10th International Conference on Flood Management (ICFM10)

Adapting to Global Change: Innovative Approaches to Flood Management and Resilience

Special Sessions

1	**Flood Risk Assessment & Modeling** - Targeted Flood Hazard, Flood Risk, and Financial Risk Analysis Using Global Flood Hazard Models

Robin Bourke	Public Safety Canada	robin.bourke@ps-sp.gc.ca

Session Description:

This session will focus on the application of global flood hazard models for assessing flood hazard and risk, and economic impacts across multiple scales. Given growing climate variability, extreme precipitation and increasing flood damages, the importance of robust and implementable models capable of estimating flood depths and extents over large areas is of critical importance.

The session encourages submissions highlighting improvements into the way global flood models represent local conditions, including climate change impacts on flooding, and with methodologies for incorporating economic and social impacts. Presentations may address model development, data integration, risk mapping, and evaluation of uncertainty.

The goal is to bring together researchers and practitioners from hydrology, engineering, and risk analysis to share advances that make flood risk assessment more accurate, transparent, and useful for planning and adaptation.

1a: Assessing Flood Risk in the Lower Reaches of the Red-Assiniboine River under a Changing Climate

Yongbo Liu (Yongbo.Liu@ec.gc.ca)

Dr. Yongbo Liu is a hydrologist and a water-quality modeler. He is actively involved in many ECCC's priority watershed modeling projects over the past years, such as the Lake Erie and Lake Ontario watersheds, the Lake of Winnipeg watershed, the Lake of the Woods watershed, and the St. Laurance River watershed. His expertise lies in hydrology, watershed hydrologic and water-quality modeling, GIS, and impact assessment of best management practices (BMPs) and climate change on watershed water quality.

Abstract: The impacts of projected climate change on flood risk in the lower reaches of the Red River in Manitoba, Canada, were investigated using the Soil and Water Assessment Tool (SWAT) with the current land management practices. Climate change scenarios were constructed based on seven global climate models (GCMs) and two shared socioeconomic pathways (SSP-245 and SSP-585). The impact of climate change at four global warming levels (GWLs) of 1.5 °C, 2 °C, 2.5 °C, and 3 °C above the pre-industrial level on flow and flood risk at three control stations was assessed. Compared with the 1980–2010 reference period, the ensemble means of the fourteen climate change scenarios indicate increases in annual flow and flood peaks at the 1.5 °C, 2 °C, and 2.5 °C GWLs, followed by a decrease at the 3 °C GWL. Relatively higher increases in the simulated flow were projected during the winter and spring snowmelt periods. This

underscores the need to update flood management strategies to address combined snowmelt–rainfall flooding under a warming climate.

1b: Canada-wide Modelling – Analysis of Model Accuracy to Drive Appropriate Use and Risk Reduction Program Development

Robin Bourke (robin.bourke@ps-sp.gc.ca)

Robin Bourke is Senior Engineering Advisor and Manager of the Data Science and Engineering Team at Public Safety Canada. He studied Water Resources Engineering and International Development in Canada and Sweden before spending ten years in northern Canada as a consulting engineer and project manager. Following three years with the Flood Mapping Team at Natural Resources Canada, he joined Public Safety Canada and developed the Data Science and Engineering Team, which provides expert advice and conducts quantitative risk analysis supporting major policy programs including Flood Insurance, Disaster Assistance, Investment Screening, and Flood Risk Communication.

Abstract: In many countries, continental and global scale flood hazard modelling methodologies are employed to provide an understanding of flood hazard over large geographical areas and at multiple return periods, flood generating mechanisms, and future climate change scenarios. These models are commonly used for estimating flood hazard in areas where high resolution flood mapping is unavailable, and for estimating portfolio risk for insurers and the financial sector. However, these products are generally lower accuracy and precision than local (e.g. regulatory, engineering-level) maps, and therefore the limitations and appropriate use cases of continental and global scale mapping should be understood when using these products to understand flood hazard and flood risk.

Public Safety Canada (PS) has the mandate to keep Canadians safe from a range of risks and is working towards several soon-to-be launched flood resilience policy programs that depend upon a consistent, Canada-wide characterization of flood risk, and has accordingly procured multiple flood hazard models. PS bridges policy work to data science and engineering practices by conducting quantitative risk analysis, using Canada-wide flood hazard models, robust exposure data, and damage estimation methodologies.

PS has done extensive testing of Canada-wide flood hazard models, including quality control and evaluation, to better understand their limitations and uses, and to support quantitative risk analysis for PS and other federal departments and agencies. This presentation will describe the results of PS's evaluation and use of global models, including performance assessment against a set of comparable regulatory-quality flood maps across Canada and recommendations for appropriate use cases. These findings will contribute to a future partnership between PS and an academic research consortium to develop a made-in-Canada, open source, Canada-wide flood hazard model that will leverage data and expertise developed across government and other sectors.

1c: High Resolution Terrain, High Impact Insights: KatRisk's Nationwide Flood Model for Canada

Nathaniel Adams (nate.adams@katrisk.com)

Nate is a hydraulic engineer and flood modeler who leads KatRisk's global flood modeling efforts. As Head of Flood Modeling, he oversees the development of hydraulic and hydrologic models that power KatRisk's probabilistic flood solutions. His work focuses on ensuring technical rigor, consistency, and innovation across inland flood and related peril modeling.

Prior to joining KatRisk, Nate spent several years at Verisk Extreme Event Solutions as a Hydraulic Engineer and Senior Hydraulic Engineer, where he contributed to the development of large-scale catastrophe models and advanced hydraulic simulations. He also worked as a Hydraulic Engineer at Alden Research Laboratory and as a Water Engineer at CH2M, gaining hands-on experience with complex water resources and infrastructure projects.

Nate holds a Master of Science in Civil Engineering from the University of Illinois Urbana–Champaign, where his work focused on modeling geologic carbon sequestration.

Abstract: KatRisk's new Canadian flood model introduces a next-generation approach to targeted flood hazard, flood risk, and financial loss analysis across the country. Built on an advanced global flood modeling framework, the model delivers consistent, high-resolution insights into pluvial and fluvial flooding for insurers, governments, and infrastructure stakeholders.

A key component of this model is KatRisk's use of the latest technology to enhance the Digital Terrain Models (DTMs) that underpin the simulations. These enhanced DTMs ensure that terrain inputs reflect the most accurate, scientifically validated representations possible. This commitment to methodological rigor and state-of-the-art processing enables more reliable and defensible flood modeling outcomes.

The model incorporates newly developed nationwide flood maps that leverage high-resolution LiDAR terrain data at 1-meter and 2-meter resolution, upscaled to 10 meters across the vast majority of populated areas to preserve fine-scale topographic detail while supporting large-domain hydraulic simulations. All other regions use the 30-meter Copernicus Digital Terrain Model, pre-processed to remove buildings, forests, and other obstructions to ensure suitability for flood modeling.

By pairing these enhanced terrain inputs with KatRisk's global modeling capabilities, the Canadian flood model provides robust estimates of flood hazard, property-level risk, and financial losses. The results highlight the importance of consistent national flood mapping and high-resolution data in supporting portfolio management, pricing strategies, and climate-resilience planning.

1d: Next Generation Flood Model for Canada: A Comprehensive Approach by Impact Forecasting

Ladislav Palán (ladislav.palan@aon.com)

Ladislav Palán, PhD, CCRMP, heads the development of Impact Forecasting's flood model for Canada and leads climate change quantification for flood within Impact Forecasting. Based in Prague and with the firm since 2014, he has worked on flood model development for multiple countries across EMEA, the Americas and Asia, including major redevelopment of the Canada flood model. His work spans the full modelling lifecycle from event sets and hydrological / hydraulic methodologies to risk and loss calculation and involves collaboration with regulators, insurers, reinsurers, public sector organisations and academic partners, including partners in Canada. Ladislav holds a PhD in Water Management and Water Structures from the Czech Technical University in Prague and is a Certified Catastrophe Risk Management Professional (CCRMP).

Abstract: Flooding is a major natural hazard in Canada, causing significant losses. The catastrophic floods in Alberta and Ontario in 2013, and more recent events in British Columbia in 2021 or Quebec in 2024, highlight the need for advanced flood risk management tools. Impact Forecasting, a catastrophe model developer of Aon, has been developing tools to aid the insurance industry. Since the release of the first version in 2015, the model has seen several updates, including a pluvial component and climate change view.

The latest version, Impact Forecasting Flood Model for Canada 3.0, represents a significant advancement in flood risk assessment, completely rebuilt using the newest data and approaches. It covers the entire Canadian territory of 10 million km^2. The model integrates floodplain, off-floodplain, pluvial, and storm surge perils. The model component consists of hazard and vulnerability and, together with property information, can estimate loss.

The model is based on simulation flood maps using high-resolution Digital Elevation Models (DEMs) with resolutions ranging from 0.5m to 10m and covering more than 95% of the population, and 30m MRDEM and 2m ArcticDEM for the rest. Flood modeling is conducted using 2D hydrodynamic simulations with Sub Grid Sampling (SGS) in TUFLOW, resulting in output flood maps with resolutions up to 5m. The detailed simulation is based on hydraulic correctness of DEMs, including removing obstacles and creating channels. Fluvial maps incorporate current information on flood protection measures. Pluvial simulations consider various rainfall intensities, soil infiltration parameters, and urban stormwater drainage systems.

The stochastic event catalog combines pluvial and fluvial events, derived from rainfall-runoff modeling. Forcing data, including historical periods from the ERA5 and EMDNA

datasets and decadal runs from GCMs and RCMs from the CMIP5 and CMIP6 projects, were bias-corrected and downscaled using machine learning techniques to cover thousands of years of daily precipitation and temperature data of present and future climate. HYPE rainfall-runoff model and the physical models MESH/SUMMA were calibrated and consider the hydrological behavior of prairies and snow patterns. The calibrated models were used to model the full dataset of forcing data to obtain stochastic flows in river channels.

The model also includes a storm surge component, simulated using the SFINCS model, accounting for the impact of tropical cyclone events on the coast and ensuring the model captures the complex interactions between different types of flooding.

The vulnerability curves are based on a damage curves simulator investigating structural damage on various buildings by different types of loads. Vulnerability curves can consider various types of modifiers such as structure, basement presence, or backwater valve. The curves translate hazard intensity (water depth and velocity) into loss per location and event. A significant innovation is the calculation of losses on specific individual buildings. However, the calculation of loss per longitude-latitude location and per administrative unit remains.

In conclusion, by integrating high-resolution data, advanced hydro-modeling techniques, and the ability to assess risks at specific buildings, the model provides insurers with the tools they need to effectively manage flood risk in an increasingly uncertain climate.

<table>
<tr><td>2</td><td colspan="3">Flood Risk Assessment & Modeling – Data-Driven Hydrological Monitoring and Modelling for Flood Forecasting</td></tr>
<tr><td colspan="2">Angela Corina</td><td>Vice-president, Services Commission, WMO</td><td>angela.corina@protezionecivile.it</td></tr>
<tr><td colspan="4">Session Description:

Session Objective: To explore and advance data-driven approaches for hydrological monitoring and AI based or physical modelling that enhance the flood forecasting to support effective risk management and decision-making.

Session Output: Participants will gain a clear understanding of how AI-based and physically based hydrological models, combined with earth observation and in-situ monitoring data, can improve flood forecasting performance for effective risk management and decision making.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">2a: Advancing Impact-Based Flood Forecasting Through Integrated Frameworks and Global Collaboration

Hwirin Kim (hkim@wmo.int)

Dr Hwirin Kim has been serving as the Chief of Hydrological Modelling and Forecasting (HMF) Section of the World Meteorological Organization (WMO), since 2019. The HMF section supports the enhancement of Members' hydrological and water resources services by coordinating diverse projects and programmes such as the Associated Programme on Flood Management (APFM, WMO/GWP), the Global Flash Flood Guidance System (GFFGS), the WMO Community of Practice (CoP) on Flood Forecasting (FF) and Early Warning Systems (EWS), and other activities related to hydrologic forecasting and water resources assessment and management.

