

Editorial

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Local scour is still a significant problem for authorities that manage in-channel structures; these can vary from road and railway bridges that cross river channels or floodplains, or bed sills used to limit channel erosion. Scour at piers and sills can occur rapidly and often during high flows in which real time inspection is not normally possible. The loss of stability of a sill or bridge pier due to local scour often leads to the destruction of structures such as bank protection works or a bridge structure. Many studies claim that the local scour during floods is the leading cause of failure for bridges crossing rivers. There is a need for the water engineering community to develop reliable, predictive methods for local scour depth and volume that can be utilised during the original design stage of any in-channel structure or a bridge that requires a pier for intermediate structural support, either in the channel or on the floodplain. Scour depth and volume predictors would allow designers to provide foundations for in-channel sills or bridge piers that could resist expected scour in flood event return periods. Currently scour depth and predictor relationships lack confidence due to their wide variability and significant uncertainty.

The development of reliable scour depth equations has been hampered by a number of issues: (i) the unsteady, three-dimensional (3D) pattern of sediment transport often develops in a complex manner; (ii) the local erosion/deposition rates within a scour hole are spatially variable and appear to depend not only on local sediment particle-size distribution but also the character of the moving bedload being supplied from the upstream river bed.

Traditionally researchers have used dimensional analysis to deduce relationships between important non-dimensional groups of relationships to estimate the characteristic geometric parameters of local scour holes, such as their maximum scour depth and volume. Such relationships need to be empirically calibrated, often using laboratory data and occasionally field data. The empirically derived regressions often ignore the complexity of heterogeneous grain-size distributions, flow alignment and the influence of the upstream sediment supply.

Owing to the complexity of the scouring processes, the calibration is often poor, especially if several data sets are used. The poor performance of current local scour depth and volume predictions has led to researchers modifying their

approach in order to provide the knowledge required to design safer in-channel structures and bridge piers. Some researchers have attempted to use more advanced calibration approaches to better calibrate non-dimensional relationships and reduce predictive uncertainty; other researchers have started to consider and develop different methods of physically protecting in-channel bridge piers from scour and then examining the performance of these physical measures against unprotected bridge piers. This special issue aims to contain studies that have followed both these approaches; better, more reliable calibration and better ways in which in-channel sills and bridge piers can be protected from local scour during high-flow events.

The work by Khan *et al.* (2018) has used more advanced calibration techniques based on genetic functions (GF) and claims to provide better predictive performance than conventional regression techniques or other artificial intelligence-based techniques. The GF have been used to develop relatively simple explicit functions that could be used in design. They tested their relationships for both clear and live bed scour using 125 field data, split into training and validation datasets. They demonstrated that their approach has better performance than previously published relationships on the field dataset, but a limited number of data had been used in the GF training.

The next paper by Ahmad *et al.* (2018) reports on a laboratory study that aimed to quantify the importance of flow orientation when considering local scour at long bridge piers. Their study showed that the equilibrium scour hole changed its shape, volume and depth as the flow orientation was changed. Several non-dimensional relationships were presented but these are limited to clear water and sub-critical conditions.

The final three papers examined a range of different types of structural devices to reduce the impact of local scour. Hajikandi and Golnabi (2018) report on laboratory tests in which model bridge piers have been modified using straight, Y- and T-shaped slots in order to change the near-bed flow field and so modify the shape and extent of the local equilibrium scour. They ran experiments in which equilibrium conditions were assumed to be attained and then the resulting 3D scour hole geometry was measured. Experimental data was presented to investigate the equilibrium scour shape of Y- and T-shaped slots in comparison with more commonly used

straight slots. The data showed that the straight slot and one of the Y-shaped slot configurations tested provided the highest levels in scour depth and volume reduction, clearly demonstrating that changing the internal pier structure so as to modify the local flow field can make a significant impact on the local scour pattern.

The final two papers examine the use of separate in-channel structures to reduce local scour at bridge piers and sills. Hamidifar *et al.* (2018) examine the effectiveness of the use of a bed sill and riprap to reduce the local scour depth downstream of a concrete apron on which high-Froude-number flows are present. Although the circumstances are quite specific to the geometry used, a clear demonstration is given of the effectiveness of these two engineering measures in reducing local scour. Ranjbar-Zahedani *et al.* (2018) argue that using scour countermeasures such as riprap and gabions is costly and time consuming. As an alternative, they proposed the use of small upstream flow-diversion structures (FDS) and tested these under clear-water conditions in the laboratory. Their data indicated equilibrium scour-depth reductions of around 40% when small FDS are used.

In summary, the papers in this themed issue address a number of current lines of investigation as the water engineering community struggles to provide better engineering tools to manage local scour in rivers. There are papers that examine

better calibration methods and the importance of flow alignment on the local scour processes. The other papers examine the effectiveness of additional engineering measures to deal with local scour.

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