SESSION DESCRIPTION

ID: S5

From mountain water towers to urban rivers: managing water systems as social-ecological-technological systems for climate resilience

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Abstract:

Water systems are increasingly recognized as social–ecological–technological systems (SETS), where ecological processes, technological infrastructure, and social governance interact in shaping water security. Climate change, with its intensifying extremes—droughts, floods, glacier melt, and shifting precipitation—adds pressure to already strained water systems. At the same time, urban growth, industrial demand, and lifestyle-driven consumption accelerate scarcity and generate competing claims across scales, from mountain "water towers" to densely populated urban riverscapes. This creates a landscape of persistent trade-offs: hydropower development may secure energy but degrade ecosystems; irrigation expansion may enhance food production but increase conflict and stress on groundwater. Strategic responses must therefore embrace the complexity of SETS, treating water not only as a physical resource

but as a nexus of ecosystems, technology, and governance. Water security is inherently political, with hydro-hegemony shaping access, control, and equity across scales.

Nature-based Solutions (NbS) offer a critical pathway within this framework. By leveraging natural processes, they deliver benefits across SETS dimensions: ecological (restoring riparian zones, recharging aquifers), technological (enhancing urban stormwater management), and social (providing co-benefits for health, recreation, and cultural values). Their strength lies in their multi-functionality—addressing climate resilience while advancing biodiversity and social well-being. Yet, NbS also have limitations: outcomes are often less predictable than engineered interventions, and impacts emerge over longer time horizons. This underscores the importance of integrating NbS into governance systems rather than treating them as isolated projects.

A strategic watershed perspective provides the necessary scale for such integration. Linking upstream mountain ecosystems with downstream rivers and urban waterscapes allows for holistic governance that reflects the interconnectedness of SETS. NbS such as forest conservation in mountain water towers, wetland restoration in river basins, and green infrastructure in cities, when strategically aligned, can together enhance hydrological resilience, reduce disaster risk, and strengthen social–ecological equity.

This session will reflect on how NbS can be leveraged to operationalize SETS approaches, demonstrating that water resilience depends not on technological fixes or ecological restoration alone, but on their integration with inclusive governance. By applying an integrated watershed perspective grounded in a SETS approach, we aim to highlight how mountain, river, and urban systems can be reconnected in ways that align climate adaptation with development goals, reduce trade-offs, and contribute to a more resilient water future.

Key themes include:

- Socio-hydrological models revealing feedback between human activities and infrastructures, ecosystems, and water resources.
- Climate change impacts on hydrology and modelling to anticipate future conditions.
- Participatory planning that integrates ecological, technological, and social knowledge.
- Nature-based solutions for enhancing water security and resilience.
- Transboundary governance and upstream–downstream interactions.

Goals and objectives of the session:

The session aims to deepen understanding of adaptive water governance, identify conditions for integrating NBS within SETS, and highlight pathways for resilient, sustainable, and secure water systems across scales.

Some of the questions that we would like to address in this session are:

- In what ways can water security be effectively operationalized across interconnected mountain-to-urban (ridge to reef) systems through a SETS lens, and which actors are most pivotal in this process?
- How can socio-hydrological modelling and ecosystem service assessments be harnessed to inform and strengthen decision-making?
- What institutional reforms or planning innovations are required to embed Nature-based Solutions within SETS for enhanced climate resilience?
- How do policy frameworks, governance arrangements, and market dynamics facilitate—or hinder—the adoption and scaling of Nature-based Solutions?

Planned output / Deliverables:

Draft conceptual framework for SETS-based water management integrating NBS across scales.
In addition, depending on the session participants' interests and the quality of contributions, we could explore the possibility of a collaborative paper, based on the session conclusions and a meta-analysis of evidence gathered therein. The conveners are planning a Special Issue to gather expanded contributions and outcomes from the session; interested participants will be invited to contribute.

Session format:
This will be a standard session featuring up to 10 presentations, each allocated 10 minutes for presentation and 2 minutes for questions and discussion. The session will open with a brief introductory overview (5 minutes) to frame the objectives and conceptual focus on SETS-based water management and Nature-based Solutions (NbS), and will possibly conclude with a moderated synthesis discussion (15 minutes) to draw cross-cutting insights and identify opportunities for collaboration. The total estimated duration is approximately 2 hours.

Voluntary contributions accepted:
Yes, I allow any abstract to be submitted to my session for review

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