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Editorial

Environmental Hydraulics, Turbulence, and Sediment Transport, Second Edition

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Within river systems, the process of bed-forming is intricate, dynamic and is shaped by different factors. Hydraulic forces exerted by water flow play a crucial role, forming the bed substrate over time. Additionally, the presence of vegetation within the riverbed and along its banks introduces further complexity, as the interaction between plants and hydrodynamics can alter sediment transport patterns and riverbed morphology. The movement of both suspended particles and bedload materials within the water column contributes to the ongoing riverbed landscape evolution. The primary aim of this editorial collection is to assemble an extensive range of research methodologies aimed to inform engineering practices pertinent to river management. Through an exhaustive exploration of various topics, including water quality indexing, erosion and sedimentation patterns, influence of vegetation, hydrological modelling for understanding flow dynamics, and identification of critical hydraulic parameters with the utilisation of both analytical and experimental modelling techniques, this paper endeavours to provide valuable insights derived from rigorous research efforts. By synthesising and presenting these findings, we offer a resource that can effectively guide future endeavours in river engineering and related disciplines.

The purpose of this Research Topic (RT) is to examine the latest advances and developments in addressing the challenges in the fluvial systems as well as to discuss the opportunities they create for sustainable city solutions. This RT comprises eleven research articles contributed by 49 authors, organised into several distinct themes. These themes encompass studies on managing scour phenomenon, mitigating water pollution, understanding behavioural aspects of fluvial dynamics, and exploring efforts towards river restoration through representative modelling. The key insights are as follows:

- Water quality and ecological impact on fluvial systems;
- Drainage network and sediment management;
- Hydrological and hydrodynamic modelling and analysis;
- Experimental approaches of the scour phenomenon.

Several proposed models were used to predict the Water Quality Index (WQI) and to investigate how industrialisation has affected the quality of surface water in the Kelani River basin, Sri Lanka [1]. From 2005 to 2012, nine criteria were assessed, and the results showed that the water quality around industrial zones, specifically at Raggahawatte Ela, was impaired. The results highlight the necessity of taking proactive steps in water management to address the declining quality of surface water from industrial activity. The impact of finite-length vegetation on flow structure during inland tsunami events was assessed using numerical simulations incorporating a Volume of Fluid (VOF) technique combined with the Reynolds Stress Model (RSM) to accurately track the free surface level [2]. The study outcomes indicate that the wider vegetation patches generate large vortices and low-velocity areas downstream, while longer patches reduce velocities within the vegetation

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but create high-velocity zones downstream. This study underscores the importance of considering vegetation layout based on Aspect Ratio (AR) for effective tsunami mitigation.

Drainage network and sediment management can effectively indicate the erosion in rural and urban drainage channels on tidal lowland [3]. However, the study suggests the lack of suitable erosion assessment models. Using the MIKE-11 2D program, different erosion scenarios were simulated, with scenario of 75% O&M model identified as being the most suitable. Numerical simulation methods were applied for hydraulic flushing in reservoir sediment management, covering drawdown flushing, pressure flushing, and turbidity current venting [4]. The study discusses empirical/analytical methods and 1D to 3D computational fluid dynamic models. Case studies illustrated model selection, domain determination, inputs, performance, and results comparison. The key findings include recommending 1D models for narrow reservoirs, 2D models for wide reservoirs or significant lateral changes, and 3D models for pressure flushing or near-field processes.

The performance of hydrological and hydrodynamic study was compared using SWAT and HEC-HMS models [5]. Both models were calibrated and validated for the period 2007–2014. The results showed satisfactory performance for both models, with SWAT capturing high flows more accurately and HEC-HMS performing better for medium flows. Both models accurately simulated low flows. SWAT outperformed HEC-HMS in seasonal flow simulations, making it accurate for wet and dry seasons. The critical hydraulic parameters (CHPs) downstream of the hydraulic structure were investigated using FLOW-3D numerical models [6]. The study identified significant parameters like velocity profiles, Froude number, and turbulent kinetic energy. The results show discrepancies from previous studies, with differences in hydraulic jumps (HJs) and sequent depths. The study suggests that the barrage efficiently holds HJs at investigated tailwater levels. The numerical model has been proven to be able to assess the behaviour of round buoyancy-driven particle clouds in still ambient conditions [7]. The results of the numerical models showed that the flow behaviour varied depending on particle buoyancy, indicating that the Boussinesq assumption is not fully suitable for such flow representation.

As observed by [3,8], the suspended sediment distribution can be represented using the Rouse model and Kundu and Ghoshal model for hyper-concentrated and diluted flows. Machine learning techniques, including XGBoost Classifier, Linear Regressor (Ridge), Linear Regressor (Bayesian), K Nearest Neighbours, Decision Tree Regressor, and Support Vector Machines (Regressor), were further applied to determine the relationship between different sediment and flow parameters.

Using cable flow–altering experimental approaches of the scour phenomenon, one can evaluate scour countermeasures [9]. It was observed that scour reduction increased with larger cable diameters and finer sediment sizes. Cables attenuated the flow within the scour holes, reducing the downflow and horseshoe vortices. Increasing the cable–pier diameter ratio further reduced the scour depth, especially for finer sediments. It was also found that cables mitigated downstream scour action and reduced the vortex shedding frequency. Experimental investigations demonstrated the effectiveness of riprap, submerged vanes, and the combination of the two in reducing scour around vertical walls and spill-through abutments under clear-water conditions [10]. Riprap proved more effective than submerged vanes alone, but the combination yielded the highest reduction in scour depth (up to 54% for vertical walls and 39% for spill-through abutments). Properly scaled riprap aprons also reduced the required riprap volume significantly. Submerged vanes improved the riprap stability and reduced edge failure, particularly with square-shaped riprap layers [11]. The effectiveness of roughened elements for mitigating bridge abutment scour were tested on rectangular abutments, with the optimal installation depth found to be 0.6–0.8 times the abutment length. Elements with a thickness and protrusion of 0.2 times the length exhibited the most effective protection, reducing the maximum scour depth by up to 32.8%.

Finally, this collective research sheds light on the complexities and possibilities inherent in managing and mitigating impacts of fluvial systems. Through a diverse array of research papers and methodologies, this RT explores current and emerging approaches aimed at enhancing the resilience of water infrastructures. Each selected contribution offers insights into innovative theories, cutting-edge technologies, and practical applications within their specific areas of study. Lastly, we extend our gratitude to all reviewers and authors whose invaluable contributions have enriched this RT.

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