IAHR 2027 World Congress Topics

Pillar A: Climate Change Adaptation and Mitigation

Theme A-1: Climate Change Adaptation

Sub-themes *(keywords)*

A-1.1 Climate Adaptation: Decision-Making Under Uncertainty *(Deep Uncertainty, Robust Decision-Making (RDM), Adaptive Pathways)*
A-1.2 Systemic Climate Risk: Multi-Hazards and Cascading Impacts *(Cascading Climate Risks, Multi-Hazard Risk Assessment, Systemic Adaptation)*
A-1.3 Decision Support under Climate Uncertainty *(Deep Uncertainty, Robust Decision-Making, Decision-Support Tools)*
A-1.4 Resilient Water Systems: Infrastructure and Irrigation Adaptation *(Irrigation Resilience, Water Scarcity Management, Salinity Control)*
A-1.5 Hydrological Extremes, Floods and Basin-Scale Adaptation *(Hydrological Extremes, Basin-Scale Adaptation, Flood and Drought Risk)*

Special Sessions:
SS-06 Integrated Flood Risk Management from Science to Practice *(Flood Risk Assessment, Hazard Mapping, Risk Governance, Mitigation Strategies, Adaptive Management, Climate Change Adaption)*
SS-08 Digital Twin of Detailed River Basin Morphology and Hydraulic Structures for Advanced Basin Management *(Digital Twin, Flood, Inundation, River Basin, Hydraulic Structures)*
SS-12 Advances and Guidelines for Water Resources Management: Adaptation Under Evolving Climate *(Climate-sensitive design, Adaptation, Guidelines, Decision making under change)*
SS-27 Buoyancy-Driven Flows *(Gravity currents, Internal waves, Atmospheric flows, Oceanic flows, Natural ventilation)*
SS-32 Integrated Water Resilience in Arid Regions: Diversified Portfolios, Digital Systems, and Adaptive Governance *(Integrated Water Resilience, Non-Conventional Water Portfolios, Water-Energy-Environment Trade-offs, Brine Resource Recovery, Adaptive Governance, Digital Water Systems)*
SS-38 Transboundary Rivers and Water Security under a Changing Climate: The Role of Water Information System? *(Transboundary Water Resources, Water Security, Climate Change, Hydrodynamic Modeling, Sediment and Water Quality, Water Information System)*

Theme A-2: Water and Nature

Sub-themes *(keywords)*

A-2.1 Nature-Based Solutions for Flooding, Stormwater and Water Quality *(Nature-Based Solutions (NbS), Hybrid Green–Gray Infrastructure, Stormwater Quality Management)*
A-2.2 Ecohydraulics and Biophysical Interactions in Aquatic Systems *(Ecohydraulics, Biophysical Interactions, Aquatic Ecosystems)*
A-2.3 River, Catchment and Urban Nature-Based Solutions *(Nature-Based Solutions, Catchment Restoration, Urban Water Resilience)*
A-2.4 Coastal, Estuarine and Riparian Nature-Based Solutions *(Coastal Nature-Based Solutions, Estuarine Resilience, Riparian Restoration)*
A-2.5 Digital, AI-Based and Data-Driven Ecohydraulics *(Digital Ecohydraulics, Artificial Intelligence, Data-Driven Modelling)*

Special Sessions:
SS-01 Ecohydraulics: Biophysical Interactions in Natural and Engineered Aquatic Systems *(Ecohydraulics, Flow–vegetation–sediment feedbacks, Restoration & climate resilience)*
SS-03 AI and Data-Driven Ecohydraulics: Monitoring, Modelling, and Design *(Ecohydraulics, Intelligent Environmental Sensing, Artificial Intelligence, Machine Learning)*
SS-14 Nature-Based Solutions for Upstream Catchments and Small Streams *(Nature-based Solutions, Ecohydraulics, Upstream catchments and small streams)*
SS-15 Nature-Based Solutions for Urban Areas *(Nature-based Solutions, Ecohydraulics, Urban areas)*

SS-16 Nature-Based Solutions for Large Rivers *(Nature-based Solutions, Ecohydraulics, Large rivers)*
SS-17 Nature-Based Solutions for Coasts and Estuaries *(Nature-based Solutions, Ecohydraulics, Estuaries and coasts)*

Theme A-3: Hydro-Environment Engineering and Society

Sub-themes *(keywords)*

A-3.1 Sustainable Hydropower and River Ecosystems *(Environmental Flows, Hydropeaking Impacts, River Connectivity)*
A-3.2 Innovation in Hydro-Environmental Education and Training *(AI-Enhanced Learning, Digital Twin Training, Immersive Experiential Education)*
A-3.3 Water and Hydro-Environment History and Heritage *(Historical hydraulic infrastructure, Water heritage conservation, History of hydro-environment management)*
A-3.4 Socio-Ecological Sustainability Transitions and Governance *(Socio-Ecological Transitions, Systems Innovation, Data-Enabled Governance)*
A-3.5 Climate Adaptation Governance and Finance *(Adaptation Governance, Climate Finance, Implementation Pathways)*

Special Sessions:

SS-33 Binding Without Erasure: River Monitoring, Plural Evidence and Environmental Obligation in Transboundary Governance *(River Governance, Environmental Evidence, Adaptive Water Resources Management)*

Pillar B: Water Engineering and Energy, Ecological and Digital Transition

Theme B-1: Hydropower and water related renewable energy

Sub-themes *(keywords)*

B-1.1 Reservoir Renewable Energy Systems *(Floating Photovoltaics (FPV), Hydropower Flexibility, Structural Reliability)*
B-1.2 Marine & Offshore Renewable Energy Systems *(Offshore Renewable Energy, Hybrid Systems & Grid Integration, Resilience, Monitoring & Environmental Impacts)*
B-1.3 Hydropower and Transient Flow Phenomena: Modelling, Monitoring and Mitigation *(Water Hammer Mitigation, Hybrid Physics–AI Modelling, Digital Twin Monitoring)*
B-1.4 Water–Energy Nexus and Integrated Water Infrastructure *(Water–Energy Nexus, Hydropower–Desalination Integration, Integrated Water Infrastructure)*
B-1.5 Digital Hydropower and Smart Asset Management *(Hydropower Digital Twins, Asset Management, Smart Hydropower Operations)*

Special Sessions:

SS-44 Advancing Hydropower through Multidisciplinary Research for Resilient Water and Energy Systems *(Hydropower Flexibility, Reservoir Operations, Digital Hydropower, Water–Energy Nexus, Climate Adaptation, Environmental Sustainability)*

Theme B-2: Water engineering for inland water bodies

Sub-themes *(keywords)*

B-2.1 Monitoring, Remote Sensing and Digital Observation of Inland Waters *(Inland Water Monitoring, Remote Sensing, Digital Observation)*
B-2.2 Hydrodynamics, Mixing and Environmental Fluid Processes in Inland Waters *(Environmental Fluid Mechanics, Mixing and Transport, Inland Water Hydrodynamics)*
B-2.3 River Morphodynamics, Sediment Transport and River Training *(River Morphodynamics, Sediment Transport, River Training)*

B-2.4 Extreme River Flows, Floods and Droughts in Inland Systems *(Hydrological Extremes, Floods and Droughts, River Flow Monitoring)*
B-2.5 Water Quality, Pollution and Ecosystem Health in Rivers and Lakes *(Inland Water Quality, Aquatic Pollution, Ecosystem Health)*

Special Sessions:
SS-05 Advances in Monitoring Extreme River Flows Across the Hydrologic Spectrum *(Advanced streamflow monitoring methods, Drought, Flood)*
SS-09 Ice Processes in Inland and Transitional Waters *(River and lake ice, Ice dynamics, Climate variability)*
SS-10 Sediment Transport and River Training in Alluvial Rivers: Current Understanding and Open Challenges *(Alluvial River hydraulics, Turbulence monitoring and modelling, Scour protection and river training works)*
SS-21 Plastic Transport in Rivers: Connecting Empiricism and Modelling *(Microplastics and Litter, Multiphase flow, Numerical modeling)*
SS-26 Advances in Environmental Fluid Mechanics *(Fluid Mechanics, Modelling, Numerics)*
SS-31 High-Fidelity 3D CFD and CFD–DEM Methods for Predictive Bed Morphodynamics *(High-Fidelity 3D CFD, CFD–DEM and Multiphase Sediment Modelling, Morphodynamic Model Verification and Validation)*
SS-40 Dam Reservoir Sedimentation: Challenges and Management Solutions *(Reservoir sedimentation, Sustainable management and operation, Monitoring, Numerical modelling, Case studies)*

Theme B-3: Water engineering and society

Sub-themes *(keywords)*

B-3.1 Water Justice, Equity and Affordability in Water Infrastructure *(Water Justice, Equity in Water Services, Affordability & Tariff Design)*
B-3.2 Participatory Water Governance and Citizen Engagement *(Participatory Governance, Co-production, Citizen Science)*
B-3.3 Climate-Resilient Water Services and Social Vulnerability *(Climate-Resilient Water Services, Social Vulnerability Assessment, Adaptation Strategies)*
B-3.4 Responsible Digital Water: Ethics, Governance and Security *(Responsible AI, Data Privacy & Cybersecurity, AI Governance)*
B-3.5 Blue Economy, Financing and Economics for Sustainable Water Systems *(Sustainable Water Finance, Cost-Benefit Analysis, Life-Cycle Costing)*