Before joining WMO, Dr Kim was with the Ministry of Environment, Republic of Korea (2005-2019), as leader of the Forecasting and Disaster Risk Reduction team of the Han River Flood Control Office, mainly working in the areas of flood forecasting and integrated water resources management. She was the first hydrologist in the Ministry and holds a Doctorate degree (PhD) in Water Resources Engineering and a Masters' degree (M.Sc.) in Hydrology. As an expert in hydrology and water resources management, she has made significant contributions to multiple programmes such as, Member of the Advisory Working Group (AWG) of WMO Commission for Hydrology (2016-2019), Theme leader of WMO Regional Association II Working Group Hydrological Services (2012-2019) and Focal point for both the UNESCO International Hydrological Programme (2011-2014) and the ESCAP/WMO Typhoon Committee (2010-2014). She has also led the development of an assessment tool for managing of water resources, which has been made available to the public at WMO's website.</td></tr>
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Abstract: Impact-based forecasting (IBF) represents a major shift in flood risk management by linking hydrometeorological hazards with vulnerability, exposure, and context-specific impacts. This approach enables more effective early warning systems, anticipatory actions, and risk-informed decision-making. Within the context of the Early Warnings for All (EW4All) initiative, IBF is a key enabling element for strengthening people-centred, end-to-end multi-hazard early warning systems, particularly for flood risk. This contribution presents recent advancements under several World Meteorological Organization (WMO) initiatives that collectively strengthen global hydrological IBF capabilities.

The WMO Flood Forecasting Initiative promotes end-to-end flood forecasting capacity, supporting National Meteorological and Hydrological Services in transitioning from hazard-centric forecasts to actionable, impact-oriented services. Complementing this, the Associated Programme on Flood Management (APFM) provides technical guidance and operational tools to implement Integrated Flood Management principles within IBF workflows through its helpdesk. The Inventory of End-to-End Early Warning Systems for Flood Forecasting, compiles operational models and system components that assist countries in selecting sustainable and context-appropriate forecasting solutions.

Building on these foundations, WMO's Flood Forecasting Framework offers structured guidance for sustainable, interoperable, open-source Members-driven solutions. To facilitate sustained knowledge exchange and operational learning, the newly launched Community of Practice for Flood Forecasting fosters collaboration among hydrologists, meteorologists, disaster managers, researchers, and humanitarian partners. This community accelerates adoption of innovations such as machine learning applications, high-resolution impact-based modelling, and personalization of alerts.

Together, these initiatives demonstrate how coordinated global efforts enhance the development, evaluation, and implementation of hydrological impact-based forecasting. The paper highlights practical lessons, evolving methodologies, and case examples illustrating how IBF reduces flood impacts and strengthens multi-hazard early warning systems, supporting the WMO long-term ambition that No One is Surprised by a Flood.

2b: A regional multi-hydrological model for the interoperable Transboundary Flood Early Warning System in the Nile Basin

Ramesh Tripathi (rtripathi@wmo.int) **and Tom Kanyike** (tom.kanyike@igad.int)

Ramesh Tripathi (rtripathi@wmo.int)

Ramesh Tripathi is currently working as the 'Adaptation Fund Project Officer' in Hydrology and Water Resources Services (HWR) division of the World Meteorological Organization for over eight years. Ramesh has been part of the Technical Support Unit (TSU) of Associated Programme on Flood Management (APFM) initiative mainly implementing various projects on flood and drought management, climate change adaptation (CCA) and disaster risk management in general, working closely with the National

Meteorological and Hydrological Services of various countries, international and non-governmental organizations worldwide. Ramesh holds double MSc degrees from University of Trento, Italy and Tata Institute of Social Sciences, India specialized in Disaster Management and Water Resources Management

Tom Kanyike (tom.kanyike@igad.int)
Previously, I worked at the National Hydrological Services of Uganda as a Principal Hydrologist focusing on operational hydrology. Since 2024, I work as a Researcher at ICPAC focusing on improving the performance of operational hydrological forecasting models. I also serve on two technical groups, namely; Member of the Nile Basin Regional Expert Working Group on Hydrology (REWGH) and Member of the WMO Expert Team on Operational Hydrological Prediction Systems (ETOHPS). I am a Registered Engineer with the Uganda Engineers Registration Board (UERB) and a Member of the Uganda Institution of Professional Engineers (UIPE). I hold a Bachelor of Science in Civil Engineering, a Post-Graduate Diploma in Hydraulic Engineering in River Basins and a Master of Science in Civil Engineering. I am currently a PhD student of Climate Change and Sustainable Development. I hold professional certificates in; Hydrologic modelling, Data science and Machine Learning, Flood Assessment, Application of GIS & Remote Sensing in Water Resources Management, Database Administration, Streamflow forecasting, Transboundary water management. Some of the software tools that I use for my work include; Mike Hydro, GeoSFM, SWAT, WEAP, HEC-HMS, GeoClim, ArcGIS, Microsoft Apps (Word, Excel, Access), Python, R and C++. While at ICPAC, I have been involved in different projects;

1. Improved Anticipation of Floods on the White Nile (INFLOW):
    - Improving the representation of hydrological processes within the White Nile and incorporating the changes into the models to enhance their accuracy. I accomplished this by adding lakes and reservoirs in GeoSFM model and recalibrating the model for the White Nile.
2. ACEWATER III:
    - Setting up Lake Tanganyika water balance model & carrying out skill assessment to improve trans-boundary water management and build capacity.
3. Strengthening Extreme Events Detection for Floods and Drought (SEED-FD):
    - Evaluating the performance of Global Flood Awareness System (GloFAS) after re-calibration, focusing on the Juba-Shebelle Basin.

I have skills in; data processing and analysis, scripting and programming, hydrological modelling and forecasting, evaluation of hydrological models, application of machine learning in hydrological modelling and capacity building.

Abstract: The development of a multi-hydrological model forecasting system within the Water at the Heart of Climate Action (WHCA) project represents a major advancement toward strengthening transboundary flood early warning capabilities in the Nile Basin countries (Ethiopia, Rwanda, South Sudan, Sudan and Uganda). The Basin currently hosts a heterogeneous suite of national and regional hydrometeorological databases

and Early Warning Systems (EWS), creating challenges for coherent risk monitoring and coordinated warning services. To address these gaps, ICPAC—together with World Meteorological Organization (WMO) and technical partners including Swedish Meteorological and Hydrological Institute (SMHI), CIMA Research Foundation, and United Nations for Disaster Risk Reduction (UNDRR)—is leading the co-development of an interoperable, ensemble-based hydrological modelling and forecasting framework integrated into the East Africa Hazard Watch platform (NILEALARM). The scientific foundation of the system lies in the coupling of multiple hydrological modelling approaches for the Hydrological Predictions for the Environment (HYPE), Geospatial Stream Flow Model (GeoSFM), Mike Hydro, and the FloodPROOF, supported by historical hindcasts, real-time observational data, and model skill assessments provided by technical partners. This multi-model configuration aims to enhance uncertainty quantification, improve forecast robustness, and enable consistent generation of riverine and flash-flood forecasts on timescales ranging from hours to seven days. Complementary exposure, vulnerability, and coping-capacity datasets provided through impact-based forecasting systems further support the transition from flood hazard forecast to warning services for anticipatory decision-making.

The open source and tailored interoperable visualization platform under development (first version is expected to be out by July 2026) will integrate global hydrometeorological monitoring and forecasting products, national datasets, and impact-focused information into a unified architecture designed for operational use by National Meteorological and Hydrological Services (NMHSs), disaster management authorities, and humanitarian partners. This coordinated approach supports the generation of harmonized regional and national advisories and aims to strengthen end-to-end EWS capabilities across the Basin. Ultimately, the multi-model forecasting system constitutes a critical scientific and institutional step toward enhancing flood preparedness, transboundary risk management, and climate resilience for vulnerable communities in the Nile Basin.

2c: Navigating jurisdictional complexity: Challenges producing impact-based warnings for flash flooding in Canada

Natalie Gervasi (natalie.gervasi@ec.gc.ca)

Natalie Gervasi is a Physical Sciences Specialist with Environment and Climate Change Canada's (ECCC) National Hydrological Service. She is a primary support and partner liaison for hydrological prediction efforts in eastern Canada, conducting outreach and engagement and providing important technical expertise on ECCC products and services to provincial and territorial flood forecasters. Natalie also provides expertise and technical support to ECCC's transboundary water management activities in the Laurentian Great Lakes. She is currently co-leading the development of a binational hydrologic regulation and routing model to support operational outflow regulation and forecasting activities in the Great Lakes – St. Lawrence River system.

Abstract: Flash flooding increasingly challenges water managers and emergency responders across Canada, yet our ability to provide effective impact-based warnings remains limited by both jurisdictional complexity and technical gaps. In Canada, provinces and territories (PTs) hold responsibility for water resources management, including flood forecasting and warnings, while the federal government provides national hydrometric and meteorological monitoring information, radar and satellite data, plus weather forecasting products and services. This creates a challenging operational environment for flash flooding, which requires highly integrated hydro-meteorological prediction but falls into a jurisdictional gap where no single authority has clear mandates for comprehensive warnings. Through the Community of Practice for Operational Hydrologic Prediction in Canada, federal and PT partners have identified challenges, including localized event prediction, inconsistent technical capacity across jurisdictions, and unclear roles compared to river forecasting. Federal numerical weather and environmental prediction systems provide some components for flash flood forecasting, but lack critical elements like real-time quantitative precipitation estimates and effective nowcasting at the spatial-temporal resolutions required for meaningful warnings. Additionally, in certain areas there is a fundamental gap in localized flood hazard and vulnerability knowledge, making it difficult to translate hydro-meteorological predictions into actionable impact assessments. While there is substantial expertise at both federal and provincial levels, resource constraints limit the ability to address these challenges independently. Efforts are underway to increasingly leverage national partnerships through enhanced federal-PT collaboration and international relationships to share knowledge, tools, and best practices. Recent experience demonstrates how complex governance structures can both challenge and motivate innovative approaches to impact-based forecasting, with lessons applicable to other jurisdictions with similar institutional frameworks.

2d: From Prediction to Action: Operationalizing Impact-Based Forecasting in Uganda's Aswa and Manafwa Catchments

Charles Kakooza (charkaks0@gmail.com)

Senior Hydrologist | Ministry of Water and Environment, Uganda

Charles Kakooza is a Senior Hydrologist at the Ministry of Water and Environment, Uganda, where he spearheads the integration of advanced modelling and digital information systems into national water resource management. With over a decade of operational experience, Charles has been instrumental in bridging the gap between raw Hydro-meteorological data and actionable early warning systems for disaster risk reduction in Uganda.

Charles holds an MSc in Water Science and Engineering with a specialisation in Hydroinformatics from the IHE Delft Institute for Water Education, Netherlands. His academic work focused on the design and implementation of innovative water information systems, culminating in his master’s thesis, ""Decision support system for sustainable utilisation of the Eocene Aquifer in the West Bank, Palestine"". This research established his expertise in leveraging advanced data analytics and artificial intelligence to resolve complex subsurface and surface water management challenges.

Currently, Charles serves as the National Focal Person for ""Water at the Heart of Climate Action"" (WHCA), a flagship initiative facilitated by the World Meteorological Organisation (WMO). In this capacity, he serves as the Pillar 2 Lead, driving the refinement and operational integration of flood and drought Early Warning Systems (EWS) in direct alignment with the United Nations' global Early Warnings for All (EW4All) mandate. His leadership is instrumental in creating interoperable national systems that seamlessly connect global hydro-meteorological data to local anticipatory action Plans.

