



2026 Technical Workshop

Abstracts

24th - 26th March 2026 – Greymouth

Back to Basics: Core Principles for a New Era

Tuesday 24th March 2026

Critical assessment of SWOT's ability to capture complex braided river dynamics

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To critically assess the Surface Water and Ocean Topography (SWOT) satellite's ability to capture the complex hydrologic characteristics of braided rivers, a field campaign was conducted on the Waimakariri River in Aotearoa New Zealand. Coinciding with SWOT's daily fast-sampling period (March – July 2023), we collected a suite of in-situ and airborne datasets to validate SWOT's satellite-derived measurements. In situ observations include along-channel water surface elevation (WSE) profiles acquired using jetboat-mounted GNSS in partnership with New Zealand Fish & Game. Airborne near infrared lidar and optical imagery, collected in collaboration with the University of Canterbury's Waterways Centre for Freshwater Management, were used to generate high-resolution (1m) topographic and land surface classification maps under varying flow conditions. Together, these datasets provide a detailed benchmark for assessing the accuracy and uncertainty of SWOT measurements.

Comparisons between SWOT-derived and field-based datasets provide insight into the satellite's ability to resolve the dynamic interconnected channels of braided rivers. When corrected for systematic biases, the SWOT Pixel Cloud (PIXC) WSE exhibited a mean absolute error (MAE) of 17–20 cm relative to GNSS and lidar surveys. Surface classification accuracy ranged from 87–90% for land and 65–73% for water pixels, with most water misclassifications occurring in narrow channels (<30 m wide), along channel boundaries, and in areas with low radar backscatter. In river reaches with full SWOT and lidar coverage, the SWOT river vector (RiverSP) product's inundation extent area accuracy within 3–5% of lidar-based estimates. Results demonstrate SWOT's ability to resolve the spatial and hydrodynamic complexity of braided river systems, and offers a powerful new tool for quantifying trends in flow variability, channel morphology, and inundation extent. SWOT expands opportunities for hydrologic research and water-resource management in environments where traditional ground-based measurements are sparse or logistically challenging.

Application of Image-Based Grain Size Analysis to Bed Material for Improving Sediment Data Reliability

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Climate change has intensified extreme rainfall events and flash floods worldwide, increasing the importance of quantitatively understanding sediment transport processes in river systems. Accordingly, the production of reliable sediment data has become an important task in hydrology and water quality research. In Korea, a nationwide sediment monitoring network consisting of 146 stations is currently in operation. To enhance data reliability, sediment surveys are being expanded to approximately 30 additional sites, resulting in a steady increase in demand for bed material grain size analysis. Conventional sieve analysis (KS F 2302), which has traditionally been used for bed material grain size assessment, has limitations including restricted measurement resolution, operator dependency, and limited capability in fine particle analysis.

This study aims to examine the applicability of image-based grain size analysis to bed material samples and to evaluate its effectiveness in improving sediment data reliability. Identical bed material samples were analysed using conventional sieve analysis (KS F 2302) and dry image-based grain size analysis (Camsizer 3D, ISO 13322-2). Laser diffraction analysis (MS3000, ISO 13320:2009) was additionally conducted to ensure continuity in the fine particle size range. Compatibility between cumulative grain size distribution curves obtained from sieve and image-based analyses was evaluated. The measurement characteristics of each method were examined in terms of resolution, consistency, and applicability to bed material samples. Particle shape parameters were additionally derived using image-based analysis, and digital data management and automated reporting functions were implemented to enhance analytical efficiency and reproducibility.

The results show strong agreement between sieve analysis and image-based analysis in the coarse fraction range. The image-based system provides improved measurement resolution and enables automated, high-efficiency analysis of bed material samples. The integration of laser diffraction results ensures continuity in the fine particle range. The successful application of image-based grain size analysis to bed material confirms its suitability for sediment monitoring purposes. This approach improves data consistency, reduces operator dependency, and supports the increasing analytical demands of Korea's expanding sediment monitoring network.