Special Sessions:
SS-25 Water Security in Latin America: From Local Experiences to the Construction of a Regional Metric *(Water Security Index, Regional / Transboundary Water Assessment, Cooperative Governance & Coordinated Decision-Making)*
SS-42 Co-Evolving Human–Water Systems: From Socio-Hydrological Science to Policy and Community Decisions *(Socio-Hydrology, Coupled Human–Water Systems, Human–Water Feedback, Participatory Modeling, Water Governance)*

Theme B-4: Irrigation, drainage and pollution control

Sub-themes *(keywords)*

B-4.1 Smart Irrigation and Precision Agriculture Water Management *(AI-Driven Irrigation Scheduling, IoT Soil–Plant Sensing, Precision Fertigation)*
B-4.2 Agricultural Drainage and Edge-of-Field Water Quality Protection *(Controlled Drainage, Water Table Management, Drainage Water Recycling)*
B-4.3 Water Reuse for Irrigation: Safety and Water Quality *(Reclaimed Water Irrigation, Micropollutants & AMR, Quantitative Microbial Risk Assessment (QMRA))*
B-4.4 Digital Groundwater Monitoring and Remediation *(Groundwater Digital Twins, AI-Enabled Monitoring, Data-Driven Remediation)*
B-4.5 Emerging Contaminants in Agro-Water Systems *(PFAS in Agro-Water Systems, Microplastics Fate and Transport, Novel Remediation Technologies)*

Special Sessions:

SS-11 Advances in Marine and Freshwater Outfall Systems: Innovations in Modelling, Design, and Environmental Protection *(Outfall systems, Climate change adaptation, Digital transformation)*

SS-43 Karst Coastal Aquifers under Pressure: Monitoring, Digital Tools and Management of Seawater Intrusion in the Mediterranean Basin *(Coastal Karst Aquifers, Seawater Intrusion, Groundwater Monitoring, Hydrogeological Modelling, Submarine Groundwater Discharge, Adaptive Groundwater Management)*

Theme B-5: Water engineering for water infrastructures

Sub-themes *(keywords)*

B-5.1 Smart Water Infrastructure and Digital Transformation *(Smart Water Digital Twins, AI-Enabled Infrastructure Monitoring, Predictive Asset Management)*

B-5.2 Reservoir and Dam Management under Climate Change *(Forecast-Informed Reservoir Operations (FIRO), Dam Digital Twins, Sediment–Ecosystem)*

B-5.3 Ageing Infrastructure, Rehabilitation and Risk-Based Asset Management *(Ageing Infrastructure, Infrastructure Rehabilitation, Risk-Based Asset Management)*

B-5.4 Hydraulic Structures: Design, Performance and Safety *(Hydraulic Structures, Performance Assessment, Infrastructure Safety)*

B-5.5 Water Allocation, System Operations and Infrastructure Reliability *(Water Allocation, System Operations, Infrastructure Reliability)*

Special Sessions:

SS-04 Transient Flows in Hydraulic Systems *(Hydraulic transients, Dam break, Tidal bores, Tsunamis)*

SS-13 Scour around Hydraulic and Coastal Structures *(Hydrodynamic-structure interaction, Foundation design, Scour protection)*

SS-19 Hydraulic Challenges of Ageing Infrastructure *(Ageing Infrastructure, Climate change adaptation, Structural health monitoring)*

SS-20 Fundamental Flow Hydraulics at Hydraulic Structures *(Hydraulic Design, Numerical Modelling, Laboratory Experiments)*

SS-28 Digital Empowerment of Whole-Process Water Allocation *(Water Allocation, Digital Twin, Artificial Intelligence)*

SS-37 Smoothed Particle Hydrodynamics (SPH) and Its Applications in Hydraulic Engineering *(Smoothed Particle Hydrodynamics; free-surface hydraulics; fluid-structure interaction)*

Pillar C: Improving Resilience Against Water Hazards and Disasters

Theme C-1: Climate Change Mitigation and hydraulic-infrastructure resilience

Sub-themes *(keywords)*

C-1.1 Digital Innovation for Sustainable Water Systems *(Low-Carbon Digital Twins, AI-Driven Operations, Operational Decision Support)*

C-1.2 Net-Zero Strategies for Water Utilities *(Net-Zero Accounting, Decarbonization Roadmaps, Best-Practice Frameworks)*

C-1.3 Circular Economy and Resource Recovery in Wastewater Systems *(Water Resource Recovery, Circular Economy, WRRF Transformation)*

C-1.4 Climate-Resilient Management of Surface Water and River Basins *(Climate-Resilient Operations, Storage & Allocation, Integrated Basin Management)*

C-1.5 Early Warning, Flash Floods and Hydraulic Infrastructure Safety *(Early Warning Systems, Flash Flood Risk, Hydraulic Infrastructure Safety)*

Special Sessions:

SS-18 Digital Ecohydraulics for River Resilience: Integrating Remote Sensing, Machine Learning, and Advanced Modelling *(Digital Ecohydraulics, Remote Sensing, Machine Learning, Hydromorphological Modelling)*

SS-22 Resilience against climate change in the Asia-Pacific Region *(Climate trends, Nature-based solutions and engineered strategies, Community-led resilience initiatives)*
SS-23 Intelligent Early Warning Systems: Machine Learning Integration for Hydrometeorological and Tsunami Hazard Management *(Physics-Informed Neural Networks (PINNs), Intelligent Early Warning Systems (EWS), Responsible AI (bias & data deserts))*
SS-29 Digital-Intelligent Empowerment of Flash Flood Disaster Prevention *(Flash Flood Early Warning, Digital Twin, AI-based Hydrological Simulation)*
SS-30 Debris and Driftwood Accumulation at Hydraulic Structures *(Driftwood and floating debris, Hydraulic structures, Flood resilience and debris management)*
SS-35 AI-Enabled Multi-Hazard Assessment for Water Systems and Water-Related Risk Reduction *(Compound and cascading hazards, Water infrastructure vulnerability, Cross-domain data interoperability)*
SS-39 From Hydraulic Processes to Resilient Bridge Management under Hydrological Extremes *(Bridge; Hydraulics; hydrodynamics; Scour; Climate change; Risk)*

Theme C-2: Urban water cycle, industrial water and water treatment

Sub-themes *(keywords)*

C-2.1 Urban Water Resilience and Sustainable Drainage *(Blue–Green Infrastructure (BGI), Sponge City Design, Hybrid Urban Drainage)*
C-2.2 Emerging Contaminants and Risk Mitigation in Water Treatment *(Microplastics Removal, Plastisphere Microbiome, Antimicrobial Resistance (AMR))*
C-2.3 Water Quality Dynamics, Modelling and Control in Urban Water Networks *(Water Quality Modelling, Urban Water Networks, Digital Twins and AI-enabled Control)*
C-2.4 Next-Generation Asset Management for Urban Water Networks *(Predictive Asset Management, Smart Water Networks, Condition Monitoring)*
C-2.5 Water Loss Management in Distribution Networks *(Non-Revenue Water (NRW), Leak Detection & Localization, Pressure Management)*

Special Sessions:
SS-07 Theory and Applications of Smart Water Networks *(Smart Water Networks, Autonomous & adaptive control, AI–Hydraulics Verification & Safety)*
SS-24 From Scarcity to Smart Management: Solutions for Intermittent Water Supply Systems *(Intermittent Water Supply (IWS), Digital Transformation (Sensors & IoT), Intermittence Modelling & Management)*
SS-34 Cities Don't Fail in Silos: Governing Water-Energy-Cooling Dependencies for Metropolitan Resilience *(Urban water resilience, Cascading infrastructure risk, Water-energy nexus)*
SS-36 Digital Transition in Water Utilities: Governance, Organizational Change and Operational Value *(Digital Transition, Digital Water Strategy, Governance and Accountability of Digital Decisions)*

Theme C-3: Deltas, coastal and maritime engineering

Sub-themes *(keywords)*

C-3.1 Advanced Coastal Modelling, Digital Twins and Hazard Forecasting *(Coastal Modelling, Digital Twins, Hazard Forecasting)*
C-3.2 Advanced Marine Biodiversity Monitoring and Assessment *(Environmental DNA (eDNA), Autonomous Sampling Platforms, AI Ecological Assessment)*
C-3.3 Coastal Protection, Design and Management *(Coastal Defense Performance, Design Standards, Scaling & Validation)*
C-3.4 Sustainable and Resilient Ports and Maritime Systems *(Shore Power (Cold Ironing), Green Shipping Corridors, Port Energy Hubs)*
C-3.5 Delta and Estuarine Resilience: Compound Flood Risk, Sediment Dynamics and River–Coast Connectivity *(Compound Flood Risk, Sediment Dynamics, River–Coast Connectivity)*

Special Sessions:
SS-02 Ecohydraulics in Coastal and Riparian Zones as Critical Interfaces under Change *(Coastal zone, Riparian zone, Transitional ecosystem, Ecohydraulics process)*

