# Session J08 – Invited speaker

# Informed performance assessment of water resources systems under uncertainty by considering trade-offs between performance and risk appetite

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**Abstract:** The effective assessment of water resources system performance is fundamental for the sustainable development of our society. This task is challenging due to uncertain conditions such as natural variability in system inputs, which can significantly affect system performance. Historically, this challenge has been addressed by using a single critical hydrological design condition. This allows the comparison of different solutions such as infrastructure plans and operational strategies for water resources systems under these critical conditions. However, this approach relies on a subjective selection of which hydrological conditions are considered "critical" *a priori*. To address this limitation, a range of hydrological conditions can be explicitly considered, representing the likelihood of potential future conditions. Typically, the resulting simulations are summarised using a single representative performance value, for example, the mean (Wu et al. 2022) or worst-case value (Giuliani et al. 2018). However, this selection relies on an implicit assumption of a particular risk appetite *a priori* (e.g., the worst-case value relates to the lowest risk appetite while the mean relates to a higher level of risk appetite), which relates to human-induced uncertainty (Wu et al. 2025). This prohibits explicit consideration of the trade-offs between system performance and risk appetite, reducing confidence in decision-making.

To address this issue, this study proposes a trade-off-based approach that removes the need to pre-select a single critical condition or performance value based on a particular risk appetite. Instead, we propose using trade-off curves between performance and risk appetite without placing any restrictions on risk appetites *a priori*. To demonstrate the benefits of our proposed approach, a reservoir management problem in China is used as the case study. Results indicate that our approach offers several key advantages: (1) it enables an explicit comparison of different solutions across the whole range of risk appetites, revealing whether one solution dominates another or whether the preferable solution is dependent on risk appetite; (2) it supports the selection of an appropriate level of risk appetite informed by the nature of the trade-off curve, such as identifying regions where there are significant increases in performance for relatively small changes in risk appetite; and (3) it offers a more formal consideration of risk through the joint evaluation of likelihood (risk appetite) and consequence (performance) with a single risk metric, if required.

Therefore, the proposed trade-off-based approach allows for the explicit assessment of system performance across the full spectrum of risk appetites, enabling more informed decisions. This presents a paradigm shift for the identification and evaluation of options for the management of water resources systems, analogous to the evolution from single-objective optimization to genuine multi-objective optimization, where trade-offs among competing objectives are revealed without requiring pre-defined subjective weightings. Furthermore, this approach is broadly applicable to other types of human-induced uncertainty such as conflicting stakeholder interests.

## REFERENCES

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