References:

- KS F 2302. 2022. Standard test method for particle-size analysis of soils.*
- ISO 13322-2. 2006. Particle size analysis — Image analysis methods.*
- ISO 13320. 2009. Particle size analysis — Laser diffraction methods.*

Duty of Care: The Mental-Health Implications of Hydrological Practice in the Agricultural Sector

Holly Munro

Aqualinc Research Limited

Mental health challenges in New Zealand's agricultural sector are well recognised, with farmers and rural communities experiencing disproportionately high levels of stress and, tragically, elevated rates of suicide. In a sector where many people are already struggling, it is important that we, as water professionals in hydrology, groundwater science, and water-resource management do not inadvertently contribute to that burden. This presentation highlights how errors or oversights in our technical work, sampling, consenting, compliance assessments, streamflow measurement, or field investigations, can cascade into real-world consequences that compound stress for the client.

Drawing on practical examples from recent consulting work, I will outline scenarios where mistakes in hydrological practice can have unintended ramifications. Inaccurate or poorly executed stream-gauging, for instance, can underestimate true flows and trigger unnecessary low-flow restrictions under stream-depletion or minimum-flow consent conditions. For landholders who rely on irrigation to sustain stock, pasture, or crop production, premature restrictions can be deeply stressful, affecting both livelihoods and wellbeing. Further, poorly planned fieldwork or inadequate measurement design can create uncertainty for consent applicants, delay processes, or result in applications being declined, with consequences that place additional emotional pressure on clients already navigating a complex regulatory environment.

Sampling errors are another area of concern. Cross-contamination or improper handling can result in false positives for contaminants, triggering costly investigations, resampling programmes, or public scrutiny. Waiting weeks for laboratory results can be anxiety-inducing for farmers and business owners whose reputations, operations, or compliance standing may appear at risk. These issues can extend beyond the rural sector: industry, councils, and even technical staff themselves may experience heightened stress where data integrity is questioned, particularly in high-profile settings.

Basic psychological principles help to explain why seemingly technical errors can have outsized impacts. Perceived loss of control, uncertainty of outcomes, and threats to identity or livelihood are well-known drivers of stress responses. Because water consents, compliance conditions, and environmental assessments directly influence a landholder's ability to operate, flawed or unreliable technical inputs can unintentionally activate these stress pathways. Further, when our work feeds into council hearings, or Environment Court proceedings, the stakes rise significantly, not only for the validity of our analyses but for the wellbeing of those whose futures may hinge on them.

This presentation is intended to remind us that as water professionals we have an ethical duty of care to ensure that our outputs are robust, defensible, and fit-for-purpose. While we cannot always deliver favourable results to clients, we must be confident in the accuracy of the data and conclusions we present, especially when the implications may cause distress or

require difficult decisions. Recognising that our work carries social as well as technical weight encourages a culture of diligence, compassion, and professional responsibility.

Ultimately, this talk is intended as a reminder that mistakes in hydrological practice are not merely scientific errors, but stressors that can ripple through communities. By upholding high standards and remaining mindful of the human impacts of our work, we contribute not only to better environmental outcomes but also to stronger, healthier rural communities.

Coordinate Systems, Height Datums and Quality Control – Minimising errors in measurements on the water

Richard Harrison
Global Survey

Errors are present in all kinds of surveys, whether on land or on the water, or when transitioning between the two. To ensure you are capturing reliable, repeatable data, it is essential to understand these errors and how to mitigate them. Some of these errors are inherent in the technologies we use, others are a result of misunderstandings or limitations in knowledge.

- RTK GNSS is the most common way to position your vessel, whether a full-size boat, an autonomous USV or a drone. We will cover the fundamentals of RTK GNSS, explain the underlying errors present in this technique, how to identify the risk of errors occurring, and how to minimise them.
- Heights are critical to all surveys on the water, whether in terms of chart datum, mean sea level, or New Zealand's official vertical datum – NZVD2016. There are multiple datums that could be used, and it is often difficult to know which datum is required just by looking at the numbers. What are these datums, how do they relate and how can you determine which one is being used.
- Coordinate systems provide the positional framework for our measurements. What do you need to know about the coordinates systems we use and the effect they can have on measurements made.