SS-41 Integrated Observations and Modelling of Estuarine and Lagoon Dynamics *(Estuaries and lagoons, hydro-morphodynamics, stratification and exchange flows, biogeochemical transport, in-situ observations, numerical modeling and forecasting)*

Details of Special Sessions

Pillar A: Climate Change Adaptation and Mitigation

Theme A-1: Climate Change Adaptation

Special Sessions:

SS-06 Integrated Flood Risk Management from Science to Practice

Flood risk is intensifying globally because of interacting drivers, including anthropogenic climate change, demographic growth, urbanization, land-use transformation, and the deterioration of critical infrastructure. The increasing concentration of population and economic assets in flood-prone river basins and coastal zones amplifies exposure and systemic vulnerability. Consequently, flood risk management has evolved from a predominantly hazard-oriented paradigm toward a risk-based framework integrating hazard, exposure, and vulnerability components. In many regions, however, limited scientific, technical, and institutional capacities constrain the effective design and implementation of mitigation measures. Integrated flood risk management (IFRM) requires interdisciplinary approaches that couple hydrological and hydraulic process understanding with socio-economic analysis, governance structures, and stakeholder engagement. The operationalization of such approaches necessitates robust modelling frameworks, reliable data infrastructures, and decision-support systems capable of supporting both structural and non-structural measures. Despite substantial methodological advances, particularly in high-resolution hydrodynamic modelling, remote sensing, real-time monitoring, and digital communication technologies, the transfer of scientific knowledge into practice remains inconsistent. Barriers include fragmented information pathways, institutional compartmentalization, financial constraints, regulatory complexity, and short-term policy cycles. Addressing these constraints is essential to enhance adaptive capacity, improve emergency response, and strengthen long-term resilience. This session aims to advance the science –practice interface in IFRM. Contributions are invited that: 1. Present critical evaluations of implemented flood risk management tools (e.g., hydrodynamic models, probabilistic risk assessment frameworks), including lessons learned; 2. Analyse technical, institutional, and socio-economic barriers to technology adoption; 3. Demonstrate rapid, remote, and sensor-based data acquisition and integration during flood events; 4. Illustrate multidisciplinary and participatory methodologies in integrated flood risk assessment and governance; 5. Present practical methods and application cases for enhancing flood resilience.

Keywords: Flood Risk Assessment, Hazard Mapping, Risk Governance, Mitigation Strategies, Adaptive Management, Climate Change Adaption

SS-08 Digital Twin of Detailed River Basin Morphology and Hydraulic Structures for Advanced Basin Management

Recent advances in digital twin technologies are transforming river basin management by enabling integrated, data-driven understanding of complex hydrological and hydraulic processes. In particular, the representation of detailed river basin morphologies and hydraulic structures—such as levees, channels, gates, bridges, and urban drainage systems—is essential for improving flood and inundation risk assessment, planning, and decision-making. This session focuses on state-of-the-art methodologies and applications of digital twins for river basins, emphasizing high-resolution morphological data, structural information, and their coupling with hydraulic and flood inundation models. Contributions are invited that address the generation, integration, and utilization of detailed digital representations of river basins, including automated model construction from heterogeneous geospatial data, real-time or near-real-time simulation, and scenario-based analysis for flood management. Topics of interest include, but are not limited to: (i) digital twin frameworks for river basin–scale flood and inundation modeling; (ii) integration of terrain, river morphology, and hydraulic structures into simulation-ready models; (iii) coupling of digital twins with observation data, forecasts, and decision-support systems; and (iv) practical applications for basin-wide risk reduction, infrastructure management, and resilient river basin planning. By bringing together researchers and practitioners from hydrology, hydraulics, geospatial engineering, and infrastructure management, this session aims to highlight emerging best practices and future challenges in digital twin–based river basin management, contributing to more effective and resilient flood risk governance.

Keywords: Digital Twin, Flood, Inundation, River Basin, Hydraulic Structures

SS-12 Advances and Guidelines for Water Resources Management: Adaptation Under Evolving Climate

This session addresses the critical need for robust water resources management guidelines in the face of climate change and variability, focusing on the transition from traditional methodologies to adaptive frameworks. By exploring hydrologic design under nonstationary climate, the proposal moves beyond static historical data to incorporate the complexities of climate change projections and uncertainty into infrastructure planning. A balanced portfolio of interventions will be discussed, ranging from hard-engineered sea level rise solutions for coastal protection to the integration of nature-based solutions that leverage ecosystem services for flood mitigation and water quality. Participants will gain a comprehensive understanding of how to bridge the gap between high-level climate data and practical adaptation strategies, ensuring that water systems remain resilient and functional under an evolving climate.

Keywords: Climate-sensitive design, Adaptation, Guidelines, Decision making under change

SS-27 Buoyancy-Driven Flows

The session is open to contributions from all types of natural and engineered flows that involve buoyancy as a main driving force. This session will cover all environmental, industrial, and geophysical flow problems spanning both aquatic, terrestrial, and atmospheric environments, where density and thermal gradients can drive transport and mixing dynamics. This special session welcomes abstracts that focus on riverine, estuarine, maritime, glacial, atmospheric, oceanic, and volcanic systems, in which density differences are initiated by variations in salinity, temperature, and/or suspended particulate loads. Some example areas include (but are not exclusive to): gravity currents (e.g. freshwater fronts, deep ocean outflows, sea-breeze fronts, salt wedge propagation in estuaries, submarine turbidity currents); turbulent buoyant jets and plumes (e.g. marine wastewater discharges, industrial emissions, volcanic plume dynamics); terrestrial flow hazards (e.g. pyroclastic flows, lahars, avalanches); buoyancy-driven exchange flows (e.g. river-sea connectivity, oceanic/sea straits, ventilation in buildings); internal waves; stratified turbulence (e.g. interfacial mixing, shear-driven instabilities); and convection processes (e.g. atmospheric and oceanic circulations; glacier-fjord interactions). Contributions can be either on fundamental or applied research topics in these or related areas, and can present findings from experimental, analytical, computational and/or field studies. We strongly welcome and encourage student and early career participation in this special session.

Keywords: Gravity currents, Internal waves, Atmospheric flows, Oceanic flows, Natural ventilation

SS-32 Integrated Water Resilience in Arid Regions: Diversified Portfolios, Digital Systems, and Adaptive Governance

This special session addresses how arid and water-scarce regions can design and implement integrated water-resilience portfolios that combine multiple supply sources, digital systems, environmental safeguards, and adaptive governance. Rather than treating desalination, wastewater reuse, smart networks, brine management, resource recovery, or decentralized supply as stand-alone solutions, contributions must examine how two or more of these elements interact within coherent resilience strategies. The session will invite comparative evidence and case studies from the GCC, wider Middle East, North Africa, and other arid contexts globally. Priority themes include diversification across conventional and non-conventional sources; water –energy–environment trade-offs; renewable and high-efficiency desalination; wastewater reuse and circularity; brine resource recovery; digital monitoring and network intelligence as enabling infrastructure; decentralized supply; and institutional mechanisms for adaptive implementation. Kuwait will serve as one comparative case rather than the session's defining focus. By integrating engineering, environmental, economic, digital, and governance perspectives, the session will identify transferable design principles and implementation pathways for resilient water systems under severe scarcity, climatic uncertainty, and rising demand.

Keywords: Integrated Water Resilience, Non-Conventional Water Portfolios, Water-Energy-Environment Trade-offs, Brine Resource Recovery, Adaptive Governance, Digital Water Systems

SS-38 Transboundary Rivers and Water Security under a Changing Climate: The Role of Water Information System?

Transboundary rivers are essential sources of water for drinking, agriculture, industry, hydropower, navigation, and ecosystems. Their sustainable management is an increasingly important scientific, engineering, environmental, and societal challenge. Climate change is altering the hydrological and hydraulic characteristics of transboundary river systems, affecting river discharge, water availability, flood and drought risks, sediment transport, water quality, and ecosystem functions. At the same time, population growth, urbanization, agricultural expansion, water diversion, reservoir construction, and hydropower development are substantially modifying natural river

processes. These challenges are particularly complex because interventions in one part of a river basin can generate physical and environmental consequences across national boundaries. Upstream reservoir operations, water abstraction, land-use changes, and pollution can affect downstream water availability, flood risk, sediment transport, salinity, and aquatic ecosystems. Ensuring water security therefore requires an integrated understanding of hydrology, river hydraulics, sediment dynamics, water quality, climate change, and basin-scale management. This special session provides an interdisciplinary platform for researchers, engineers, water-resource managers, and practitioners to exchange knowledge and experience on transboundary rivers under changing climatic conditions. Emphasis will be placed on advanced hydraulic and hydrological modelling, data and information exchange, remote sensing, artificial intelligence, and integrated decision-support tools to address emerging transboundary water challenges and the development of the needed Water Information System.
Keywords: Transboundary Water Resources, Water Security, Climate Change, Hydrodynamic Modeling, Sediment and Water Quality, Water Information System.