As part of the technical architect for the UNICEF-supported ""Strengthening Climate Resilient WASH Programming"" initiative, Charles is leading the operationalisation of Aswa and Manafwa Impact-Based Forecasting (IBF) EWS in Uganda. By calibrating coupled hydrological (HEC-HMS) and hydraulic (HEC-RAS) models, he successfully defined inundation extents and risk profiles for 5 to 100 year return periods. His methodology significantly advanced regional forecasting capabilities by assimilating global datasets from ECMWF and NOAA and incorporating antecedent soil moisture conditions, effectively extending flood prediction lead times to seven days with a Probability of Detection exceeding 85%.

Beyond his national duties, Charles is an active member of the Nile Basin Initiative (NBI) regional technical working group, where he participates in optimising and operationalising transboundary drought EWS, River Flow Forecasting System and Hydropower decision-support system. He is also a pioneer in applying Nature-Based Solutions (NbS) for urban flood resilience and utilises Remote Sensing (GEOGLOWS) to enhance forecasting in data-scarce environments.

At ICFM-10, Charles represents a new standard of hydroinformatics expertise, dedicated to transforming Hydro-meteorological prediction into life-saving outcomes for vulnerable communities in East Africa.

Abstract: This paper presents the technical development of an operational Impact-based Forecasting (IBF) and Early Warning System (EWS) for the Aswa and Manafwa catchments in Uganda. Addressing the critical gap between raw meteorological data and actionable decision-making, the study establishes a scalable framework that translates hydro-meteorological hazards into location-specific risk indicators for flood and drought management under the UNICEF-supported "Strengthening Climate Resilient WASH Programming" initiative.

To overcome regional data scarcity, the methodology integrates local historical records with global datasets. For flood impact assessment, coupled hydrological (HEC-HMS) and hydraulic (HEC-RAS) models were calibrated to define specific inundation extents and depth-velocity profiles for return periods ranging from 5 to 100 years. Crucially, the

forecasting logic incorporates antecedent soil moisture conditions to refine trigger thresholds, ensuring that alerts reflect actual hydrological impact potential rather than precipitation magnitude alone. Drought impacts are assessed using a water balance model and the deciles method to identify specific agricultural moisture deficits.

The delivered solution is a fully automated web-platform that assimilates short-term (ECMWF, NOAA) and seasonal (NMME) forecasts, enabling a flood prediction lead time of seven days or more, a significant gain over the three-day limit of conventional systems. Validation against historical events shows high skill, with a target Probability of Detection (POD) of over 85% and a manageable False Alarm Ratio (FAR) below 20%, proving the system's utility in supporting anticipatory action. This system demonstrates a successful transition from traditional monitoring to impact-based forecasting, enhancing the capacity of local institutions to anticipate climate shocks and implement proactive resilience measures.

2e: Contribution of Earth Observation from Satellites to Flood Monitoring and Forecasting

Hwirn Kim (hkim@wmo.int) **and Marcelo Uriburu Quirno** (muriburu@conae.gob.ar)

Dr Hwirin Kim has been serving as the Chief of Hydrological Modelling and Forecasting (HMF) Section of the World Meteorological Organization (WMO), since 2019. The HMF section supports the enhancement of Members' hydrological and water resources services by coordinating diverse projects and programmes such as the Associated Programme on Flood Management (APFM, WMO/GWP), the Global Flash Flood Guidance System (GFFGS), the WMO Community of Practice (CoP) on Flood Forecasting (FF) and Early Warning Systems (EWS), and other activities related to hydrologic forecasting and water resources assessment and management.

Before joining WMO, Dr Kim was with the Ministry of Environment, Republic of Korea (2005-2019), as leader of the Forecasting and Disaster Risk Reduction team of the Han River Flood Control Office, mainly working in the areas of flood forecasting and integrated water resources management. She was the first hydrologist in the Ministry and holds a Doctorate degree (PhD) in Water Resources Engineering and a Masters' degree (M.Sc.) in Hydrology. As an expert in hydrology and water resources management, she has made significant contributions to multiple programmes such as, Member of the Advisory Working Group (AWG) of WMO Commission for Hydrology (2016-2019), Theme leader of WMO Regional Association II Working Group Hydrological Services (2012-2019) and Focal point for both the UNESCO International Hydrological Programme (2011-2014) and the ESCAP/WMO Typhoon Committee (2010-2014). She has also led the development of an assessment tool for managing of water resources, which has been made available to the public at WMO's website.

Abstract: Earth observation (EO) from satellites plays an increasingly significant role in operational hydrology, particularly in flood monitoring and forecasting. Numerous

satellite sensors orbit the Earth, providing access to a wide range of observations of hydrological variables at varying spatial, temporal, and spectral resolutions, including rainfall, water surface elevation in rivers, soil moisture, snow cover, and land cover. These observations are essential for understanding water system dynamics and improving flood prediction accuracy. One of EO's main strengths is its global coverage and continuous data provision, which complement traditional ground-based networks and provide comprehensive views of hydrological systems, especially in regions with sparse ground data. This paper explores how satellite-based remote sensing contributes to flood monitoring and forecasting operations, highlighting its potential to meet the challenges associated with real-time applications. This paper discusses how satellite data supports operational flood forecasting activities, with a focus on three key aspects: (i) hydrological modelling operations, (ii) hydrological model setup and calibration, and (iii) flood detection and impact assessment. The contribution of satellite EO data to hydrological modelling operations is by providing data as model forcing, model initialization, and model updating (through data assimilation). This use of EO data imposes a stringent requirement for low latency. Hydrological model setup and calibration leverage on the ability of satellite data of describing the physiographic characteristics of river basins that more significantly influence rainfall runoff processes. Satellite derived data, such as digital elevation models (DEMs), land cover maps, and vegetation indices, provides critical information on topography, slopes, land use, and drainage networks. Earth observation can aid model parameter calibration by capitalising on statistical relationships between model outputs and remote sensing data. For example, satellite-based altimetry and flood width measurements can be used to compute discharge, enabling the calibration of hydrological and hydraulic models. Additionally, satellite-derived basin-outlet top width data can be incorporated into combined hydrologic and hydraulic models, optimizing model parameters by comparing remote-sensing top widths with those generated by the models. Finally, EO contributes to flood detection and impact assessment: satellite products, including from optical and radar sensors, help detect flood events and assess their severity. Analyzing satellite images over time allows for tracking flood progression, mapping flooded areas, and estimating flood depth. These capabilities are fundamental for assessing the potential impact of floods on communities and infrastructure, enabling decision-makers to better prepare and respond to flood events. In conclusion, Earth observation from satellites has significantly advanced flood forecasting, offering an efficient means of monitoring hydrological variables, improving model calibration, and enhancing flood detection and impact assessment. The ability to obtain real-time, high-resolution data from satellites has enhanced flood forecasting, making it more accurate, timely, and reliable, thus reducing the risk of flooding and helping mitigate its impacts on communities worldwide.

3	**Flood Risk Assessment & Modeling** - From Impact based forecast to action: Hydrological and Warning Services for protecting lives and livelihoods	
Dr Hwirin Kim	Chief of Hydrological modelling and forecasting section, WMO	hkim@wmo.int

Session Description:

Session Objective: To strengthen the development and use of impact-based hydrological forecasts into timely and actionable warning services, enabling effective preparedness, response, and decision-making to protect lives and livelihoods from flood-related hazards.

Session Output: Best practices, innovative tools, and technologies for incorporating hydrological impact-based forecast information into local
and national risk informed decision-making processes will be highlighted to safeguard lives and livelihoods.

3a: EW4All: Impact-Based Forecasting and Warning Services for Floods and Droughts

Angela Corina (angela.corina@protezionecivile.it)

Angela Corina is one of the vice-presidents of the WMO Commission for Weather, Climate, Hydrological, Marine and Related Environmental Services and Applications. Expert engineer and civil servant of the National Civil protection Department of Italy, where she has worked for over 20 years in a variety of forecasting, training and senior roles in the field of operational hydrology and development of Early Warning System with a multi-disciplinary approach. Responsible for the coordination of research activities, author of scientific publications and designer of information systems for meteo-hydro monitoring and risk assessment, expert in international capacity building and technical assistance projects in disaster risk reduction. She has served in a variety of international and WMO bodies, where she has been involved since 2011, primarily through the former Commission for Hydrology, then in the SERCOM since its establishment, and also as Regional Hydrological Adviser of RAVI-Europe since 2018.

Abstract: Early Warnings for All (EW4All) calls for a step change in how early warning systems translate forecasts into timely, people-centred action. Impact-Based Forecasting and Warning Services (IBFWS) for floods and droughts are a cornerstone of this transformation, enabling decision-makers and communities to understand not only *what the hazard will be*, but *what it will do* and *what actions are required*.

This contribution presents the approach for the new WMO publication *Guidelines on Impact-Based Forecasting and Warning Services for Floods and Droughts*, informed by extensive international expert review and explicitly aligned with the four pillars of EW4All: disaster risk knowledge, monitoring and forecasting, dissemination and communication,

and preparedness and response. The publication addresses key gaps identified by practitioners, including uneven national capacities, insufficiently operational drought guidance, and the need for clearer methodologies to manage uncertainty, quantify impacts, and evaluate performance.

The revised framework introduces scalable implementation pathways tailored to different country contexts, strengthens technical guidance on modelling and impact assessment, and provides fully operational, endto-end workflows for both floods and droughts, linking indicators and forecasts to triggers, standard operating procedures, decision timelines, and communication products. Governance and communication components are reinforced to ensure alignment with people-centred early warning principles, institutional coordination, and accountability.

Illustrated through operational case studies, including transboundary basin applications and progressive "call-and-response" mechanisms, the revised guidelines demonstrate how IBFWS can accelerate anticipatory action, support early response, and reduce loss and damage. By translating EW4All principles into practical, hydrology-specific guidance, the revised guidelines aim to support National Meteorological and Hydrological Services and their partners in delivering effective, inclusive, and sustainable early warning services for floods and droughts worldwide

3b: Collaborative People-Centered Solutions for Humanitarian Flood Resilience: Alternative Roadmaps and Transitions toward the Early Warnings for All

Eduardo Mario Mendiondo (emm@sc.usp.br)

Science-policy-innovation expert on climate services and solutions in Asia, Africa, Europe and the Americas. A shaper and doer in topics of: climate services, water-adaptive design & innovation (WADI), fair transition, sustainable insurance, people-centered humanitarian engineering, early warnings for all (EW4All), and Disaster Risk Reduction and Resilience. In 2000, participated of the Organizing Committee of the 1 st Intl. Symp.on Flood Defence, Kassel, Germany. He was a former author of the Millennium Ecosystem Assessment. In the last 20 years, he has participated in WMO-affiliated initiatives and programs, i.e. the Associated Programme on Flood Management (APFM); the Prohimet ("Red iberoamericana para el monitoreo y pronóstico de fenómenos hidrometeorológicos") and collaborated with INMET, ANA, SGS/CPRM (Brazil), SENAMHI (Peru), INA (Argentina) and CIC-Plata (Arg., Braz., Uruguay, Paraguay, Bolivia). He has contributed with EDI values (equity, diversity and inclusiveness) in different science-policy boards of global initiatives, namely: in the IAHS (in Science Steering Group of the "Prediction in Engaged Basins"-PUB, 2003-2012; co-leader of the Panta Rhei Sci. Decade, 2013-2022, and as the first Editor-in-Chief of the IAHS Digital Water Globe of the IAHS-HELPING Science Decade, 2023-2032); in the in the IWA (e.g. in the Steering Group of the Digital Water Programme, and in the Earth Observations for Water Management Community of Practice,2023-2026); in the African Centre of Excellence in Water and Environment (ACEWATER, 2019-2028), in the UNEP World Water Quality Alliance

