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*Editorial*

# Research on Hydraulics and River Dynamics

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## 1. Introduction

River engineering is one of the most important subjects in hydraulic engineering. The main scientific fields that are necessary to understand the basic principles of river engineering include hydrology, hydraulics and geomorphology. Using hydrologic rainfall–runoff models, the river inflows originating from rainfall-induced overland flow can be calculated. In case of intense storms, the extreme situation of flood routing in rivers should be faced. Flood routing can be calculated using both hydrologic and hydraulic models. Hydraulic models are based on the water mass and momentum conservation equations, which are partial differential equations of a hyperbolic type and are solved using numerical methods, e.g., finite difference schemes. The assessment of the hydraulic resistance is a critical point in the hydraulic models.

Soil erosion products from the surrounding basins are transported from the overland flow into the rivers, and constitute the so-called wash load, which is transported in the rivers, in suspension. The riverbed can be eroded by the river flow, or suspended sediment can be deposited on the riverbed. A particularly practical case of bed erosion constitutes the local scour around or downstream of hydraulic structures, e.g., bridge piers or dams, respectively. Generally, the hydraulic structures, e.g., dams, lead to modifications to the hydraulic and geomorphologic regimes in rivers.

Therefore, the geomorphology of riverbeds is strongly affected by the phenomenon of sediment transport. Numerous computational models of bed load and total load have been developed. To consider sediment transport in rivers, the sediment continuity equation should be added to water mass and momentum conservation equations. Sediment transport is mainly influenced by unsteady turbulent flows, which constitute the normal physical condition in rivers. The formation of turbulence and the phenomenon of sediment transport are particularly noticeable in curved channels or river bends. In reservoirs and lakes, the hydraulic and geomorphologic conditions are particularly different from those that dominate in rivers.

In recent years, the flow over a rough bed channel subjected to downward seepage was investigated.

This Special Issue aims to exhibit scientific research on the themes mentioned above.

## 2. Overview of This Special Issue

This Special Issue includes nine original contributions focused on river hydraulics. Four of these resulted from cooperation between universities from different countries: (a) Russia and Poland [1], (b) Taiwan and the USA [2], (c) Iran and Italy [3], and (d) India and Italy [4]. The other contributions resulted from research carried out in universities from South Korea [5], Greece [6], China [7,8], and Japan [9].

The nine articles in this Special Issue can be divided into four categories: Category A: “Hydraulic resistance and sediment transport in rivers”; Category B: “Curved channels or river bends”; Category C: “Local scour around spur dikes and pile groups”; Category D: “Rough bed channels subjected to downward seepage”. Articles [1,5,6] belong to Category A; Articles [7–9] belong to Category B; Articles [2,3] belong to Category C; Article [4] belongs to Category D.



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The article by Gladkov et al. [1] deals with assessments of the hydraulic resistance of the river channel and improvements to the river sediment transport model in a simulation of riverbed transformation on the basis of previous research. To verify the sediment transport model, 296 field measurements of the Central-East European lowland rivers were used. The test calculations show that the modified van Rijn formula provides the best results of all the considered variants.

The article of Sidiropoulos et al. [6] deals with the applicability of the Meyer–Peter and Müller (MPM) bed load transport formula. The performance of the formula is examined based on data collected from a particular location of the Nestos River in Thrace, Greece, in a comparison to a proposed Enhanced MPM (EMPM) formula and two typical machine learning methods, namely, Random Forests (RF) and Gaussian Processes Regression (GPR). The EMPM formula presented a definitely improved performance in comparison to the original formula, which is also competitive with purely data-driven techniques and even superior in the case of smoothed data.

The article by Ahn et al. [5] analyzes a numerical simulation of open-channel turbulent flow over two-dimensional fixed dunes to reveal the effect of roughness on the dune bottom and determine the optimized combination of the turbulence scheme and the roughness height formula. The results of all cases calculated with OpenFOAM are compared with the laboratory experimental data for model validation.

In the study of Zhang et al. [7], the complex flow field in a 60$^{o}$ bend of a river with a groyne is experimentally examined, and the bed shear stress is estimated using the turbulent energy method (TKE method—Tubulent Kinetic Energy method), modified turbulent energy method (TKE–w′ method), Reynolds stress method (Reynolds method), and logarithmic law (log–law) method.

The aim of the study by Andriamboavonju et al. [9] is to experimentally investigate the bedrock incision under sediment bed load transport along curved channels by varying flow speed. Erosion by incision of the bedrock along uniformly curved channels was successfully simulated using the annular flume. The findings of this study reveal that the type of bedform has a more significant impact on bedrock incisions than rotation speed.

According to the article by Zhang et al. [8], laboratory flume experiments were implemented to better understand the influence of transition section configuration on the correlation of flow movement characteristics between the front and back bends of a continuous bend. The three-dimensional instantaneous velocity was measured by Acoustic Doppler Velocimeter (ADV). Through the analysis of circulation structure, circulation intensity and turbulent kinetic energy, the correlation of flow movement characteristics between the front and back bends in a continuous bend under different width/depth ratios of the transition section was studied.

Local scour is a common threat to structures such as bridge piers, abutments and dikes constructed on natural rivers. To reduce the risk of foundation failure, understanding local scour phenomenon around hydraulic structures is important [2]. In the study of Liao et al. [2], a repose angle formula and bed geometry adjustment mechanism are integrated into a 2D mobile-bed model to improve the numerical simulation of local scour holes around structures. A comparison of the calculated and measured bed variation data reveals that a numerical model involving the improvement technique can predict the geometry of local scour holes around spur dikes with reasonable accuracy and reliability.

The study of Daneshfaraz et al. [3] experimentally and numerically investigated the local scour around pile groups positioned upstream and downstream of a harvest pit. Both circular and hydrodynamic shaped piers were considered. Numerical modeling of local scouring around hydrodynamic and circular bridge pile groups was performed using a Computational Fluid Dynamics (CFD) model and Large Eddy Simulation (LES) turbulence model and van Rijn sedimentary model with FLOW-3D software.

The work of Sharma et al. [4] experimentally investigated the turbulent flow characteristics in developing and fully developed flows over a rough bed channel subjected to downward seepage. In concrete terms, the fluid structures in developing and developed wide-open-channel flows over a sandy bed are investigated in the present work. A series of experiments were carried out in a laboratory flume to investigate the fluid features of downward seepage. The streamwise and vertical velocities, as well as the Reynolds shear stress distributions in a developing flow and in a developed flow, were observed and studied in no-seepage and downward seepage conditions.

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