Theme A-2: Water and Nature

Special Sessions:
SS-01 Ecohydraulics: Biophysical Interactions in Natural and Engineered Aquatic Systems
Aquatic systems, from headwater streams to rivers, lakes, deltas, and estuaries, are dynamic environments shaped by interacting hydraulic, ecological, and geomorphic processes. Increasing climate variability and human pressures make understanding these interactions critical for sustaining ecosystem function while meeting societal water needs. This session focuses on Ecohydraulics of riverine, lake and estuarine systems, highlighting advances that inform management, restoration, and climate resilience.
Keywords: Ecohydraulics, Flow–vegetation–sediment feedback, Restoration & climate resilience

SS-03 AI and Data-Driven Ecohydraulics: Monitoring, Modelling, and Design
Recent advances in artificial intelligence (AI), coupled with rapid improvements in data storage capacity, cloud computing, high-resolution sensing technologies, and remote observation platforms, have created unprecedented opportunities for data-driven research across Ecohydraulics. There is growing availability in large, multi-modal datasets from laboratory measurements and in situ sensor networks to numerical simulation outputs, which enable deeper investigation of complex biophysical interactions in aquatic systems. This session welcomes contributions that leverage emerging AI methodologies and data-driven approaches to advance Ecohydraulics understanding and practice. Topics of interest include, but are not limited to, machine learning and deep learning applications; physics-informed and hybrid modelling frameworks; surrogate modelling for computational efficiency; intelligent environmental sensing; real-time monitoring systems; habitat and ecosystem prediction; sediment –vegetation–flow interactions; and AI-supported design and decision-making in natural and engineered aquatic systems.
Keywords: Ecohydraulics, Intelligent Environmental Sensing, Artificial Intelligence, Machine Learning

SS-14 Nature-Based Solutions for Upstream Catchments and Small Streams
This session considers nature-based solutions in headwaters, upstream catchments and small streams. It examines hydrological and Ecohydraulics processes, restoration effectiveness, monitoring and upscaling, highlighting how distributed interventions can reduce runoff and erosion, improve habitat and water quality, and strengthen climate resilience.
Keywords: Nature-based solutions; Upstream catchments; Small streams

SS-15 Nature-Based Solutions for Urban Areas
This session examines nature-based solutions for urban water challenges, including stormwater, flooding, heat and water quality. Contributions address design, Ecohydraulics performance, monitoring, modelling and governance of blue-green systems, with emphasis on integration with grey infrastructure and evidence of scalable urban benefits.
Keywords: Nature-based solutions; Urban Ecohydraulics; Blue-green infrastructure

SS-16 Nature-Based Solutions for Large Rivers
This session explores nature-based solutions for large rivers, addressing restoration, flood-risk reduction, sediment dynamics, habitat connectivity and navigation constraints. It combines Ecohydraulics science, modelling,

monitoring and implementation experience to evaluate performance, trade-offs and long-term resilience at reach and basin scales.
Keywords: Nature-based solutions; Large rivers; River restoration

SS-17 Nature-Based Solutions for Coasts and Estuaries
This session focuses on nature-based solutions for estuaries and coasts, including wetlands, dunes, reefs and hybrid measures. Contributions investigate hydrodynamic and ecological performance, sediment processes, monitoring, design and governance, supporting resilient shoreline management under sea-level rise and changing storm conditions.
Keywords: Nature-based solutions; Estuaries; Coastal resilience

Theme A-3: Hydro-Environment Engineering and Society

Special Sessions:
SS-33 Binding Without Erasure: River Monitoring, Plural Evidence and Environmental Obligation in Transboundary Governance
Rivers are material systems, ecological communities, historical archives, territories, legal objects and, in some jurisdictions, legal or relational subjects. Yet the institutions that know and govern them rarely encounter these realities on equal terms. Monitoring networks, models, indicators, sediment records, community observations, Indigenous knowledge and legal orders can describe the same river through different relations of evidence, authority and responsibility. This session asks a consequential question: how can heterogeneous knowledge become institutionally binding without being reduced to a single metric, epistemic or juridical form? It brings river science, hydromorphology, ecology, monitoring, restoration, Indigenous and community-based knowledge, transboundary governance, environmental law and science diplomacy into a shared inquiry into environmental obligation. Contributions will trace how river science and monitoring evidence travel across scales and jurisdictions, with particular attention to international and transboundary river-basin case studies. They will explore how baselines, thresholds and standards acquire authority, and how material and ecological change can reopen established interpretations. They will also examine how plural forms of knowledge shape governance and management outcomes without epistemic capture. The session seeks comparative concepts, methods and institutional designs through which river knowledge can remain contestable and situated while supporting restoration, cooperation, prevention, accountability and remedy.
Keywords: River Governance, Environmental Evidence, Adaptive Water Resources Management

Pillar B: Water Engineering and Energy, Ecological and Digital Transition

Theme B-1: Hydropower and water related renewable energy

Special Sessions:
SS-44 Advancing Hydropower through Multidisciplinary Research for Resilient Water and Energy Systems
Hydropower is essential for the transition towards resilient, low-carbon water and energy systems. Beyond renewable electricity generation, hydropower provides flexibility, storage, balancing services and multipurpose reservoir functions that support the integration of variable renewable energy while contributing to flood protection, water supply and climate adaptation. These benefits must be delivered under increasingly uncertain hydrological conditions and while safeguarding river ecosystems and societal needs. This special session will bring together multidisciplinary research on the coordinated advancement of hydropower technology, reservoir operation, digitalisation and environmental performance. Contributions are invited on flexible and variable-speed hydropower, pumped-storage systems, hydraulic transients and operational reliability, real-time monitoring, data-driven decision support, digital twins, predictive maintenance and smart asset management. The session will also address climate-resilient reservoir operation, water–energy trade-offs, environmental flows, hydropeaking impacts, sediment and ecosystem considerations, and the integration of hydropower within renewable and hybrid energy systems. Particular attention will be given to studies that connect technical innovation with operational evidence, environmental assessment and implementation pathways. By linking hydraulic engineering, energy-system analysis, digital technologies and ecohydraulic knowledge, the session aims to identify transferable

methods and research priorities for hydropower systems that are flexible, reliable, environmentally responsible and responsive to changing water and energy demands.
Keywords: Hydropower Flexibility, Reservoir Operations, Digital Hydropower, Water–Energy Nexus, Climate Adaptation, Environmental Sustainability

Theme B-2: Water engineering for inland water bodies

Special Sessions:
SS-05 Advances in Monitoring Extreme River Flows Across the Hydrologic Spectrum
Rivers worldwide are experiencing increasingly frequent and severe hydrologic extremes, ranging from prolonged low-flow conditions driven by drought and groundwater depletion to high-flow events associated with intense precipitation, rapid snowmelt, and compounding flood processes. These extremes pose growing challenges for water-resource management, flood and drought mitigation, ecosystem health, and community resilience. Despite progress in observation technologies, significant gaps remain in our ability to accurately measure and monitor river flow extremes—particularly at high temporal resolution, across large spatial scales, and under rapidly changing environmental conditions. This session brings together scientists, engineers, and practitioners developing and applying innovative tools to monitor and characterize extreme river flows across the full hydrologic range. We invite contributions spanning in-situ instrumentation, remote sensing platforms, data-driven modelling, uncertainty quantification, sensor networks, citizen-science approaches, low-technology/low-cost techniques (solutions that can be deployed at large scale and beyond the traditional monitoring networks), and hybrid systems that integrate multiple data streams. Studies focused on challenges such as capturing peak flows during hazardous events, quantifying persistent low-flow conditions, assimilating sparse or noisy observations, and leveraging emerging technologies— including UAVs, satellite missions, distributed fiber-optic sensing, machine learning, and autonomous platforms—are especially encouraged. Among the focal topics for the special session are new innovative monitoring approaches for: - Spatiotemporal gradually varied flows (unsteady, non-uniform flow regimes) - Flood flows through vegetated floodplains-Runoff- and tide-modulated flows-Extreme flows observed with remote sensing technologies-Low technology/low-cost techniques for any of the above flows By highlighting advances in observation and monitoring strategies for both low-flow and high-flow extremes, this session aims to foster cross-disciplinary dialogue and accelerate the development of robust, scalable, and actionable river-monitoring capabilities. Contributions addressing global, regional, and local contexts are welcome, as are those linking hydrologic extremes to broader climate, geomorphic, ecological, or societal impacts.
Keywords: Advanced streamflow monitoring methods, Drought, Flood

SS-09 Ice Processes in Inland and Transitional Waters
Ice formation, evolution, and breakup in inland and transitional waters are governed by complex interactions between hydrodynamic, thermal, and mechanical processes operating across multiple spatial and temporal scales. Rivers, lakes, and transitional coastal basins such as brackish lagoons and estuarine systems each exhibit distinct ice regimes shaped by flow variability, wind forcing, salinity gradients, water-level fluctuations, and anthropogenic regulation. All of these environments require continued scientific attention, as their ice dynamics directly influence flood risk, navigation safety, ecosystem functioning, and hydraulic infrastructure performance. In the context of ongoing climate change, the study of ice processes has become increasingly important. Rising air temperatures, altered precipitation patterns, changing wind regimes, and increased hydrological variability significantly affect freeze-up timing, ice thickness development, mid-winter stability, and breakup intensity. Transitional systems are particularly sensitive due to the combined influence of river inflow and marine forcing, where small climatic perturbations may trigger substantial changes in ice conditions. At the same time, regulated river systems and inland lakes may experience more dynamic and less predictable ice behaviour because of modified discharge patterns and thermal regimes. This contribution focuses on process-based understanding of ice formation and decay, including frazil ice production, ice cover evolution, ice movement, and jam development. Numerical modelling approaches integrating hydrodynamics, heat transport, and ice mechanics are discussed as tools for improving prediction capability under increasingly non-stationary climatic conditions. Enhanced understanding of ice processes in inland and transitional waters is essential for adaptive management strategies in a rapidly changing climate, where ice-related phenomena remain difficult to predict and strongly climate-dependent.
Keywords: River and lake ice, Ice dynamics, Climate variability