(WWQA/GEMS); in the UNESCO Intergovernmental Hydrologic Programme (IHP, IX Phase) and as the CEO of the UNESCO Urban Waters Chair at the Univ. of São Paulo. During COVID pandemic, he created and supported campaigns of science diplomacy through engaging different groups of stakeholders (vulnerable communities, academy, decision-makers, private sectors) with the #OneDropOfScience #OneDoseOfResilience campaign. In the period 2014-2016, he acted as the Head Coordinator of the Center of Monitoring and Alerts of Natural Disasters (CEMADEN), of the Braz. Ministry of Sci., Tech. and Innovation. He is recipient of the São Paulo Government Medal of Civil Defense for Outstanding Community Works. Nowadays he is Coordinator of the Water Security and Adaptive Management axis of the FAPESP Climate Crisis and Disasters Resilience Research Center (CLIMARES). Also supported the Nat. Inst. Sci. & Tech. (INCTs) on: "Climate Change-Phase 2"; "Fighting Hunger" at FSP/USP; and the "Nat. Observatory of Wat. Security & Adaptive Mgmt." at UFPE, Brazil. Moreover, he acts as Assoc. Researcher of FAPESP research centers: the "Center for Artificial Intelligence" C4AI at INOVA+ICMC/USP; the Center for Biodiversity and Climate Change-CbioClima at IB/UNESP, the INRS Planetary Health Intl. Research Centre-PHIRC; and the BIOTA-NASSE Environment- Health- Ecosystem Services Nexus- from risk to adaptation and resilience. He holds a B. Eng. Water Resources Eng. (FICH, Univ. Nac. Litoral, Argentina), a MSc and PhD in Water Resources and Sanitation (IPH, Univ Fed. Rio Grande do Sul, Brazil), and as a BMBF researcher at the Center for Environmental Sys. Research, Univ Kassel, Germany. Since 2002, he is Prof. Dr. of Hydrology and Water Resources at the Department of Hydraulics & Sanitation (SHS) of the Escola de Engenharia de São Carlos (EESC), Univ. São Paulo, Brazil, where he also is the Director of the Center for Water Resources and Environ. Studies (CRHEA) and the Center for Education and Research on Disasters (CEPED/USP). He has advised numerous M. Sc. and PhD works, receiving recognitions for Awarded PhD Theses and Dissertations. Since 2024, he is Visiting Professor at the Intl. Centre for Excellence in Dams, IIT-Roorkee, India. Full CV and list of publications at: https://orcid.org/0000-0003-2319-2773. Email: emm@sc.usp.br

Abstract: We introduce science-based, people-centered, bottom-up experiences, and low-cost examples with solutions through real case studies demonstrating the effectiveness of impact-based forecasting in reducing flood-with-drought impacts. By merging traditional with unconventional methods with impact-based approaches are hybrid, low-cost and decentralized schemes here presented, not only integrating vulnerability and exposure data, but also developing comprehensive impact-based forecasts. In the period 2014-2025, with real experiences at the Nat. Center for Monit. & Alerts of Disasters (CEMADEN/MCTI) and at the statewide Center for Education and Research on Disasters (CEPED/USP) we have promoted African, Latin and North American case studies. We present citizen-engineered solutions through open-source, community models and citizen-science training with viable applications for Municipality, State and National early warning systems. On the one hand, selected examples combine multi-hazard early warning systems, protocols and services for water-related disasters (Horita et al, 2015; 2017), citizen-driven prediction streamflows forecasting (Restrepo-Estrada et al, 2018), humanitarian perspectives on modeling and mitigating

unprecedented disasters in data-scarce regions (Sánchez et al, 2023), integration of machine learning and artificial intelligence in hydrological impact-based forecasting (Lago et al, 2024), hydrological digital twins for hurricane-prone regions with high-resolution impact-based flood forecast with operational implementation needs (Castillo et al, 2024), serious games for infrastructure collapse risk mapping (Gómes Jr. et al, 2024), and human-centered assessment for heavy rains, flashfloods and changing climate (Castillo-Rápalo et al, 2025). On the other hand, we discuss how these innovations accelerate private-public-partnerships (PPP) in developing multi-hazard early warning systems for water-related hazards, i.e. through PPP's index-based insurance to mitigate current and future extreme events financial losses for unprecedented floods and droughts (Gesualdo et al, 2024), and data-driven frameworks for assessing climatic impact drivers in the context of water-energy-food-ecosystem-society nexus. These forementioned evidences and field-based learning do pose new PPPs through the Center for Climate Emergency and Disasters Resilience (CLIMARES CEPID FAPESP, Ambrizzi et al, 2025) on: i) how a new generation of evolutionary hydrological forecasting is either affordable and solver-driven for disaster risk reduction on worldwide most vulnerable regions, ii) in what manner feasible low-cost solutions can be upscaled into NHS (National Hydrological Services), Regional Specialized Meteorological Centres-RSMCs and National Disaster Centers, and iii) which digital crowdsourced experiments aided by ancestral hydro-solutions perform collaborative recommendations for risk communication toward fair transition of WMO/EWs4All with global community of practice of UNESCO-IHP, IWA-DWP, IAHS-HELPING and UNEP WWQA/GEMS.

3c: Transitioning from regional flood warnings to localized decision support systems: an approach for user participation and prototype for local risk assessment tailored to different municipality needs

Trine Hegdahl (tjh@nve.no)

Trine Jahr Hegdahl is a hydrologist and researcher at the Norwegian Water Resources and Energy Directorate (NVE), specializing in flood forecasting, hydrological modelling, and climate driven changes in water systems. She is currently working with integrating field observations and quantitative modelling, with additional relevant data to improve early warning systems and strengthen society’s preparedness for extreme weather events, both in Norway and Nepal.

Hegdahl led the national impact-based forecasting project, FlomRisk, and also contributes to European research such as STARS4Water, collaborating with public-sector partners to turn scientific findings into practical decision-support tools. Her research covers hydrological ensemble prediction, water management and climate-sensitive processes in areas fed by snow and glaciers. Additionally, she is a member of the national flood forecasting team.

She holds a PhD in hydrology from the University of Oslo, where she is an associate professor II, and has extensive experience presenting research in academic, policy and operational settings.

Abstract: The national flood warning system in Norway is currently undergoing a comprehensive renewal process. Efforts are being directed toward implementing risk-based flood forecasting as part of the national FlomRisk project, which commenced in 2022 and spans four years. User engagement has been integral to the project, with five municipalities selected as pilot study areas. Over the past four years, various flood forecasting modelling chains have been systematically evaluated, including hydrological and hydraulic model selection and approaches for aggregating local impacts. One primary objective of the project is to enhance the regional warnings issued by the national flood warning service by more accurately reflecting local consequences. Additionally, the project seeks to identify the specific informational needs of municipalities during critical flood events. To address these goals, a service design methodology has been employed. Active collaboration and codesign with municipalities have ensured that national warning services are aligned with the development of relevant and effective products for local decision support.

The involvement and codesign processes were initiated concurrently with modelling and impact mapping activities in 2022. Significant progress to establish user needs was made in 2023, including the completion of over 100 user interviews across more than five municipalities, as well as with national flood experts and consultants. To better understand the decision-making processes during flooding events, information requirements were identified for different stages: before (preparation phase), during (coordination and crisis management), and after (event evaluation and extraction of future learning points). Through these efforts, municipalities highlighted four primary needs: 1) timely access to information to facilitate situational overview and support emergency response planning, 2) relevant, localized insight into the current situation and potential consequences, 3) improved communication both within organizations and externally—particularly with media and residents, and 4) streamlined documentation of impacts and adaptation measures throughout ongoing situations.

Insights from 2023 and 2024 were used to develop a decision support prototype for Voss Herad, a municipality facing complex flood and natural hazard challenges. By collaborating with local contacts, emergency leaders, modeling teams, and other stakeholders, the team codeveloped a prototype for decision support.

The initial prototype was presented to an external panel of municipalities and users, who provided essential feedback, suggestions, and proposed changes. Users contributed valuable insights based on their diverse experiences with flood and natural hazard challenges, as well as differing knowledge and organizational structures in emergency responses. This collaborative approach led to recommendations on how municipalities could develop or integrate decision support systems to better manage local flood

situations. A second version was developed including more text, and more options for integration of action cards, towards different flood hazards at different levels.

The second version was then introduced to two of the original pilot study areas, each with different internal organizations and flood risks, to develop local adapted decision support systems for these diverse municipalities.

Through this process, we identified the essential information municipal emergency preparedness teams require. The system is under development for operational testing, and highly anticipated focusing on fulfilling information needs, assessing visualization approaches, and recognizing data constraints. Ultimately, the goal is to deliver a unified system enabling municipalities to access all necessary data and information to effectively respond to natural hazard emergencies.

This abstract represents one part of the larger FlomRisk project. The contribution of all involved is important providing insight, knowledge and skills at all levels needed to make overall optimal decisions support systems. A large thank you to the FlomRisk team!

3d: Designing for Decisions: Harmonizing Warnings Across Germany Aligning Data, Maps, and Messages: The NGP for Disaster Risk Reduction

Bodo Erhardt (Bodo.Erhardt@dwd.de)

Bodo Erhardt, currently working as Product Owner of the Natural Hazards Portal for Germany (since 2024) and responsible for development and operations of the portal. I'm holding a bachelors' degree in meteorology and a masters' degree in disaster management and risk governance. Further steps in my career is leading the subteam for impact based warnings within DWD (2022-2023) and before that I worked as aviation meteorologist (2007-2022) and deputy head of the Munich Met Watch Office (2019-2022). Parallel to my position as Product Owner of the Natural Hazards Portal I'm part of the DWD-Team that develops impact-based weather warnings for the general public and professional users.

Abstract: Motivating people to take the appropriate actions for disaster management and risk governance requires not only skillful hazard prediction but also consistent, user-centered communication that enables actionable decisions.

We present the German Natural Hazards Portal (Naturgefahrenportal, NGP), developed and operated by Germany's National Meteorological Service (Deutscher Wetterdienst, DWD) an operational, multi-hazard entry point that standardizes and harmonizes public warning information. The approach builds on three pillars: (1) data and semantic standardization across contributing agencies to create high-resolution layers for floods and other natural hazards; (2) cartographic harmonization of symbology, scales, color ramps, and legends to ensure coherent multi-hazard risk representation across regions; and (3) integration of socio-economic insights to tailor messages, visualize uncertainty,

and enhance comprehension for diverse audiences. NGP complements existing alerting channels (e.g., warning apps) by linking to them rather than issuing push notifications.

We report on partnerships with Federal Flood Forecasting Centers, the Federal Maritime and Hydrographic Agency (Bundesamt für Seeschifffahrt und Hydrographie, BSH), and the Federal Office of Civil Protection and Disaster Assistance (Bundesamt für Bevölkerungsschutz und Katastrophenhilfe, BBK) that enable end-to-end information flows from hydrological forecasting to public-facing warning products. Building on lessons from the Risk Information Management, Risk Models and Applications (RIMMA) 2025 conference, we prioritize an evidence-based evaluation framework over intuition for message design. By bridging disciplines and phases of disaster management, NGP exposes inconsistencies in warning systems and challenges in communicating natural hazard information. We address these through a co-design process and nationwide public surveys to identify the most effective ways to support informed decisions.

3e: Recent developments of the Flood Forecasting Centre for England and Wales

Julia Perez (julia.perez@metoffice.gov.uk)

Julia Perez is a Senior Hydrometeorologist at the Flood Forecasting Centre in the UK Met Office with over 10 years of experience in flood forecasting, incident management and impact based risk communication. She is a Chartered Meteorologist with the Royal Meteorological Society specialising in hydrometeorology, and is currently a project lead enhancing real-time national surface water flood forecasting capability to improve operational services for emergency responders and the UK government.

With an 18 year career with the Met Office including operational forecasting, model and service development, and strategic incident management, Julia is committed to advancing hydrometeorological forecasting capabilities to strengthen the UK's operational flood preparedness and response. She holds a BSc (Hons) in Physics with Meteorology from the University of Edinburgh and qualifications in flood forecasting and operational meteorology.