A Builders take on Environmental Monitoring Installations

Glen Wratt

Bay of Plenty Regional Council

What is Plumb, Level, Straight or Square? Are they important? Site enclosures are generally built to house monitoring equipment for many years, decades even. A few simple techniques along with correct material and fixings selections can be the difference between something that requires constant maintenance or something that one can be proud of that will outlast your time running the site. Where does NEMs sit regarding site construction? Some examples of what has worked and what has not worked in my short experience as an EMO will be provided.

Some Basic Hydrology

Graeme Horrell

G H Engineering Hydrologist

This talk will wander from the importance of your field checks to validate your recordings, to a couple of things revealed when completing data audit reports.

I was inspired at last year's Technical Workshop in Hamilton by Reuben Stuart and Pete Mason's talk, describing their chasing down and capturing (measuring) large floods, so I wish to explain a bit about the flood gauging's importance to an engineer when completing flood design.

Surface alpha – Field observations and an initial attempt at Discharge – Alpha curves

Darren Gerretzen
Earth Sciences NZ

Determining surface alpha is a critical component for calculating discharge from surface velocity methods. I'll talk to a recent example of determining alpha during a spring flood event on the Grey river and follow with some initial results from producing Discharge – Alpha curves using historic ADCP measurements.

Precision in the Flood Zone: Comparing Slope–Area, Drone/STIV, and Radar Gauging, West Coast Style

Pete Mason and Reuben Stuart
West Coast Regional Council

At long last, we can compare Slope Area, Drone/STIV and Radar Gun Flood Gaugings, all on the same reach, same flood and at the same time. It doesn't get better than that!!

Labour Weekend floods in 2025 provided the perfect storm for us to gather further flood gauging data, including at our specially set up flood gauging reach on the Inangahua River at Blacks Point, just out of Reefton.

The value of extending Rating Curves with historic, high end and validated flood gaugings, cannot be underestimated and should be a challenge and priority for all field teams to achieve.

With Pete being decommissioned later this year, this will be the final showdown between the "Old Dog" Pete Mason and the "New Tricks" from Kumara, Reuben Stuart.

Positioning Hydrometric Monitoring Assets in the Modern Era

Matthew Pilkington

Queensland Hydro & Australian Hydrographers Association Representative

The siting of a hydrometric monitoring system is dependent on monitoring objects, desired data outputs, the monitoring environment, technical attributes, and contextual factors. The correct siting of a monitoring station is vital to ensure the site meets the relevant standards and guidelines, and that the data collected is accurate, representative, and fit for purpose. With many modern tools available to assist with site investigations, such as Geographic Information Systems (GIS), satellite imagery, and Light Detection and Ranging (LiDAR), the siting of monitoring stations should be straight forward. But how do these modern methods of reconnaissance compare to traditional methods and information; and how do these modern approaches compare with ground truthing monitoring location?

This presentation will discuss and compare various tools available to hydrologists to position monitoring assets such that they achieve repeatable, reliable, and reportable data, in the context of standing up a new hydrometric network for a pumped hydro megaproject.

Rainfall, resilience and data sovereignty: Lessons from the Ōtetao Reti Marae rain gauge

Marcus Schlesier

Northland Regional Council

Rainfall, resilience and data sovereignty: Lessons from the Ōtetao Reti Marae rain gauge
The Whangaruru–Punaruero rohe on the eastern hills of Northland receives significant rainfall, leading to frequent flooding of the main road and limiting school access for up to 15 days per year. It is home to a large Ngātiwai population with multiple marae.

Northland Regional Council (NRC) received funding from the National Infrastructure Fund to improve flood resilience at Punaruero, some of which supported the installation of a new rain gauge at the local Ōtetao Reti Marae for the primary purpose of flood warning.

Rainfall collection began in September 2025, without prior kōrero about Māori data sovereignty. After installation, valid questions were raised by local tāngata whenua and kaitiaki regarding who should be able to see and access the data. The data was therefore not initially made publicly available on the NRC Environmental Data Hub.

On 18 January, a non-forecasted storm with torrential rain hit the area, causing widespread flooding, slips, and damage to critical infrastructure. The new rain gauge recorded almost 280 mm of rain over six hours, with intensities reaching 80mm per hour and 20mm per 10 minutes.