SS-10 Sediment Transport and River Training in Alluvial Rivers: Current Understanding and Open Challenges

Bridges and hydraulic structures are critical elements of modern transport networks, enabling rapid and reliable movement of people and goods across rivers and other waterways. When traffic is disrupted by bridge failure or severe damage, societies face major challenges that threaten quality of life and demand coordinated responses from engineers, authorities, and operators. Local scour around piers, abutments, spur dikes, and other foundation elements remains one of the primary threats to bridge safety worldwide. Floods and erosion due to flowing water are among the most common causes of bridge damage and collapse, and systematic research on these processes has expanded rapidly over recent decades. For the successful design, assessment, and rehabilitation of hydraulic structures in alluvial rivers, engineers must understand how sediment transport and bed mobility control scour, aggradation, and degradation. Accurate estimation of design scour depth and sediment transport rates under both routine and extreme conditions is essential, as these govern foundation levels, protection works, and long-term performance. Effective collaboration between hydraulic, geotechnical, and structural engineers is therefore crucial. Recent advances in remote sensing and artificial intelligence (AI) provide powerful new tools to address these challenges. Multi-temporal satellite and UAV imagery, LiDAR, radar, and sonar now allow monitoring of river planform, bar dynamics, bank retreat, and bed evolution at unprecedented resolution, while AI and machine-learning methods are increasingly used to extract geomorphic features, detect scour or instability, and develop predictive or surrogate models of flow and sediment processes. This session aims to bring together recent advances on hydraulics of alluvial rivers, bridge scour, sediment transport, and river training works, with particular emphasis on the role of remote sensing and AI. Topics of interest include, but are not limited to: (i) local and contraction scour at hydraulic structures; (ii) flow patterns and turbulence in the vicinity of structures; (iii) sediment transport and bed evolution in alluvial channels; (iv) design and performance of river training and scour protection works; (v) remote sensing–based monitoring; and (vi) AI and data-driven methods for prediction, detection, and decision support.

Keywords: Alluvial River hydraulics, Turbulence monitoring and modelling, Scour protection and river training works

SS-21 Plastic Transport in Rivers: Connecting Empiricism and Modelling

Plastic mobilization, transport, retention, and degradation in rivers are increasingly recognized as serious ecological and human threats. In recent years, these processes have been investigated through laboratory experiments, field studies, and numerical modelling. The goal of this special session is to bring together robust insights and data with different modelling approaches enabling the simulation of plastic movement in rivers.

Keywords: Microplastics and Litter, Multiphase flow, Numerical modelling

SS-26 Advances in Environmental Fluid Mechanics

The proposed session, “Advances in Environmental Fluid Mechanics,” will provide a state-of-the-art overview of emerging theoretical, experimental, numerical and data-driven approaches in environmental fluid mechanics, with applications spanning environment, hydraulic systems, turbulence, sediment/micro-plastic and pollutant transport, multiphase flows, and climate-related transport processes. The session will adopt a mixed format of invited and contributed presentations, fostering broad participation and interdisciplinary exchange across the hydro-environmental community. The session will address key scientific and technical challenges associated with understanding, modelling, measuring, and predicting complex environmental flows across multiple spatial and temporal scales. Attention will be given to new advances in modelling fluids. The role of advanced experimental methods, field and laboratory measurement techniques, including remote sensing, uncertainty quantification, data assimilation, high-performance computing, numerical modelling, and data-driven approaches as well as new methods and emerging tools to interpret experimental and numerical results and support decision-making in environmental and water systems related with turbulence and mixing processes, transport and dispersion mechanisms, flow instabilities, sediment dynamics, flow–structure and flow–biota interactions, and the coupling between environmental fluid mechanics and climate-related processes. The expected contribution of the session is to strengthen connections between fundamental fluid mechanics, environmental sciences, and practical water-sector applications. By integrating perspectives from hydraulics, geophysical fluid dynamics, oceanography, atmospheric sciences, and environmental engineering, the session aims to promote innovative modelling strategies and improved understanding of environmental flow processes relevant to sustainable water management, ecosystem preservation, coastal and riverine resilience, hazard mitigation, and climate adaptation. The session is

also expected to stimulate new interdisciplinary collaborations and provide a platform for discussing emerging research directions and implementation challenges in environmental fluid mechanics.
Keywords: Fluid Mechanics, Modelling, Numerics

SS-31 High-Fidelity 3D CFD and CFD–DEM Methods for Predictive Bed Morphodynamics
High-fidelity three-dimensional computational fluid dynamics (CFD) is increasingly enabling process-based prediction of complex flow –sediment interactions and bed morphological evolution. Despite substantial progress in turbulence modelling, sediment transport formulations, multiphase flow modelling, and high-performance computing, the accurate prediction of erosion, deposition, and morphodynamic evolution remains one of the most challenging problems in hydraulic engineering. This Special Session will focus specifically on high-fidelity 3D CFD methodologies for predictive bed morphodynamic across fluvial, estuarine and coastal environments. Contributions are invited on RANS, LES and DES approaches; CFD –DEM formulations; multiphase flow and sediment–fluid interaction modelling; advanced turbulence and sediment transport closures; and high-performance computing strategies for computationally intensive morphodynamic simulations. Emphasis will be placed on model verification and validation, benchmarking, uncertainty assessment, computational efficiency, and model transferability. Machine learning and remote sensing approaches are also welcomed where they directly support model development, calibration, validation, uncertainty assessment or predictive performance. The session will provide a forum for critically evaluating the predictive capabilities, robustness, and limitations of high-fidelity 3D CFD morphodynamic models, discussing emerging computational approaches, and identifying future research priorities for improving the predictive accuracy, reliability, computational efficiency, and transferability of process-based numerical models in fluvial, estuarine, and coastal environments.
Keywords: High-Fidelity 3D CFD, CFD–DEM and Multiphase Sediment Modelling, Morphodynamic Model Verification and Validation

SS-40 Dam Reservoir Sedimentation: Challenges and Management Solutions
Reservoir sedimentation represents a growing challenge to the long-term sustainability of water infrastructure worldwide, progressively reducing storage capacity, affecting operational performance, and disrupting sediment continuity in river systems. These challenges are intensifying as the global reservoir fleet ages, accumulated sediment deposits increase, and climate change modifies hydrological regimes, sediment dynamics, and the frequency and magnitude of sediment-related natural hazards. Addressing these challenges requires proactive, adaptive, and sustainable sediment management, supported by advances in scientific understanding, Earth observation technologies, monitoring techniques, numerical modelling, and innovative engineering approaches. Particular attention is needed to understand the interactions between catchment sediment dynamics, natural hazards such as landslides and extreme floods, reservoir sedimentation processes, and downstream environmental responses. This special session aims to present recent scientific advances and methodological developments in sediment monitoring and modelling, Earth observation applications, sediment-related hazard assessment, sediment routing and removal techniques, and integrated management strategies. Its expected scientific contribution is to advance understanding of sediment processes across catchment–reservoir–river systems, evaluate emerging modelling and monitoring approaches and address uncertainties in sediment dynamics and management effectiveness. By connecting fundamental research with applied investigations, the session seeks to strengthen the scientific basis for sustainable sediment management.
Keywords: Reservoir sedimentation, Sustainable management and operation, Monitoring, Numerical modelling, Case studies

Theme B-3: Water engineering and society

Special Sessions:
SS-25 Water Security in Latin America: From Local Experiences to the Construction of a Regional Metric
The Water Security Index transforms a complex concept into an objective measure capable of guiding technical, policy and strategic decisions by integrating dimensions such as availability, quality, access, infrastructure, governance and climate risk. In Latin America, several countries have already developed national or sub -national indices, although using different methodologies that reflect different realities and priorities. However, water does not respect administrative boundaries. Rivers, aquifers and water supply systems across national borders, forming interdependent systems. Therefore, measuring water security at a regional scale is fundamental to understand how the system functions, to strengthen cooperation and to support coordinated decision-making. The idea of this proposal is to present existing experiences in the region and discuss pathways toward the development of a

representative regional water security index for Latin America, considering the high level of hydrological integration among its countries.
Keywords: Water Security Index, Regional / Transboundary Water Assessment, Cooperative Governance & Coordinated Decision-Making

SS-42 Co-Evolving Human–Water Systems: From Socio-Hydrological Science to Policy and Community Decisions