Abstract: The UK has experienced a heightened period of flood risk with significant summer and winter storms over a five-year period from February 2020 to February 2025 with multiple named storms bringing periods of flooding and disruption. Heightened political and user interest in this frequent domestic flooding, against increased awareness of catastrophic international flood events, has driven investment and interest in further improvements to flood forecasting guidance for incident managers and government departments.

Recent developments at the Flood Forecasting Centre have focused on four areas:

i. improvements in nowcasting and rapid flood updates (less than 6 hours) to anticipate rainfall / meteorologically driven flood impacts in small watercourses and urban centres
ii. better use of high resolution hydrometeorological ensembles and hazard impact modelling in short- and medium-range flood guidance to improve resource deployment planning up to five days ahead
iii. enhancing outlook capabilities in long range flood forecasts to support monthly and seasonal preparations, enabling organisational readiness
iv. improving impact collection capabilities in near real time using novel data sources to meet the user need for almost instantaneous assessment of forecast performance as part of the operational service

These developments are enabled by a joint partnership team able to access tools and techniques across a number of organisations and increasingly include exploring the use of AI/ML techniques in an operational setting drawing on national data sets to improve operational efficiency and add value for users.

4	**Flood Risk Assessment & Modeling** - Panel Session: Emerging Technologies in Flood Hazard and Flood Risk Estimation	
Robin Bourke	Public Safety Canada	robin.bourke@ps-sp.gc.ca

Session Description:

This panel discussion will examine how new and emerging technologies are transforming the understanding, mapping, and management of flood hazard and flood risk in a changing climate. The session will highlight how traditional flood models are being updated with advanced components such as remote sensing, artificial intelligence, cloud computing, and high-resolution climate and terrain data. These approaches, working in concert, are enabling us to generate speedier, more accurate, and more granular understanding of flood behavior and its effect on communities. A discussion will follow on how satellite imagery, drone data, and digital elevation models are improving our ability to assess flood dynamics and how AI and machine learning can help to optimize model calibration, enable early event detection, and enable more accurate long-term risk forecasting. Panelists will also discuss some of the benefits of open-access datasets, online modeling platforms, and probabilistic risk methods, which contribute to good decision making by governments, engineers, and insurers.

Discussion Themes:

- What new technologies and methodologies are available, and how can this improve the accuracy and usability of flood hazard models?
- What are the opportunities and challenges in integrating AI, satellite data, and open-access platforms into operational flood risk management?
- How can we ensure that these advances lead to equitable, transparent, and actionable outcomes for communities at risk?

Delivering a platform to bring together participants from research, government, and industry, this panel is intended to showcase the advances capable of aiding the transition to more predictive, evidence-based, and climate-resilient flood risk management.

Session Panelists:

Robin Bourke (robin.bourke@ps-sp.gc.ca) (Moderator)
Robin Bourke is Senior Engineering Advisor and Manager of the Data Science and Engineering Team at Public Safety Canada. He studied Water Resources Engineering and International Development in Canada and Sweden before spending ten years in northern Canada as a consulting engineer and project manager. Following three years with the Flood Mapping Team at Natural Resources Canada, he joined Public Safety Canada and developed the Data Science and Engineering Team, which provides expert advice and conducts quantitative risk analysis supporting major policy programs including Flood Insurance, Disaster Assistance, Investment Screening, and Flood Risk Communication.

Julie Van de Valk (julie.vandevalk@ps-sp.gc.ca)
Julie Van de Valk, EIT (Senior Engineering Advisor, Public Safety Canada) has an engineering and emergency management background and works to bridge natural hazards engineering, risk assessment and reduction, emergency management, and effective policy development.

Nathaniel Adams (nate.adams@katrisk.com)
Nate is a hydraulic engineer and flood modeler who leads KatRisk's global flood modeling efforts. As Head of Flood Modeling, he oversees the development of hydraulic and hydrologic models that power KatRisk's probabilistic flood solutions. His work focuses on ensuring technical rigor, consistency, and innovation across inland flood and related peril modeling.
Prior to joining KatRisk, Nate spent several years at Verisk Extreme Event Solutions as a Hydraulic Engineer and Senior Hydraulic Engineer, where he contributed to the development of large-scale catastrophe models and advanced hydraulic simulations. He also worked as a Hydraulic Engineer at Alden Research Laboratory and as a Water Engineer at CH2M, gaining hands-on experience with complex water resources and infrastructure projects.
Nate holds a Master of Science in Civil Engineering from the University of Illinois Urbana–Champaign, where his work focused on modeling geologic carbon sequestration.

Jennifer Nafziger (jnafzige@ualberta.ca) Ph.D., P.Eng
Professor in water resource engineering at the University of Alberta.

Anaïs Couasnon (anais.couasnon@deltares.nl) Ph.D.
Deltares

5	**Urban Flooding & Infrastructure** - Assessment and mitigation of urban flooding using advanced modelling tools	
Soheil Kashi	GHD	Soheil.Kashi@ghd.com

Session Description:

In light of recent urban flooding experienced across Canada, causing significant damages to homes and infrastructure and increasing public safety risks, this session explores new developments in flood modelling and risk assessment techniques, including methodologies and innovations to make models more accurate, accessible and practical. Several case studies showcasing for a wide range of applications of these advancements in planning and implementation of flood mitigation strategies as well as emergency response will be presented.

5a: Investing in a Resilient Future: Uses & Applications of the Risk & Return on Investment Tool (RROIT)

Emma Haug-Kindellan (Emma.Haug-Kindellan@cvc.ca)

Emma Haug-Kindellan is a Water Resources Engineer with Credit Valley Conservation. She has over 10 years of experience in both consulting and public sector environments, focusing on hydrologic / hydraulic modelling, floodplain mapping, municipal stormwater master planning, stormwater management & infrastructure design, as well as emergency preparedness. Emma holds a Professional Engineering License with PEO and has both an Honours Bachelor and Masters Degree in Water Resources Engineering from the University of Guelph.

Abstract: Credit Valley Conservation (CVC) will share lessons learned from extreme storm / flood events experienced within the Credit River Watershed over the last 20 years and how that led CVC and its partners to develop the Risk and Return on Investment Tool (RROIT). The RROIT is intended to help CVC and municipal partners prioritize actions and investment in infrastructure to reduce multi-flood risk areas (including riverine & urban overland, etc.) under both existing and future climate change scenarios. This innovative tool has identified priority neighborhoods at risk of natural hazards, with consideration for identifying publicly owned properties, infrastructure and socially vulnerable populations at risk. By prioritizing risks, CVC and its partners can target actions and investment in natural, green and grey infrastructure to build a resilient future with the greatest return on investment. CVC will provide an overview of case study applications of RROIT, where analysis outputs have been used to inform watershed scale planning, municipal capital infrastructure improvements as well as emergency management planning for major storm events and potential flood risks now and for the future.

5b: Developing Solutions in Downtown Toronto to Alleviate Basement and Surface Flooding

Jonathan Edwards (jonathan.edwards@arcadis.com)

Jonathan Edwards is a Practice Lead of Infrastructure Planning at Arcadis, and brings over 13 years of experience in the planning, assessment and design of municipal sewer infrastructure and collection systems. He has a robust background in field investigations, master and secondary planning studies, Inflow and Infiltration studies, design projects, and capacity assessments on wastewater, stormwater, and combined sewer systems. His specialty lies in urban area hydrologic and hydraulic modelling and has led numerous impactful and innovative model builds for municipal clients across Canada. When away from his desk he's typically running around chasing frisbees or his 2-year old daughter.

Abstract: The City of Toronto's Basement and Surface Flooding Reduction Program, initiated in 2007, has conducted comprehensive Environmental Assessment Master Planning studies citywide, culminating in the assessment of the downtown core; a densely developed, largely impervious 6,000-hectare area serviced by complex combined, storm, and sanitary sewer systems. This study aimed to identify the root causes of basement and surface flooding and develop alternative solutions aligned with the City's service level targets for all drainage systems.

Given the area's size and system complexity, traditional approaches such as addressing isolated problem areas proved inadequate. Instead, an integrated, city-wide hydrologic and hydraulic modelling strategy was adopted, employing a linked 2D surface and 1D network model. This enabled a holistic understanding of interactions between runoff, overland flow, and piped networks, especially under a 100-year storm scenario.

Initial model scenarios demonstrated that even widespread application of inlet controls reduced peak hydraulic grade lines but could not achieve target service levels alone, and in some cases exacerbated surface flooding. Storage analysis revealed that the volume required for effective flood mitigation (200,000–300,000 m^3) far exceeded feasible underground storage opportunities in the downtown area where open space is limited and high-value.

Further modelling of system interactions showed that existing combined and storm-combined sewer outfalls (SCSOs) became overwhelmed in extreme events, often increasing local flood risk. The study concluded that neither source controls nor storage alone were sufficient; instead, a primary conveyance solution including a large diameter central tunnel system branching to local connections was needed. The approach to the development of solutions was enabled by the comprehensive 1D-2D model, and the resulting solutions allow central relief to enable effective local interventions and provide a functionable flood mitigation strategy for Toronto's downtown core.

5c: Advanced 1D-2D Urban Drainage Modelling Streamlined by Automation

Angela Peck (Angela.Peck@ghd.com)

Angela Peck is a water resources engineer with technical and project management experience on complex, multidisciplinary research and design projects involving academia, consulting, and government stakeholders. Her expertise spans conceptual planning through detailed design, with a focus on drainage and hydrology for major infrastructure projects, including MTO work, and regulatory coordination with municipal, provincial, and federal agencies. Angela holds a PhD focused on climate change impacts on coastal cities, has specialized training in coastal engineering, and was an instructor for GIS applications in water resources management. She also holds a professional microcredential in Sustainable Infrastructure and Low Impact Development from the Sustainable Technologies Evaluation Program (STEP). She is a proud graduate of Western University and Facility for Intelligent Decision Support (FIDS) alumni.

Abstract: Over the past two years, GHD Limited (GHD) has advanced integrated 1D–2D flood modelling and flood management practices across the Lower Mainland, BC using InfoWorks ICM. Increasing development pressure and the impacts of climate change have heightened the need for more detailed, accurate, and scalable hydraulic models to support watershed planning and flood response for clients such as the City of Vancouver and the City of Surrey. This paper presents the methodology and innovative application of Python and Ruby scripting to enhance the development, calibration, and efficiency of large-scale 1D–2D models. The intent is to demonstrate how recent technological developments have made advanced 1D–2D modelling more practical and accessible for a wide range of applications. Model workflows can now be efficiently streamlined through scripting, while cloud computing has significantly improved simulation speed. More detailed models and parallel runs of multiple model scenarios are now enabled by cloud computing. Three project examples are presented to illustrate these innovations and their practical benefits. These project examples cover a range of applications, which include complex lowland water management, combined sewer overflow (CSO) management and sewer separation. All these project examples will demonstrate how the advanced 1D-2D modelling can improve the outcomes for planning and option development for flood mitigation.

6	**Urban Flooding & Infrastructure** - Estimating Impacts of Changing Precipitation Extremes on Urban Flood Hazard and Risk	
Robin Bourke	Public Safety Canada	robin.bourke@ps-sp.gc.ca

Session Description:

This session explores how changes in precipitation extremes driven by climate change are influencing urban flood hazard and risk. Cities are increasingly exposed to intense rainfall events that exceed the capacity of existing drainage and infrastructure systems, leading to more frequent and severe pluvial flooding. Understanding these changes is critical for designing resilient urban environments and updating risk management strategies.

The session invites contributions that quantify the impacts of shifting precipitation patterns on urban flooding using observational data, climate model projections, or hydrological and hydraulic simulations. Topics may include downscaling of extreme rainfall, model validation, assessment of exposure and vulnerability, addressing challenging in pluvial and urban flood estimation, and evaluation of adaptation or mitigation measures.

By bringing together experts in climate science, hydrology, and urban planning, the session aims to identify methods and tools that improve prediction and management of flood risk in a changing climate.

