must be complemented by detailed field measurements in natural systems.

About the speaker

Hubert CHANSON is a Professor in Civil Engineering, Hydraulic Engineering and Environmental Fluid Mechanics at the University of Queensland, Australia. His research interests include design of hydraulic structures, experimental investigations of two-phase flows, applied hydrodynamics, hydraulic engineering, water quality modelling, environmental fluid mechanics, estuarine processes and natural resources. He has been an active consultant for both governmental agencies and private

organisations. His publication record includes over 620 international refereed papers and his work was cited over 4,000 times (WoS) to 12,300 times (Google Scholar) since 1990. Hubert Chanson is the author of over 18 books, including "Air Bubble Entrainment in Free-Surface Turbulent Shear Flows" (Academic Press, 1997), "Applied Hydrodynamics: an Introduction of Ideal and Real Fluid Flows" (CRC Press, 2009), and "Tidal Bores, Aegir, Eagre, Mascaret, Pororoca: Theory And Observations" (World Scientific, 2011). His textbook "The Hydraulics of Open Channel Flows: An Introduction" (Butterworth-Heinemann, 1st edition 1999, 2nd edition 2004) has already been translated into Spanish (McGraw-Hill Interamericana) and Chinese (Hydrology Bureau of Yellow River Conservancy Committee). In 2003, the IAHR presented him with the 13th Arthur Ippen Award for outstanding achievements in hydraulic engineering. The American Society of Civil Engineers, Environmental and Water Resources Institute (ASCE-EWRI) presented him with the 2004 award for the Best Practice paper in the Journal of Irrigation and Drainage Engineering ("Energy Dissipation and Air Entrainment in Stepped Storm Waterway" by Chanson and Toombes 2002). Hubert Chanson He chaired the Organisation of the 34th IAHR World Congress held in Brisbane, Australia between 26 June and 1 July 2011. He chaired the Scientific Committee of the 5th IAHR International Symposium on Hydraulic Structures held in Brisbane in June 2014.