Water systems and societies continuously shape one another. Climate variability, hydrological extremes, infrastructure, land-use change, and ecosystem degradation influence human behavior and institutions, whereas water allocation, policy interventions, economic activities, and community decisions alter hydrological processes and future vulnerability. Despite advances in climate and hydrological forecasting, these dynamic and bidirectional feedbacks remain insufficiently represented in water planning and decision-making. Coupled human–water systems research provides an interdisciplinary foundation for understanding how water availability, risk perception, livelihoods, institutions, infrastructure, and collective behavior co-evolve across spatial and temporal scales. Such understanding is essential for translating scientific knowledge into equitable, adaptive, and socially legitimate decisions. This session invites empirical, theoretical, modeling, and participatory contributions that may examine: (1) feedback among hydrological processes, human behavior, institutions, infrastructure, and ecosystems; (2) the co-evolution of water demand, land use, livelihoods, risk perception, and adaptation decisions; (3) the integration of scientific, local, and Indigenous knowledge into models and decision-support processes; (4) societal and distributional consequences of climate and hydrological change; and (5) policy interventions, including their behavioral responses, trade-offs, unintended consequences, and potential for maladaptation. This session will connect socio-hydrological science with practical decisions by policymakers, water managers, stakeholders, and communities.
Keywords: Socio-Hydrology, Coupled Human–Water Systems, Human–Water Feedback, Participatory Modeling, Water Governance

Theme B-4: Irrigation, drainage and pollution control

Special Sessions:

SS-11 Advances in Marine and Freshwater Outfall Systems: Innovations in Modelling, Design, and Environmental Protection

This special session addresses critical advances in marine and freshwater outfall systems, focusing on innovations in modelling, design, and environmental protection. Outfall systems serve as essential infrastructure for maintaining water quality and protecting aquatic ecosystems through effective discharge and dispersion of treated wastewater and stormwater into receiving water bodies and safeguarding human health by minimizing exposure to pathogens, emerging contaminants, and harmful algal blooms associate d with inadequate effluent management. The session explores state-of-the-art technologies and methodologies in outfall system design, performance prediction, and environmental management, with particular emphasis on the integration of digital tools, including AI and machine learning, with traditional hydraulic engineering approaches to optimize outfall performance. The session addresses several critical challenges facing the water sector today. These include the increasing complexity of effluent dispersion modelling under changing climate conditions, growing demands for enhanced environmental protection and regulatory compliance, and the need for resilient outfall infrastructure capable of withstanding extreme weather events and sea-level rise. Additionally, the session examines the integration of real-time monitoring and adaptive management strategies while balancing technical performance with ecological sustainability. The session also recognizes the growing public health implications of outfall system failures, including risks of waterborne disease transmission, contamination of recreational and aquaculture waters, and exposure to micropollutants and antibiotic-resistant organisms that pose direct threats to human health. The session will advance knowledge and solutions in the water sector through presentation of cutting-edge near-field and far-field dispersion modelling techniques, demonstration of AI and machine learning applications in predictive modelling and performance optimization and sharing of international case studies showcasing sustainable outfall implementations. Participants will explore climate-proofing strategies for outfall system design and discuss innovative monitoring technologies for real-time water quality management. By bringing together researchers, practitioners, and policymakers, this session will facilitate knowledge exchange, identify research gaps, and foster collaboration within the IAHR-IWA Joint Committee on Outfall Systems and the broader water community. The

outcomes will contribute to developing more resilient, efficient, and environmentally sustainable outfall systems that meet the evolving challenges of the 21st century water sector.
Keywords: Outfall systems, Climate change adaptation, Digital transformation

SS-43 Karst Coastal Aquifers under Pressure: Monitoring, Digital Tools and Management of Seawater Intrusion in the Mediterranean Basin
Coastal karst aquifers are strategic freshwater resources throughout the Mediterranean Basin, supporting drinking-water supply, irrigation, ecosystems and economic activities. Their high permeability, complex conduit networks and direct hydraulic connection with the sea make them particularly vulnerable to overexploitation, seawater intrusion, pollution and the combined effects of climate change and prolonged drought. Effective protection and management therefore require integrated approaches able to characterize groundwater flow, freshwater–seawater interactions and the rapid propagation of contaminants under strongly heterogeneous conditions. This special session will bring together researchers, water managers and public authorities to discuss recent advances in monitoring, assessment and sustainable management of coastal karst aquifers. Contributions are invited on hydrogeological and hydrogeophysical investigation, hydrochemical and isotopic techniques, groundwater-level and salinity monitoring, submarine groundwater discharge, numerical modelling, GIS and remote sensing, data-driven tools, early-warning indicators and decision-support systems. Particular attention will be given to the integration of field observations and digital technologies, the assessment of climate and anthropogenic pressures, and the transfer of scientific evidence into adaptive groundwater-management strategies. Comparative studies from the Mediterranean and other coastal karst regions are welcome when they provide methods or findings transferable to Mediterranean settings. By connecting scientific innovation with operational needs, the session aims to strengthen cooperation and support more resilient management of vulnerable coastal groundwater resources.
Keywords: Coastal Karst Aquifers, Seawater Intrusion, Groundwater Monitoring, Hydrogeological Modelling, Submarine Groundwater Discharge, Adaptive Groundwater Management

Theme B-5: Water engineering for water infrastructures

Special Sessions:
SS-04 Transient Flows in Hydraulic Systems
Hydraulic transients remain one of the most critical yet often underestimated phenomena affecting water systems. Sudden system perturbations, caused by hydraulic operations or natural events, may generate violent system responses, involving strong transient flows and unexpected forces and pressures oscillations, which may result in catastrophic structural failures, even loss of human lives. This special session carries a double-fold ambition. On the one hand, research on pressurized transient flows beyond classical water-hammer theory will be presented, with emphasis on emerging challenges in water infrastructure. Contributions are expected on topics including computational fluid dynamics, experimental methods and high frequency instrumentation, as well as non-standard transients and phenomena not accounted for in the classical theory, such as unsteady friction, fluid-structure interaction or pipe-wall viscoelasticity. By integrating advanced modelling, field measurements, and operational data, the session seeks bridging theory with practice, bringing advanced knowledge and practical solutions for safer, more resilient, and more sustainable water infrastructure in the context of increasing system complexity and uncertainty. On the other hand, the newly created Technical Committee on Transient Flows seeks for its context within IAHR community, wandering beyond the boundaries of pressurized transient flows. Water hammer is that phenomena upon the classic water-hammer theory has been built for decades mainly using the reservoir-pipe-valve system as a paradigmatic example. In the scope of hydro-environment though there are other transient flow phenomena with their respective groups of researchers and paradigmatic examples, namely dam breaks, gravity currents, tsunamis or tidal bores. This special session aims at gathering high experts representing these groups in the form of keynote lectures that will explain the transient flow nature of each of these phenomena, how they are scientifically tackled, and their implications and applications in hydro-environmental infrastructure. Implicit objectives of this special session are therefore to determine commonalities among these research groups and synergize towards future research lines.
Keywords: Hydraulic transients, Dam break, Tidal bores, Tsunamis

SS-13 Scour around Hydraulic and Coastal Structures
This proposed session focuses on the critical issue of scour around hydraulic and coastal structures, a fundamental challenge affecting the safety, stability, and longevity of infrastructure such as bridge piers, offshore wind turbine

foundations, pipelines, and seawalls. The session will have a strong scientific and practice-oriented focus, aiming to bridge the gap between advanced research and engineering application. Key topics will include the latest advancements in understanding scour and sediment transport mechanisms, innovative numerical and physical modelling techniques for predicting hydrodynamic-structure-seabed interactions, and the development of robust foundation design and scour protection strategies. The session will address pressing challenges such as scaling laboratory findings to field conditions, predicting scour under complex combined wave-current flows and extreme events, and designing cost-effective and environmentally sustainable scour countermeasures. By bringing together leading researchers and practitioners, this session is expected to significantly contribute to advancing the state-of-the-art in scour prediction and mitigation. It will foster the exchange of knowledge that directly translates into safer, more resilient, and economically optimized water infrastructure, thereby supporting sustainable development in coastal, offshore, and riverine environments.
Keywords: Hydrodynamic-structure interaction, Foundation design, Scour protection

SS-19 Hydraulic Challenges of Ageing Infrastructure
This special session will address the hydraulic challenges associated with ageing water infrastructure, including dams, spillways, levees, gates, culverts, and urban drainage systems. As many assets worldwide operate well beyond their original design life, or are subject to conditions not envisaged during design, they face increasing pressures, which can be driven by material deterioration, changing hydrological extremes, sedimentation, higher safety expectations, and evolving operational demands. The session will bring together recent advances in modelling, assessment, monitoring, rehabilitation, and risk-informed management, and will serve as a forum of discussion.
Keywords: Ageing Infrastructure, Climate change adaptation, Structural health monitoring

SS-20 Fundamental Flow Hydraulics at Hydraulic Structures
This session addresses the fundamental understanding of flow hydraulics that governs the design, performance, and safety of hydraulic structures. Today, advanced measurement techniques and instrumentation both in the laboratory and in the field together with significant progress in numerical modelling provide new opportunities to resolve details of complex flow processes. Hydraulic structures such as spillways, tunnels, culverts, energy dissipators, fish passages, and others involve a wide range of interacting flow processes. These include air entrainment, detrainment, turbulence, secondary currents, sediment transport, and interactions with aquatic organisms. An improved understanding of these processes is play a critical role in performance, environmental compatibility, structural integrity, and long-term functionality of hydraulic structures. The session will highlight practical applications, emerging research needs, and recent scientific developments in the field. Contributions addressing experimental, numerical, and field-based investigations of fundamental flow processes at hydraulic structures are particularly encouraged.
Keywords: Hydraulic Design, Numerical Modelling, Laboratory Experiments