6a: Collaborate for Resilience: Advancing Integrated Urban Flood Risk Modeling Across Canada

Sara Karam (sara.karam@ps-sp.gc.ca)

Sara Karam, Ph.D., P.Eng., is a bilingual engineering advisor at Public Safety Canada specializing in water management and environmental engineering. Her doctorate in Environmental Engineering focused on climate change and hydrological regimes in data scarce environments. Her work supports federal flood mapping initiatives by integrating and harmonizing Canada-wide flood data, enabling climate-informed mitigation strategies and resilient infrastructure planning to better protect communities. Beyond her technical contributions, Sara is committed to inclusion and community engagement, with a history of leadership roles and advocacy for equity and accessibility.

Abstract: Extreme precipitation events are intensifying across Canada, increasing the frequency and severity of urban pluvial flooding. Current flood risk assessments often rely on fragmented, localized models that fail to capture the complexity of urban drainage systems and surface runoff interactions. This gap limits our ability to accurately estimate flood depths, extents, and associated risks under changing climate conditions. This presentation will outline the case for a Canada-wide, integrated pluvial flood modeling framework; one model capable of consistently estimating urban flood hazard

and risk across diverse geographies. We will explore how such a model can incorporate both explicit and implicit representations of urban drainage systems, including catch basins and stormwater infrastructure, to better reflect real-world conditions. The session will highlight key challenges, data requirements, and methodological considerations for building a scalable, national platform that supports climate-informed risk assessments and resilient urban planning.

By the end of this session, participants will understand why a unified approach is critical and how collaborative research and action can close existing gaps. We invite researchers, practitioners, and policymakers to join in shaping this next-generation modeling effort, because anticipating tomorrow's flood risks starts with building the right tools today.

6b: Quantifying Residential Flood Risk in Canada: A Five-Year Review by Public Safety Canada

Karl Chastko (karl.chastko@ps-sp.gc.ca)

Karl Chastko is a Senior Policy Analyst in the Resilience and Economics Integration Division at Public Safety Canada. His research interests are focused on integrated flood risk management and natural hazard risk quantification. He holds a BSc in Earth and Environmental Sciences and an MSc in Geography and Spatial Statistics. Outside of work Karl enjoys hiking, canoeing, and traveling.

Abstract: Since 2020, Public Safety Canada has undertaken comprehensive Canada-wide assessments of flood hazards and financial flood risks. This initiative has involved the acquisition, compilation, refinement, and enrichment of extensive residential property databases, resulting in the development of a high-resolution Canada-wide residential exposure dataset. Additionally, Public Safety Canada has operationalized several Canada-wide flood hazard models to evaluate residential flood hazards across the country.

This presentation will provide a detailed overview of Public Safety Canada's efforts over the past five years to quantify residential flood hazards. It will cover the methodologies employed, including the Average Annual Loss calculations, assumptions made, and the source data utilized. The estimates have been iterated over time and the team has delved into parameters to understand the induced uncertainty. The presentation will highlight key findings and results, offering insights into residential flood hazards by various flood-generating mechanisms and geographic regions. The presentation will share characterization of flood loss including distribution between high and low frequency events; flood exposure of new developments; and approximate role of flood defenses in mitigating flood losses. This data-driven understanding of flood risk can provide insights to inform risk management activities and policies.

6c: FIFRA Part 1 – Technical Overview of Federally Identified Flood Risk Areas (FIFRA)

Julie Van de Valk (julie.vandevalk@ps-sp.gc.ca)

Julie Van de Valk, EIT (Senior Engineering Advisor, Public Safety Canada) has an engineering and emergency management background and works to bridge natural hazards engineering, risk assessment and reduction, emergency management, and effective policy development.

Abstract: Since 2020, Public Safety Canada has been evaluating and operationalizing Canada-wide flood hazard modelling to conduct national-scale estimates of flood hazard and financial flood risk. Public Safety Canada has developed a tool to communicate flood hazard and to allow for flood hazard screening of new federal investments: the Federally Identified Flood Risk Areas (FIFRA). The FIFRA dataset includes two layers – one which identifies Low, Moderate, High and Extreme flood hazard zones for Canada, and one with identifies the flood mechanism(s) including coastal, pluvial, and fluvial flooding. It is intended as a screening tool to identify areas with potential flood hazard.

This presentation will share the research, innovation, testing, and lessons learned developing the FIFRA dataset from continental scale flood hazard modelling outputs. The development of the FIFRA dataset included significant technical exploration of the Canada-wide model, iterative testing of various approaches, and eventual development of the data layer in question. The matrix-based approach ultimately employed provides a robust representation of flood hazard that combines multiple flood hazard likelihoods and depths into one rating. This session will outline this process and highlight the strengths and limitations of the final product. The FIFRA dataset is part of a larger FIFRA program which includes policy context and a FIFRA guideline explored in the following presentation.

7	**Flood Mapping & Technology** - Innovations and case studies in Canadian flood mapping	
Robert Chlumsky	Heron Hydrologic	robert.chlumsky@heronhydrologic.ca

Session Description:

Canada is a challenging country to undertake flood mapping in, with several factors contributing to this including varied climatographic regions and vast expanses of land. Case studies in flood mapping in northern communities and special techniques for design storms are presented here. The session also covers the validation and testing of novel flood mapping techniques developed in Canada for real-time and large-scale flood mapping.

7a: Flood Action Plan for the Nahanni Butte Community

Meggie Letman (mletman@dillon.ca)

Meggie is a professional engineer with ten years of experience in environmental and water resources engineering across Canada. Her recent work experience has focused on watershed-scale assessments to support flood mapping, secondary planning exercises, and source water availability studies in Nova Scotia, Nunavut, and the Northwest Territories. As a project manager and technical lead, she brings a calm, measured presence to a fast-paced environment, prioritizing humanity and connection to help teams thrive amid the noise. That focus on people, experience, and community has led to the successful delivery of complex climate resilience initiatives, such as the integrated flood hazard and erosion mitigation study for the Nahanni Butte Dene Band.

Abstract: The community of Nahanni Butte, located at the confluence of the South Nahanni and Liard Rivers in the Northwest Territories, faces escalating risks from open-water flooding and riverbank erosion. Dillon undertook a comprehensive two-phase study designed to enhance community resilience against these hazards in a data-sparse northern environment. The assessment integrated Traditional Knowledge and community-led monitoring initiatives with advanced engineering analysis to develop quality flood hazard maps and a prioritized mitigation action plan. Hydrologic assessment was conducted using a Raven hydrologic model calibrated to regional datasets and the 2012 flood of record, supplemented by a Regional Flood Frequency Analysis (RFFA) to estimate peak flows for 1% and 0.5% Annual Exceedance Probability (AEP) events. To account for future climate uncertainty, a sensitivity analysis was used to estimate conservative flow estimates for future planning horizons. These inputs drove a two-dimensional (2D) HEC-RAS hydraulic model, underpinned by a merged bathymetric and drone-acquired topographic dataset, to delineate floodways and flood fringes. The study results indicate that while the community's eastern hilltop remains outside the flood zone, the majority of essential infrastructure lies within the flood fringe, with shoreline erosion rates estimated at approximately 1.0 meter per year. The resulting Flood and Erosion Action Plan proposes a multi-pronged mitigation strategy. This

includes structural interventions such as raising buildings and constructing dykes, alongside non-structural measures like updated land-use planning and enhanced emergency protocols. This project demonstrates the efficacy of combining community engagement with rigorous hydraulic modelling to support evidence-based decision-making in remote Indigenous communities facing climate change.

7b: Design Storm Development for Floodplain Mapping and Flood Risk Assessment in Cold Climate Conditions: Credit River Watershed, Ontario

Neelam Gupta (neelam.gupta@cvc.ca) **and Tim Mereu**

Neelam Gupta has over 20 years of experience in water resources engineering and currently serves as the Manager of Hydrology & Flood Risk Mapping at Credit Valley Conservation (CVC). In this role, she is responsible for the delineation of floodplain maps and the development and upkeep of hydrology and hydraulic models for the entire Credit River watershed. Additionally, she manages the real-time gauge network within the watershed. Prior to joining CVC, Neelam worked in consulting for five years, where she gained expertise in designing Stormwater Management (SWM) and Low Impact Development (LID) practices.

Tim brings 40 years of experience as a leader, mentor, and innovator in the field of water resources engineering. Working in both the public and private sector, he has successfully led and integrated teams of engineers, scientists, and geoscientists across multiple offices, guiding them through organizational mergers and transitions. His leadership emphasizes the development of shared purpose and efficient delivery, balancing innovation with practical implementation. At the center of Tim's practice is a drive to understand our relationship with water and the environment, to improve the practice of engineering, and to deliver skills and services that support public and private sector initiatives. His expertise spans flood risk management, floodplain mapping, stormwater management, erosion control, natural channel design, and water balance analysis. Tim's approach combines technical depth with strategic insight—advancing sustainable infrastructure while supporting community vibrancy, climate resilience and watershed health.

Abstract: In cold-climate watersheds, winter hydrologic processes including snowfall accumulation, snowmelt, frozen ground conditions, and rain-on-snow events play a critical role in generating flood peaks. Recognizing these unique dynamics, CVC developed winter-specific design storms to accurately capture the timing, intensity, and runoff response of cold-season events. These storm profiles were derived from historical winter precipitation and temperature records to reflect current winter flood conditions. Incorporating these winter-specific storms provides a more robust basis for assessing peak flows, flood risk, and related hydraulic and erosion impacts under existing and changing winter conditions.

Hydrologic models used for floodplain mapping and flood risk assessment must generate peak flows corresponding to 2- to 100-year return periods, consistent with the availability of monitored streamflow data. Where gauge records exist, modeled peak flows are calibrated to align with observed flood frequency analyses, ensuring realistic representation of local watershed behavior. Both continuous simulation and event-based modeling approaches are commonly applied, with event-based models relying on design storms as critical inputs. To produce credible runoff estimates, the response from these design storms must reflect observed flood frequency characteristics.

Traditional design storms often emphasize rainfall-driven events, which can overlook the significant contribution of winter hydrology in many rural Canadian watersheds. In regions where winter rainfall, snowmelt, or combined events drive flooding, seasonally tailored design storms are essential for accurate hydrologic modeling. This study presents a methodology for generating winter (and summer) design storms that reproduce observed flood frequencies at site-specific gauged locations.

Results demonstrate that integrating winter-specific hydrologic processes into floodplain mapping and flood risk assessment substantially improves model reliability. By applying these winter-focused design storms, engineers and planners can better evaluate the impacts of land use changes, watershed restoration, and evolving winter conditions on flood risks, supporting more effective and resilient flood management in cold climates.

7c: Validation of Blackbird Model for Floodplain Mapping in Ontario with an Intelligent Flow Forecasting Tool

Trevor Boston (tboston@grnland.com) **and Hamid Mohebzadeh** (hmohebzadeh@grnland.com)

Trevor Boston M.Sc., P.Eng. is an Associate and Software Development Lead with GREENLAND? with 25 years of technical project management experience. Trevor manages water resources projects and oversees research and development related to Greenland’s software platform initiative with university and other partners across Canada. He has extensive experience in modeling water quality, hydrology, flood inundation, watershed processes and undertaking projects with a cumulative effects and assimilative capacity focus. Trevor has worked extensively with ECCC and the Ontario MECP to develop policy options and conduct benefit/cost assessment of management practices to reduce contaminant loading to Lake Erie and Lake Simcoe, including contributing to development of the Lake Simcoe Protection Plan.

Hamid Mohebzadeh, PhD. holds a post doctoral position at the University of Guelph funded by Greenland and Mitacs. He is a highly accomplished water resources engineer with a strong background in Python programming, machine learning, remote sensing, and hydrologic / hydraulic modeling including both applied industry and academic experience. He holds a PhD in water resources engineering from the University of Guelph and has published over 22 peer-reviewed journal articles.

