Editorial
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Langeveld, Jeroen G.; Kapelan, Zoran; van der Werf, Job Augustijn

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Editorial: Advances in urban drainage research

Jeroen G. Langeveld[a,b,*], Zoran Kapelan[a] and Job Augustijn van der Werf[a]

[a] Department of Water Management, Delft University of Technology, Delft, The Netherlands
[b] Partners4UrbanWater, Nijmegen, The Netherlands
*Corresponding author. E-mail: j.g.langeveld@tudelft.nl; jeroen.langeveld@urbanwater.nl

The 16th International Conference on Urban Drainage (ICUD), supported by the IWA/IAHR joint committee on Urban Drainage, was held in Delft, the Netherlands, from 9 to 14 June 2024. The conference was attended by over 470 registered delegates from around 60 different countries who presented 360 extended abstracts and papers. The conference addressed a wide range of topics of direct interest to both academics and practitioners working in the field of urban drainage. The focus was on complex and interdisciplinary challenges in these systems related to management, sustainability, climate change adaptation, socio-economic and other aspects. Participants presented the latest advances and innovations in both fundamental and applied research within the broad urban drainage field. Selected conference papers have been invited for publication in the *Water Science and Technology* journal, among which are the nominees for the Poul Harremoës Award (https://iwaponline.com/pages/virtual_special_issue_poul_harremoes_award), the award for the best urban drainage paper by a young water professional (YWP).

One of the outcomes of the above conference is a position paper by van der Werf *et al.* (2025). This paper, coauthored by 34 YWPs, is a result of a year-long project with the aim of identifying research challenges for future sustainable development of urban drainage systems. This work highlighted the four key challenges: limited public visibility leading to resource constraints, insufficient collaboration across subfields, issues with data scarcity and data sharing, and geographical specificities. The authors emphasised the importance of raising public and political awareness regarding urban drainage system (UDS)'s vital role in climate adaptation and urban resilience, advocating for Blue-Green Infrastructure (BGI) and open data practices, the two topics that were addressed in many presentations at the ICUD.

The role of open data on combined sewer overflow (CSO) regulation was investigated by Schellart *et al.* (2025). They concluded that increasingly complex regulation goes hand in hand with limited compliance checking and opaque decision-making, whereas opening up relatively simplistic performance data has generated public and political discussion about urban drainage systems and the potential costs of improvements in water quality of the impacted surface water bodies. Making the CSO data open does, however, need to be done with due care, ensuring that the data are correct, easy to access and understand, while avoiding a blame culture.

To support the uptake of BGIs, several urban planning tools were presented at the ICUD 2024. Roozbahani *et al.* (2025) developed a tool to select an optimal combination of low impact development measures, including green roofs, rain barrels, bioretention cells, porous pavements and vegetated swales. The optimal selection was based on cost, performance and service benefits. For new urban developments, Amback *et al.* (2025) introduced a supportive tool to guide urban planning actions focused on effective urban drainage choices in a sustainable and resilient manner. The evaluation demonstrated success in flood mitigation, illustrating the potential for creating multifunctional landscapes that incorporate social and ecological functions into effective urban drainage projects.

The focus of many BGI applications has been the reduction of urban flooding risk. Many BGIs have been designed to mitigate flooding, with the reduction of urban heat stress as a side effect. BGIs can help reduce the urban heat stress as long as they are able to provide shade and cooling by evaporation. The latter, however, increases the urban water demand. Andrusenko *et al.* (2025) analysed the additional urban water demand of a range of BGIs at the household scale. They found that the urban water demand increases sharply if the aim is to provide maximum cooling by maximising the evaporation.

Machine learning and artificial intelligence have found widespread application within the urban drainage field, with automated assessment of CCTV images as a prominent example. Bhase *et al.* (2025) used machine learning to estimate water depths in gravity sewers based on CCTV data. CCTV surveyors record the water level during inspection, and deriving the water level from CCTV footage is not a straightforward task. They compared six machine learning methods for automated level estimation in sewer pipes and demonstrated good results with a combination of segmentation masks as input for a regression tree method. Another example of machine learning is given by Loots *et al.* (2025), who quantified urban land cover imperviousness as input for urban flood modelling in South Africa. They used satellite imagery and a land cover dataset with multiple built-up urban classes through remote sensing, machine learning and field verification. The high-quality input for the flood model improved the efficiency of parameter estimation for related modelling.

Performing research on emerging pollutants is still relatively costly due to high sampling and analysis costs, and subsequently, significant knowledge gaps remain with respect to pollutant loads and pathways. Benisch *et al.* (2025) presented the results of a monitoring campaign at two urban streams with multiple monitoring sites along an increased urban gradient. The number of detected compounds followed an increasing trend along the streams during baseflow and increased during storm events. The comparison between baseline samples and storm event samples showed that storm events cause a significant increase in the number of detected chemicals, as well as in their concentration and relative loads. No correlation was found between concentration levels and storm event characteristics, such as peak discharge, event duration, or event volume. Thiebault *et al.* (2025) assessed the occurrence of various types of drugs in a sedimentary archive cored in a sewer settling basin. The sediment archive allowed us to analyse the historical introduction of certain drugs and to estimate the drug uses in specific periods by back-calculating the concentration in the sediment to an apparent concentration in the wastewater.

The Poul Harremoës Award nominees presented high-quality research on three interesting topics.

The first nominee, Vincent Pons, presented the results of a study on the relevance of epistemic uncertainty when addressing modelling uncertainty for pollutants of emerging concern (Pons *et al.* 2024). They suggested a paradigm shift in the current pollutant modelling approaches by adding a term explicitly accounting for epistemic uncertainties. In a proof-of-concept, they used this approach to investigate the impact of epistemic uncertainty in the fluctuation of pollutants during wet-weather discharge (input information) on the distribution of mass of pollutants (output distributions). They found that the range of variability negatively impacts the tail of output distributions. The second nominee, Manuel Reguiro-Picallo, revitalised the research on sewer sediments by introducing a temperature-based method to monitor the development of a sediment bed based on the propagation of temperature variations of the sewage into the sediment. Regueiro-Picallo *et al.* (2024) analysed the influence of the flow conditions on heat-transfer processes at the water–sediment interface during dry weather flow conditions. A depth estimation accuracy of ± 7 mm was achieved. The results confirm the ability of using temperature sensors to monitor sediment build-up in sewers under dry weather conditions, without the need for flow monitoring. Finally, the winner, Travis Dantzer, presented the results of a research project on real-time control for UDS. Dantzer & Kerkez (2024) developed an automated method for generating tunable linear feedback controllers that require only system response data. The controller design consists of three main steps: (1) estimating the network connectivity using tools for causal inference, (2) identifying a linear, time-invariant (LTI) dynamical system that approximates the network and (3) designing and tuning a feedback controller based on the LTI urban drainage system approximation. The results suggest that the system knowledge required for generating effective, safe and tunable controllers for UDS is surprisingly basic. This method allows near-turnkey synthesis of controllers solely from sensor data or reduction of process-based models.

The papers featured in this special issue represent only a sample of a lot of good work that was presented at ICUD 2024 and that has been going on in the field of urban drainage. Finally, we would like to thank all the reviewers for their valuable feedback provided during the peer-review process. We would also like to thank IWA Publishing for providing the opportunity to publish this special issue, which clearly demonstrates that addressing the complex challenges in urban drainage requires an increasingly interdisciplinary-based approach. This approach is already used by the urban drainage community, and this trend is likely to grow in the future.

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