SS-28 Digital Empowerment of Whole-Process Water Allocation
Against the background of growing water scarcity, fluctuating water supply and demand patterns, and ongoing digital transformation of global water governance, traditional empirical and static water allocation modes can no longer adapt to refined, precise and real-time water resource management requirements. This proposed session focuses on the digital empowerment of whole-process water allocation, aiming to explore innovative theories, technical methods and practical paradigms for data-driven water resource deployment. The proposed session concentrates on the full life cycle of water allocation, covering demand forecasting, dynamic scheduling, real-time monitoring, process supervision and post-evaluation. It highlights how digital technologies including big data, intelligent algorithms and digital twin systems optimize traditional water allocation workflows, eliminate management blind spots, and improve the overall efficiency, fairness and resilience of water resource distribution. This session welcomes frontier research results, engineering application cases and practical management experiences worldwide. Through in-depth academic exchanges and industrial discussions, it intends to summarize effective digital transformation paths for whole-process water allocation, provide technical and decision-making support for adaptive water resource management, and promote the high-quality and sustainable development of modern water management systems.
Keywords: Water Allocation, Digital Twin, Artificial Intelligence

SS-37 Smoothed Particle Hydrodynamics (SPH) and Its Applications in Hydraulic Engineering

Smoothed Particle Hydrodynamics (SPH) is increasingly used to simulate complex hydraulic flows involving large free-surface deformation, moving boundaries, impact loads, and fluid–structure or fluid–sediment interaction. This special session will connect advances in mesh-free particle methods with validated applications across inland, coastal, maritime and renewable-energy engineering. Contributions will address river and flood hydraulics; flows around bridge piers, local scour and sediment dynamics; waves and overtopping at coastal structures; wave-energy converters; and stratified or multiphase flows around hydraulic infrastructure. Methodological topics include turbulence modelling, boundary treatments, GPU/HPC performance, adaptive resolution, and coupling with finite-volume, shallow-water or other numerical solvers. Particular emphasis will be placed on experimental benchmarking, uncertainty and numerical convergence, multiscale modelling, and demonstrated engineering applicability. The session will connect the international SPH community with hydraulic engineers to critically discuss where SPH offers advantages, how hybrid strategies extend its applicability, and which validation protocols are needed before high-fidelity simulations can support design, risk assessment and digital engineering workflows.
Keywords: Smoothed Particle Hydrodynamics; free-surface hydraulics; fluid-structure interaction.

Pillar C: Improving Resilience Against Water Hazards and Disasters

Theme C-1: Climate Change Mitigation and hydraulic-infrastructure resilience

Special Sessions:

SS-18 Digital Ecohydraulics for River Resilience: Integrating Remote Sensing, Machine Learning, and Advanced Modelling

Earth Observation (EO) and remote sensing (RS) provide massive and rapidly expanding data streams on land and water surfaces, enabling new opportunities to quantify riverine ecosystem dynamics across multiple spatial and temporal scales. At the same time, advances in machine learning and data analytics are accelerating the extraction of physically meaningful information from EO/RS products (e.g., vegetation traits, roughness proxies, bathymetry/topography, inundation dynamics, sediment and habitat indicators). However, a key challenge remains: converting heterogeneous observations into actionable, uncertainty-aware inputs for Ecohydraulics and hydro-morphodynamic modelling, and ultimately into robust decision support for river management under increasing hydroclimatic and societal pressures. This special session —promoted as an activity of the IAHR Working Group on Remote Sensing—introduces and develops the concept of Digital Ecohydraulics, defined here as the integrated use of EO/RS, machine learning –enabled information extraction, advanced hydro-morphodynamic modelling, and data-driven decision frameworks to enhance river resilience. We invite contributions including, but not limited to: EO/RS integration with in-situ measurements; innovative sensors and multi-platform data fusion (satellite –UAV–LiDAR– radar); machine-learning approaches for parameter inference and classification (e.g., roughness/vegetation structure, geomorphic units, sediment/habitat indicators); coupling of EO-derived products with Ecohydraulics and morphodynamic models; uncertainty quantification, validation, and explainability; and operational decision-support applications for flood risk reduction, river restoration, and adaptive management.
Keywords: Digital Ecohydraulics, Remote Sensing, Machine Learning, Hydromorphological Modelling

SS-22 Resilience against climate change in the Asia-Pacific Region

The theme of the proposed session is ‘Resilience against flooding and disasters in the Asia-Pacific Region’. The session highlights the past and future flooding induced disasters and their impact on the integrated water management considering climate resilience to increase the capacity of social, economic and ecosystems for mitigating and adapting the impacts of climate change. Especially, for improving climate resilience, the change of climate-related risks needs to be evaluated, and the capacities of defence, recovery and adaptation should be increased. For further developing climate-resilient infrastructures, soft countermeasures on flood forecasting and early warning systems, other functions. i.e. ecosystem restoration together with positively increasing biodiversity, integration of water resource management, active community participation, and effective strategies etc. need to be discussed. The Asia-Pacific region is highly diverse in its geography, socio-economic conditions, and ecological systems. However, many countries across this region are united by shared vulnerabilities—rising sea levels, erratic monsoons, increasing frequency and intensity of tropical cyclones, saline intrusion, shifting agricultural zones, and threats to freshwater availability. These challenges are further compounded by rapid urbanization, population pressure, and limited institutional capacities in many areas. This special session seeks contributions about the

following themes in APD region: •Climate trends, variability, and projections at national and sub-national levels •Nature-based solutions and engineered strategies for climate adaptation •Indigenous knowledge systems and community-led resilience initiatives • Climate finance, governance mechanisms, and institutional frameworks supporting adaptation • Adaptation measures and interventions implemented at local, regional, and national scales
Keywords: Climate trends, Nature-based solutions and engineered strategies, Community-led resilience initiatives

SS-23 Intelligent Early Warning Systems: Machine Learning Integration for Hydrometeorological and Tsunami Hazard Management

Proposal for regional deployment of Intelligent Early Warning Systems based on physics-informed neural networks. Unlike traditional numerical models, these approaches embed differential equations directly into machine learning models enabling physically consistent predictions up to 100 times faster. The initiative aims to improve tsunami and flood management while addressing algorithmic bias and data-desert challenges through responsible AI.
Keywords: Physics-Informed Neural Networks (PINNs), Intelligent Early Warning Systems (EWS), Responsible AI (bias & data deserts)

SS-29 Digital-Intelligent Empowerment of Flash Flood Disaster Prevention

This special session aims to address the prominent characteristics of flash floods, including abrupt onset, rapid confluence, scattered impact areas and great difficulties in monitoring and management. Traditional prevention modes relying on manual inspections and empirical forecasting can no longer adapt to complex and variable mountain hydrological environments. This theme focuses on the integrated application of digital technologies and intelligent algorithms throughout the whole chain of flash flood prevention and control. Discussions centre on core directions including high-precision real-time monitoring of flash floods, coupling of multi-sources hydrometeorological data, AI-based flash flood runoff and risk simulation, dynamic optimization of distributed early warning thresholds, as well as intelligent scheduling and emergency response for flash flood disasters. Supported by internet of things sensing, digital twins, machine learning, low-altitude remote sensing and other digital-intelligent technologies, an integrated flash flood prevention system covering "monitoring – analysis – early warning – disposal – post-event review" is established to address industry pain points such as scarce hydrological data in mountain small watersheds, delayed early warnings and insufficient targeted prevention measures. By integrating physical hydrological mechanisms and intelligent models, an adaptive flash flood risk assessment framework is constructed, shifting flash flood disaster prevention from passive post-disaster rescue to proactive pre-disaster control and refined zonal management. It provides digital and intelligent solutions for resilient governance of mountain watershed flood disasters and regional water security guarantee.
Keywords: Flash Flood Early Warning, Digital Twin, AI-based Hydrological Simulation

SS-30 Debris and Driftwood Accumulation at Hydraulic Structures

Recent flood events have demonstrated that high waters often carry significant amounts of driftwood and floating debris (both natural and anthropogenic), which can accumulate at hydraulic structures such as bridges, culverts, racks, weirs, and intake structures. These accumulations can adversely affect the performance and capacity of waterways and critical infrastructures by reducing discharge capacity, causing upstream backwater rise, intensifying local scour and altering the propagation of flood peaks. Such effects can exacerbate flood characteristics, increase the intensity of damage in surrounding areas, and trigger cascading effects during extreme flood events. Understanding the physical processes behind these accumulations, as well as their consequences for hydraulic infrastructures, is essential for improving flood resilience, developing predictive tools, enhancing monitoring approaches, and optimizing debris/driftwood management strategies. This special session aims to bring together researchers and water managers from around the world who are studying or working on this issue and contributions may include field observations and monitoring, post-flood analysis, physical modelling, numerical modelling, structural loading, and operational management. The session will provide a platform for sharing recent advances, identifying knowledge gaps, and discussing how scientific evidence can be translated into practical strategies for flood-risk reduction and infrastructure resilience.
Keywords: Driftwood and floating debris, Hydraulic structures, Flood resilience and debris management