Hamid is a skilled Water Resources Engineer with expertise in flood forecasting, floodplain mapping and effective risk mitigation strategies. He has been recognized for his achievements, receiving a PhD scholarship from the University of Guelph and the Dr. William Cairns Scholarship in Water Resource Engineering in 2020.

Abstract: Flooding is among the most frequent and costly natural hazards worldwide, causing billions of dollars in damages each year. Conventional hydraulic models for flood mapping often face limitations: simple approaches lack accuracy, while more sophisticated hydraulic models require extensive data and computational resources. These limitations restrict their scalability and timely application. Consequently, static flood maps are often outdated or unavailable in many regions. Further, resource requirements of conventional models make them costly to operationalize in a real-time, early warning systems. Recent advances have sought to bridge this gap through geo-spatial techniques and streamlined hydraulic modelling. This study evaluated the performance of the Blackbird model for integration into the THREATS platform alongside a machine-learning based, real-time flow forecast system.

Blackbird can be rapidly setup for river reaches using newly available, high resolution digital elevation mapping (HRDEMs) across large parts of Canada. The model executes quickly with minimal computational resources making it suitable for real-time applications in more remote watersheds. In this study, Blackbird flood extent predictions were successfully validated in the Mattagami River against those produced by the widely used HEC-RAS 1D model. This achievement set the stage for integration within THREATS where functionality is already established for computing design storm events and 14-day flow forecasts at more than 8000 hydrometric stations across North America as part of the ISWMS module. Potential uses include: protection of vulnerable communities, utilities, resource industry projects and infrastructure assets such as roads, bridges and pipelines.

7d: Application of Blackbird for Large-Scale Modelling of the Grand River Watershed

Robert Chlumsky (robert.chlumsky@heronhydrologic.ca)

Dr. Robert Chlumsky is a Water Resources Engineer with a wide range of experience in water resources applications, and is currently President of Heron Hydrologic. Robert completed his PhD at the University of Waterloo in 2024, where he researched the blended hydrologic model structure and also developed the Blackbird software for large-scale and real-time flood mapping. Robert has completed many projects using the Raven hydrologic modelling framework, and has also delivered courses to professionals and students on topics ranging from hydrology to data analysis. Robert is also the Past President of the Canadian Water Resources Association Ontario Branch. In his spare time, Rob enjoys martial arts and chasing his kids around.

Abstract: Flood mapping in Canada has historically focused on engineering scale maps, produced for specific jurisdictions as funding and political will allowed projects to be undertaken. The current system has led to the lack of widely available flood maps, and many maps being years or decades out of date. New approaches as well as ever-improving computational abilities is leading to more efficient and larger scale flood mapping without sacrificing quality, as global flood products often do.

This presentation will discuss the Blackbird methodology in recent applications, focusing on the development of a large-scale inundation model of the Grand River watershed. The Grand River watershed is approximately 6,800 km2 in size. The model is developed with a cell size of 4m and over 1700 computational streamnodes along the channels, which represents a size and accuracy that would be impractical for 2D models and highly time consuming for other conventional approaches. The methodology is explained in detail and the results compared to existing flood maps within the watershed.

8	**Flood Mapping & Technology** - Panel Session: Success and Challenges from the Flood Hazard Identification and Mapping Program (FHIMP)	
Brian Perry	Natural Resources Canada	brian.perry@NRCan-RNCan.gc.ca

Session Description:

Natural Resources Canada established the Flood Hazard Identification and Mapping Program (FHIMP) in November 2021 to deliver on a commitment to complete flood mapping for higher-risk areas in Canada. In June 2023, the program was significantly expanded under the National Adaptation Strategy, with an additional investment over five years to advance nation-wide flood mapping coverage. Delivered through cost-shared agreements with all 13 provinces and territories, FHIMP has supported more than 400 completed or ongoing flood-mapping-related projects to date. These efforts are strengthening Canada's capacity to understand flood hazards and help communities, governments, and stakeholders better plan for and adapt to the increasing frequency and costs of flood-related disasters.

This one-hour panel session, led by FHIMP's Senior Engineering Advisor, will bring together panelists to reflect on the program's progress and explore key themes, including:

- Major successes and lessons learned since the launch of the FHIMP
- Ongoing challenges and opportunities in program delivery
- Integration of Indigenous Traditional Knowledge (ITK) in flood mapping practices
- The role of scientific innovation in advancing flood mapping
- The future of national flood mapping efforts within FHIMP and beyond

Session Panelists:

Maxim Fortin, Senior Engineering Advisor in Flood Modelling, Flood Hazard Identification and Mapping Program, Natural Resources Canada
Maxim Fortin is Senior Engineering Advisor in Flood Modelling at Natural Resources Canada's Canada Centre for Mapping and Earth Observation (CCMEO). He provides technical leadership for the federal Flood Hazard Identification and Mapping Program (FHIMP), serving as the advisor for more than 200 flood mapping projects in Eastern and Atlantic Canada. With over 15 years of experience in water resources engineering, he previously held senior roles in consulting, delivering hydrology, hydraulics, and climate resilience projects in Canada and abroad. He is a licensed professional engineer in Quebec and Ontario and contributes to national standards and organizations, including as expert on the national CSA Flood Resiliency Technical Committee and director for the Canadian Water Resources Association (CWRA).

Danielle MacCorkindale, Coordinator, Natural Hazards Management Section, Policy Division, Ontario Ministry of Natural Resources

Danielle MacCorkindale is the Coordinator of the Natural Hazards Management Section, Policy Division at the Ontario Ministry of Natural Resources. Danielle has led and contributed to significant policy initiatives over her 24 years with the Ministry, including supporting Ontario's Special Advisor on Flooding and developing Ontario's Flooding Strategy. Danielle is currently leading her team in the review and update of Ontario's suite of natural hazard technical guides which guide the identification and management of water-related natural hazards, including flooding hazards. Danielle is also the lead for the Flood Hazard Identification and Mapping Program for Ontario.

Sandra Mancini, Managing Director, Natural Hazards and Infrastructure, South Nation Conservation Authority

Sandra is an accomplished and result-driven professional that has been working in her field since 1994. She started her career at SNC in 2004, after working in consulting. At SNC, she collaborates with a diverse group of stakeholders to create and share knowledge, address needs for information to inspire actions that will protect watershed residents from natural hazards.

As Managing Director, Natural Hazards and Infrastructure, Sandra's main responsibilities include the development of the Authority projects, implementation of natural hazards programs; development of annual programs and multi-year project budgets and plans, manages the flood and erosion hazards programs and the Authority's infrastructure.

Sandra is an advocate of the Engineering profession. She sits in the Professional Engineers of Ontario Upper Canada Chapter as Secretary. She enjoys mentoring young Engineers and ensures to provide training to at least one Engineering student every year.

As animal lover, she dedicates her time to promoting dog health and good habits to dog owners. Sandra and her husband David own three beautiful German Shepherds and live in Ingleside, Ontario.

Charlotte Milne, PhD candidate, Institute for Resources, Environment and Sustainability, University of British Columbia; Research Affiliate, Natural Resources Canada

Charlotte Milne is a PhD Candidate in the Institute for Resources, Environment and Sustainability at the University of British Columbia and a Research Affiliate with Natural Resources Canada. She holds an MSc specializing in fluvial geomorphology and GIS but has transitioned primarily into the social sciences over the last seven years during her work on flood risk projects in Canada and Aotearoa (New Zealand). Charlotte currently researches Canada's flood mapping system. She works with the engineering community and First Nations to explore expert perceptions of what might be done to improve current flood mapping practice. Additionally, she investigates how flood mapping is (or isn't) being employed in Canadian jurisdictions to drive risk-reducing regulation.

9	**Flood Mapping & Technology** - The Role of Remote Sensing and AI in Flood Mapping	
Brian Perry	Natural Resources Canada	brian.perry@NRCan-RNCan.gc.ca

Session Description:

This session explores the role of artificial intelligence and remote sensed data in the flood mapping process. Presentations from government and academia highlight how these tools can create or streamline the development of crucial flood information and explores their application in a Canadian context.

9a: Spatiotemporal Isochrone Analysis for Detecting Outdated Flood Hazard Maps under LULC Change

Heather McGrath

Abstract: Land-use and land-cover (LULC) can alter watershed hydraulics by modifying surface roughness, infiltration capacity, and flow pathways, thereby modifying runoff timing and hydrograph characteristics. This study evaluates the spatiotemporal effects of LULC change on surface water drainage efficiency in the Merritt, British Columbia watershed between 2000 and 2020. Isochrone maps, representing zones of equal travel time to the watershed outlet, were generated for five time-steps (2000, 2005, 2010, 2015, and 2020) using composite cost surfaces that integrate land-cover-dependent hydraulic resistance and flow velocity. A screening-level Hydraulic Signal Change Score (HSCS) metric was developed to provide an easy-to-run approach for quantifying relative changes in upstream travel time and hydraulic resistance reaching a point of interest. Hydrographs from the point of interest and nearby river gauges were analyzed to contextualize the isochrone-based indicators. Preliminary results indicate modest increases in peak flows over time, while forest loss is associated with reorganization of flow pathways and reductions in hydraulic resistance. Peak timing became more variable, and rising limb dynamics exhibited increased event dependence rather than uniform acceleration. These findings suggest that LULC change primarily alters hydraulic connectivity and response structure rather than producing consistent downstream amplification. The proposed framework provides a screening-level approach for identifying spatially mediated hydrodynamic change and supporting adaptive flood risk assessment in rapidly evolving watersheds.

9b: The use of deep learning to improve river channel detection for bathymetry assessment from LiDAR data in regional-scale flood modelling

Susan Ly and Guénolé Choné: susanly17@gmail.com, guenole.chone@concordia.ca

Susan Ly is an MSc student in Geography, Urban and Environmental Studies in the River Management Lab at Concordia University, based in Montréal, Québec. She holds an Honours BSc in Environmental and Sustainability Science. Her research focuses on improving the large-scale flood-modelling workflow developed by the lab, including developing a deep learning method for automated river-channel extraction using LiDAR data.

Guénolé Choné is a fluvial geomorphologist and specialist in hydraulics and geomatics. He has been working as a research associate at Concordia University since 2013. His research focuses on identifying and mapping river-related risks, including flooding and riverbank erosion, in collaboration with various levels of government. In recent years, he has developed a regional-scale flood modelling approach, largely based on LiDAR data and including an assessment of river bathymetry, which is notably used by the Government of Quebec to map floods outside areas covered by traditional modelling methods requiring extensive field data.

Abstract: Accurate representation of river channel geometry remains one of the greatest challenges in regional-scale flood modelling, particularly in regions where bathymetric data and consistent flood mapping practices are limited. Recently, an inverse hydraulic modelling approach based on high-resolution LiDAR digital elevation models was developed to estimate riverbed elevations at the watershed scale, achieving unprecedented accuracy in simulated flood levels in Canadian watersheds. However, creating the wetted (LiDAR) channel polygons required for bathymetry estimation, whether semi-automatically produced by LiDAR vendors or manually digitized by end-users, remains labour-intensive, inconsistent across provinces and difficult to scale nationally. This research presents a deep learning (DL) workflow that automates river-channel detection directly from LiDAR-derived raster products. A convolutional neural network was trained exclusively on 1-m LiDAR derivatives, including DEM, slope, LiDAR point density and intensity. The model predicts continuous channels across diverse geomorphological contexts with strong overall consistency, achieving a mean Intersection-over-Union of 91% when compared with manually digitized ground truths. Performance is highest in large, clearly defined channels with high-quality LiDAR data, and decreases in wetlands, forested zones, and narrow meandering tributaries. The key difficulty lies in managing domain shift, the differences between training conditions and regional-scale production environments, which arises from geomorphological variability between watersheds, differences in LiDAR sensor specifications and spatially heterogeneous point-density distributions. These factors limit model generalization and require careful selection of training sites, extensive input normalization, and targeted data augmentation strategies. Overall, this DL method greatly decreases the resources needed to obtain LiDAR channel polygons. For example, for the Grand River (Ontario), it took approximately 17 seconds per km of river using the DL workflow, compared with roughly 380 seconds per km for manual digitization. This work highlights the potential of scalable DL-based river-geometry extraction to substantially improve the efficiency and consistency of the regional-scale flood modelling process.

9c: Enhancing Flood Management in Canada: Leveraging SAR and AI for Improved Emergency Flood Mapping

Nicolas Desrochers (nicolas.desrochers@nrcan-rncan.gc.ca)

Nicolas Desrochers is an Emergency Geomatics Specialist at Natural Resources Canada, where he contributes to disaster response and risk management through applied geospatial analysis. His research focuses on flood mapping using Synthetic Aperture Radar (SAR), with particular emphasis on near-real-time applications and the operational use of satellite data during emergency events. He is currently working on the development and evaluation of convolutional neural network (CNN) models to support emergency flood mapping, with the goal of improving flood detection performance and mapping accuracy. His academic interests include remote sensing, SAR data processing, and the integration of artificial intelligence with Earth observation for hazard monitoring and emergency management.

Abstract: Floods are among Canada's most frequent and damaging natural hazards, requiring near-real-time mapping to support emergency response operations. Synthetic aperture radar (SAR) satellites enable rapid flood detection under cloud cover, and Natural Resources Canada's Emergency Geomatics Service (EGS) has produced SAR-based flood maps for over two decades. However, current workflows rely on extensive manual editing during quality control, particularly when delineating flooded vegetation, which limits response speed during large or concurrent flood events. Convolutional neural networks (CNNs) offer a promising approach to reducing analyst workload by learning spatial and contextual patterns from SAR imagery and auxiliary data. This study evaluates how auxiliary datasets affect the performance of CNN-based flood mapping for Radarsat Constellation Mission (RCM) imagery, with a focus on improving detection of flooded vegetation. Using historic EGS flood products as training labels, multiple model configurations were tested, incorporating local incidence angle, NALCMS land cover, and global surface water occurrence. Results show that while open water detection remains consistently accurate across all scenarios, flooded vegetation mapping benefits substantially from selected auxiliary inputs. Local incidence angle reduced terrain-induced false negatives by compensating for backscatter variation due to topography and sensor geometry while land cover provided contextual information that helped the model differentiate vegetated surfaces from spectrally similar urban or agricultural areas, both leading to a 0.2 increase recall. In contrast, long-term water occurrence contributed little additional information, as its strong correlation with permanent water boundaries limited its relevance for detecting transient flood events. Overall, the integration of auxiliary datasets improved recall for flooded vegetation and reduced manual post-processing, enabling faster and more reliable operational flood mapping.

9d: Towards a Unified Physically-Based and Data-Driven Framework for High-Fidelity, Large-Area Flood Inundation Mapping

Saman Razavi (saman.razavi@usask.ca)

Dr. Saman Razavi is an Associate Professor in the School of Environment and Sustainability at the University of Saskatchewan and a Future Fellow in Civil and Environmental Engineering at the University of New South Wales (UNSW), Australia. His research bridges hydrological and flood and drought modelling with integrated water resources management and decision-making. He specialises in hydrologic modelling, water resources systems analysis, surrogate modelling, sensitivity and uncertainty analysis, and machine learning. Dr. Razavi has published more than 90 peer-reviewed journal articles and has supervised over 35 graduate students and postdoctoral researchers. His work has been recognised through major awards, including the 2024 Walter L. Huber Civil Engineering Research Prize from the American Society of Civil Engineers (ASCE), the 2020 Early Career Research Excellence Award from the International Environmental Modelling and Software Society (iEMSs), and the 2019 Young Scientist Award from the Canadian Geophysical Union (CGU). He also serves as an Editor for Environmental Modelling & Software and sits on the Boards of Directors of iEMSs and the Sensitivity Analysis of Model Output (SAMO) society.

Abstract: Accurate and timely flood inundation prediction over large regions remains a major scientific and operational challenge. Physically-based 2D hydrodynamic models are widely regarded as the high-fidelity, gold standard for simulating floodplain processes, but they are computationally intensive, data-hungry, and difficult to scale to basin-wide domains or to large ensembles of scenarios. At the other end of the spectrum, physically-simplified, conceptual approaches, such as those based on the Height Above Nearest Drainage (HAND) framework, are computationally efficient, data parsimonious, and easily deployed across large areas, but they offer lower fidelity in representing dynamic behavior of floods. In this context, recent advances in machine learning, particularly convolutional neural networks (CNNs), have shown considerable promise in flood inundation prediction. Two main research avenues have emerged. The first uses CNNs as emulators or surrogates for high-fidelity 2D hydrodynamic models, yielding rapid predictions with high spatial and temporal resolution. However, these surrogates tend to be site-specific, with limited transferability beyond the regions on which they were trained. The second avenue builds on the increasingly rich information from remote sensing of flood extent—and, more recently, water surface elevation—over large spatial extents. This avenue trains CNNs on remote-sensing-derived inundation maps spanning diverse geographic settings, enabling broader generalization across regions. However, the data and resulting predictions remain constrained by the limitations of remote sensing, including coarse spatial resolution, sparse temporal sampling, cloud contamination, and relatively short observational records, and they lack the physical accuracy of hydrodynamic models. This study seeks to bridge these avenues by building a machine learning framework that relies on a large, hybrid training dataset that integrates high-fidelity 2D hydrodynamic simulations, the broad but lower-fidelity insights from conceptual models, and the wide spatial coverage of remote sensing. As a prototype, we focus on one or a few test rivers for which we generate extensive ensembles of real and synthetic flood scenarios using a 2D model, complemented by HAND-type simulations and satellite-derived inundation information. We present preliminary results showing that integrating physically based modelling with multiple levels of fidelity and remote sensing within a unified machine-learning framework can improve both predictive.

10	**Policy, Insurance & Governance** - Panel Session: Flood insurance in Canada: a policy perspective	
Mathieu Boudreault	Université du Québec à Montréal	boudreault.mathieu@uqam.ca

Session Description:

On this flood insurance discussion panel, you will learn about the financial management of flooding in Canada and the challenges ahead. Come meet our experts from the University of Waterloo, the Insurance Bureau of Canada, and the Institute for Catastrophic Loss Reduction for an interesting discussion and debate on the best course of action for the Federal government, the provinces and the insurance industry to improve Canadian homeowners' resilience to floods.

The session will be chaired by Mathieu Boudreault, Professor of Actuarial Science at Université du Québec à Montréal and Chairholder of UQAM's Research Chair in Actuarial and Climate Sciences.

Session Panelists:

Mahan Azimi serves as the Director of Catastrophic and Emerging Risk Policy team at IBC, where he oversees initiatives related to earthquake, flood, climate resilience and cyber risks. He also plays a key role in corporate and strategic planning.
Prior to joining IBC in 2021, Mahan gained valuable experience working in the federal government and in private sector consulting. Mahan holds a master's degree in political science from York University and a bachelor of arts from the University of Toronto.

Dr. Daniel Henstra is a Professor of Political Science at the University of Waterloo and co-lead of the Climate Risk Research Group. His research focuses on the governance of complex climate risks—particularly flood risk—through multilevel policy systems and public-private collaboration. With more than two decades of applied policy experience, he advises governments on the design and implementation of effective, equitable climate risk management strategies.

Alexa Tanner is the Senior Manager of Resilience in Recovery at ICLR. Her work contributes to advancing disaster risk reduction across communities in Canada by increasing the uptake of resilience actions at all stages of the disaster cycle. Before joining ICLR, she completed a PhD focusing on risk perceptions and decision-making related to community resilience and multi-hazard risks.

11	**International & Regional Perspectives** - Panel Session: Ontario Conservation Authorities: Watershed Management - A Proven Solution to Building Flood Resilience	
Jo-Anne Rzadki	Conservation Ontario	Email: jrzadki@conservationontario.ca

Session Description:

Conservation Authorities (CAs) are unique to Ontario and formed on a watershed basis. The mandate of CA's is the protection of people and property from flooding and natural hazards through the delivery of watershed-based programs. CAs enable economic, social, and environmental benefits through the conservation of natural resources. CAs' deliver and support programs that minimize or prevent the impacts of flooding and erosion, conserve and restore water resources, woodlands, wetlands, natural habitats and the relationship between people and their natural environment. Conservation Ontario (CO) represents the 36 Conservation Authority network. CO's mission is to promote and continuously strengthen a watershed based conservation coalition in Ontario. This 90-minute panel session will be led by CO and its member CAs. The panelists will address the following flood management activities provided by CAs.

- Floodplain mapping, modelling, and monitoring streamflow, rainfall and snowpacks
- Regulation of development in flood prone areas in cooperation with municipalities and the Province
- Provision of planning support and advice to municipalities to minimize flood impacts and issue warnings
- Acquiring and managing important floodplain lands and flood vulnerable structures
- Operation of over 900 dams, dykes, channels and erosion control structures
- Foundational watershed management activities which include: watershed-scale monitoring, data collection management and modelling, watershed-scale studies, plans, assessments and strategies, and watershed-wide actions including stewardship, communications, and outreach and education activities.

Session Panelists:

Angela Coleman, LL.B., B.A., General Manager: Conservation Ontario
Angela graduated from the Faculty of Law at the University of Ottawa in 2009 and was admitted to the Bar of the Province of Ontario in 2010. Angela summered, articled, and practised with a large Ottawa firm, in real property and municipal law and now works with Conservation Ontario as General Manager. Angela has worked with Federal, Provincial, and Municipal governments on a wide range of environmental, development, and water policy issues including: source water protection, flooding, and planning and development approvals.

Mark Peacock, P. Eng. B.A., B.Sc. (Eng.)

CAO / Secretary Treasurer, Lower Thames Valley Conservation Authority
Mark Peacock graduated from the University of Guelph in 1988 with a bachelors degree in Water Resources Engineering. Prior to this, he graduated from the University of Toronto with an Honours Bachelor of Arts Degree with a Specialist Certificate in English Literature. He is currently a registered Professional Engineer.

In 2017 Mark moved to Southwestern Ontario be become the CAO / Secretary Treasurer of the Lower Thames Valley Conservation Authority.

In the past Mark provided watershed engineering direction and services to the Ganaraska Region, Central Lake Ontario, Kawartha Region, Otonabee Region and Nottawasaga Valley Conservation Authorities. Mark has been involved in a number of flood plain mapping and management programs. This has included numerous 1- and 2D riverine modeling projects and developing shoreline management plans in Lake Ontario and Lake Erie. Mark has participated in Conservation Authority, provincial and federal flood plain technical committees and has presented technical papers at many conferences including the NRC International workshop on Flood-Resistant Buildings, 2020.

Sommer Casgrain-Robertson, General Manager, Rideau Valley Conservation Authority
Sommer grew up on a small family farm in Eastern Ontario, on the banks of the St. Lawrence River. As the seventh generation of her family to be raised on that farm, Sommer learned firsthand through woodlot management, farming practices and waterfront living that everything in the natural environment is connected and that decisions we make today impact our land, health and communities for years to come.

Since graduating from Queen’s University, Sommer has been fortunate to work for the Rideau Valley Conservation Authority. She began as a Resource Specialist in planning and regulations, later joining the newly formed drinking water source protection program as a Communications Specialist and then Co-Project Manager. In 2013, she became General Manager of the RVCA, a position that enables her to promote watershed management and community engagement.

Rob Baldwin – Chief Administrative Officer, Lake Simcoe Region Conservation Authority
Rob Baldwin is the Chief Administrative Officer at the Lake Simcoe Region Conservation Authority, where he has been leading several of the organization's key service areas for over two decades. Rob is responsible for the delivery of a proactive programs to ensure a resilient Lake Simcoe watershed with a client focused approach. Rob has focused on applying innovative approaches related to watershed management in several areas across North America. Rob is a graduate from Trent University with his Honours Bachelor of Science.