SS-35 AI-Enabled Multi-Hazard Assessment for Water Systems and Water-Related Risk Reduction

Water systems and water-related territories (rivers, floodplains, coastal zones and watersheds) face compounding hazards from urban and groundwater flooding, rainfall-induced landslides, tsunamis and co-seismic ground effects, which are often assessed independently despite their physical interconnections through water. This session aims

to bring together researchers exploring how artificial intelligence can support integrated multi-hazard assessment for water systems and water-related risk reduction, through shared methodologies, interoperable data workflows and real case studies. As climate change intensifies extreme events, the session addresses the key challenge of integrating heterogeneous hydrological, geotechnical and seismological data, models and early warning systems into coherent digital frameworks for decision-making. Seismic hazards are considered where they interact with water: groundwater conditions controlling liquefaction, earthquake-triggered failures of levees, dams and water networks, and co-seismic landslides affecting river systems. Building on a concrete Taiwan –Italy collaborative framework, the session aims to advance data-driven, multi-hazard resilience methodologies for water systems that can be transferred to water-related territories facing similar convergent risks worldwide.
Keywords: Compound and cascading hazards, Water infrastructure vulnerability, Cross-domain data interoperability

SS-39 From Hydraulic Processes to Resilient Bridge Management under Hydrological Extremes
Bridges are critical components of infrastructure systems. Their interaction with water flows exposes them to a wide range of hydraulic actions, including scour, sediment deposition, debris accumulation, flow constriction, and hydrodynamic loading. The increasing frequency and magnitude of hydrological extremes due to climate change are further challenging current approaches to bridge design, assessment, operation, and maintenance. This special session will bring together researchers, engineers, and practitioners to advance understanding of the complex interactions between hydraulic processes, bridges and relative transport networks. It will address recent developments in integrating scour, debris accumulation, flow constriction and hydrodynamic loading with decision-making and/or management. The session contributes to fostering interdisciplinary exchange with scientific, technical, policy, and practice-oriented focus. Contributions should address bridges as integrated infrastructure systems and explicitly connect hydraulic processes with risk assessment, monitoring, maintenance, retrofitting, asset management or transport-network resilience. Studies focused exclusively on scour mechanisms, debris accumulation, sediment transport or CFD development are outside the primary scope unless they demonstrate a direct bridge-management or decision-support application.
Keywords: Bridge; Hydraulics; hydrodynamics; Scour; Climate change; Risk

Theme C-2: Urban water cycle, industrial water and water treatment

Special Sessions:
SS-07 Theory and Applications of Smart Water Networks
This special session aims to bridge the gap between theoretical advances and practical implementation in Smart Water Network operations, aligning with the IAHR-WSO Working Group's renewed focus on control science, physics-based intelligence, and system-wide autonomy. The session will focus on the scientific and technical foundations necessary for transitioning from human-assisted decision support to truly autonomous, adaptive, and smart water infrastructure management. Key challenges to be addressed include: integrating control theory, artificial intelligence (AI), and physical hydraulics into a unified operational framework; ensuring the safety, reliability, and trustworthiness of Smart Water Network through rigorous verification architectures; and scaling up pilot demonstrations to large, complex, and interconnected water networks under changing environmental and social conditions.
Keywords: Smart Water Networks, Autonomous & adaptive control, AI–Hydraulics Verification & Safety

SS-24 From Scarcity to Smart Management: Solutions for Intermittent Water Supply Systems
Intermittency in water supply constitutes an operational reality in several countries in Latin America, including Brazil, where intermittent systems serve a significant portion of the population. Despite the growing academic interest in the last decade, important gaps still exist regarding the systematization of experiences, the comparison of methodologies and the evaluation of solutions applied in real contexts. The organization of a session on this topic would allow discussion of recent advances associated with the digital transformation of the water sector, including the emerging use of sensors, IoT and new approaches to modelling and management intermittence.
Keywords: Intermittent Water Supply (IWS), Digital Transformation (Sensors & IoT), Intermittence Modelling & Management

SS-34 Cities Don't Fail in Silos: Governing Water-Energy-Cooling Dependencies for Metropolitan Resilience

Urban water resilience cannot be governed independently from energy, cooling, communications, health services, mobility and other critical metropolitan functions. A disruption that begins in one network can propagate rapidly across the city, while sector-specific dashboards may still show acceptable asset performance. This proposed session brings together water, utility, infrastructure, resilience, digital and governance perspectives to examine how cities can identify, quantify and govern these cross-sector dependencies before they become cascading failures. The session aligns with the Congress focus on water engineering, digital water, resilience and global transitions, while adding a system-of-systems perspective that connects technical performance to decision authority and service continuity. The session uses two representative stress horizons — a 72-hour power interruption and a 7-day water disruption — to frame discussion around dependency mapping, early warning, operational thresholds, digital intelligence, governance and investment prioritisation. The objective is not to prescribe one city model, but to develop a transferable approach for connecting water engineering with metropolitan resilience governance.

Keywords: Urban water resilience, Cascading infrastructure risk, Water-energy nexus

SS-36 Digital Transition in Water Utilities: Governance, Organizational Change and Operational Value

Digital transformation in water utilities is not achieved through the isolated adoption of sensors, artificial intelligence, digital twins or information platforms. It requires changes in governance, organizational capabilities, professional roles and operational processes that enable digital solutions to become reliable and accountable services. This Special Session will examine how water utilities move from technology-centred pilot projects to digital services embedded in routine decision-making across water supply, sewerage and wastewater treatment. Contributions will address digital strategy, organizational readiness, integration of data and information, engineering and operations, data governance, procurement and investment decisions, professional competencies, accountability, regulatory alignment and the assessment of operational, environmental and societal value. Technical applications will be considered when they provide evidence on implementation, organizational integration, validation in utility workflows, measurable outcomes and transferability. Their primary contribution should concern organizational adoption, service integration or value assessment. Contributions primarily focused on control algorithms, hydraulic modelling, autonomous control architectures or AI methodological advances fall outside the primary scope unless their central contribution concerns organizational adoption, workflow integration, governance, accountability or measurable utility value. The expected outcome is a research-to-practice framework supporting utilities in scaling trustworthy digital services while preserving human expertise, engineering responsibility and transparent decision-making.

Keywords: Digital Transition, Digital Water Strategy, Governance and Accountability of Digital Decisions

Theme C-3: Deltas, coastal and maritime engineering

Special Sessions:

SS-02 Ecohydraulics in Coastal and Riparian Zones as Critical Interfaces under Change

Coastal and riparian zones are dynamic, ecologically vital interfaces where land and water converge, governing fluxes of water, sediment, nutrients and organisms. These transitional ecosystems are increasingly vulnerable to climate-driven shifts, including sea-level rise, altered flow regimes, and intensified storms, as well as growing anthropogenic pressures from urbanization, agriculture and infrastructure development. Understanding the Ecohydraulics processes that shape these zones is essential for predicting their resilience, guiding restoration, and enabling sustainable management in a changing world. This session invites contributions that explore the biophysical interactions within coastal and riparian systems, with an emphasis on the interplay between hydraulics, geomorphology, and ecology communities. We welcome studies addressing key topics such as flow-sediment-plant feedback in riparian corridors and shorelines; habitat suitability and organism response to hydrological regime shift; Ecohydraulics principle and design of nature-based solutions for erosion control, flood mitigation and habitat restoration; impacts of human modifications (e.g., levees, revetments, dredging) on interface connectivity and ecosystem function; carbon and nutrient dynamics across land-water gradients. We invite papers that leverage diverse investigative tools, from numerical models and controlled laboratory experiments to field observations and remote sensing, to address the complex challenges of Ecohydraulics in changing environments. By fostering dialogue across these themes, this session aims to advance the science and practice of Ecohydraulics in some of the world's most productive and threatened transitional ecosystems.

Keywords: Coastal zone, Riparian zone, Transitional ecosystem, Ecohydraulics process

SS-41 Integrated Observations and Modelling of Estuarine and Lagoon Dynamics

Estuaries and lagoons present complex dynamics that differ substantially from those of the open ocean, with strong controls from bathymetry, freshwater inputs, stratification, boundaries and human interventions. These processes are often highly non-linear, limiting predictability and increasing the need for high-resolution observations and advanced modelling approaches under varying hydrological and marine conditions. This session aims to discuss recent advances in understanding and predicting estuarine and lagoon dynamics, including: (a) coupled hydrodynamic, morphodynamic and biogeochemical processes, with particular attention to stratification, mixing, exchange flows and the transport of nutrients and pollutants; (b) integration of in-situ observations, remote-sensing data and numerical modelling; (c) operational estuarine and lagoon forecasting; and (d) knowledge-based applications supporting the monitoring and management of these environments under changing hydrological and climatic conditions. The session will provide an opportunity to bring together researchers working across disciplines and spatial scales to advance our understanding and prediction of estuaries and lagoons as coupled and rapidly changing systems.

Keywords: Estuaries and lagoons, hydro-morphodynamics, stratification and exchange flows, biogeochemical transport, in-situ observations, numerical modeling and forecasting