With another severe weather system approaching, NRC and kaitiaki agreed to make the rainfall data public on NRC's Environmental Data Hub to keep the community as informed as possible. At this stage the data could be viewed but not downloaded, but the underlying data sovereignty concerns remained unresolved.

Engagement and collaboration with local tāngata whenua have been very positive, and their concerns are both valid and increasingly shared by other marae, who are now expressing interest in establishing similar gauges at their own sites.

Balancing OIA, LGOIMA, Te Tiriti obligations, and the needs of the wider community is challenging. The need and purpose of Māori data sovereignty are well documented, and greater learning and acceptance are needed to strengthen collaboration between hapū, iwi, and both local and central government.

It is essential to have meaningful conversations about data use, expectations, and availability before collecting data. Raising awareness and involving hapū early helps build capability within their communities, empower proactive hapū-led response and develop flood-resilience models that are grounded in kaupapa Māori.

Flood measurement systems: Stereoscopic camera stations, drones with RTK GPS, towed depth sounder systems, and aerial GPR

Biggs, H. J.,¹ Starr, A.,¹ Smith, B.,¹ Sutton, H.,¹ and Haddadchi, A.¹

¹ *Earth Sciences New Zealand*

Flood discharge measurements are essential for various applications, such as developing stage-discharge rating curves, calibrating and validating flood models, issuing flood warnings, and evaluating the impacts of climate change. However, accurately and safely conducting these measurements remains a challenge. The extreme flow conditions and the presence of in-stream debris can prevent the use of traditional monitoring equipment like Acoustic Doppler Current Profilers (ADCPs) or tethered current meters deployed from bridges or cableways. Non-contact measurement methods, such as Surface Velocity Radar (SVR), surface image velocimetry using drones/UAVs, and oblique imagery from riverbanks, are becoming more common, but they still face significant challenges. Key issues include: measurement timing coinciding with flood peaks, safely reaching flooded river sites during extreme weather, conducting measurements in very wide rivers and floodplains (often requiring oblique drone measurements or nadir measurements in sections), cross-section changes during floods (due to sediment transport), and setting up oblique camera stations with Ground Control Points (GCPs).

To tackle these challenges, Earth Sciences New Zealand are developing “Next Generation Flood Measurement Systems,” which include: (1) stereoscopic camera stations for oblique surface image velocimetry in small streams and rivers (5-30 m wide), triggered by water level or time-lapse, and which do not require GCPs; (2) drones with Real-Time Kinematic Global Positioning Systems (RTK GPS) for nadir surface velocimetry in wide rivers and floodplains (30 m to >4 km); and (3) cross-section measurements that coincide with surface velocity measurements, using echosounder systems towed by drones or aerial Ground/Water Penetrating Radar (GPR) mounted on drones.

This talk provides an overview of the development of these systems and their deployment in the field.

RTK GPS on ADCP boats for discharge gauging and bedload transport

Sutton, H.¹, Biggs, H.¹, Haddadchi, A.¹, and Rennie, C.¹

¹ *Earth Sciences New Zealand*

² *University of Ottawa, Canada*

The increasing availability and reducing cost of Real Time Kinematic Global Positioning Systems (RTK GPS) provide unprecedented opportunities for increasing the accuracy of ADCP boat location data. This is particularly valuable for moving boat gaugings or cross section measurements during floods when significant bedload transport is occurring. The absolute elevation and position data provided by RTK GPS also provides consistent measurements of cross sections, which can be used to assess their change over time. This can be used to quantify cross section changes during floods (e.g. scour on the rising limb and deposition on the falling limb) and help with interpretation of rating shifts due to cross section changes. When ADCPs are held static (e.g. section by section gauging using the software SxS Pro) or their position known precisely (e.g. with RTK GPS), they can also be used to directly measure bedload transport through bottom track velocity.

This talk provides an overview of the setup and use of RTK GPS on ADCPs, showing an Emlid Reach M2 on a Teledyne RDI RiverPro. It then provides examples of field deployments at the Rakaia Gorge for discharge gauging and bedload transport measurements.

Bedload transport measurements from ADCP bottom track: Rakaia River flood event (October 2025)

Rennie, C.D.,¹ Biggs, H.J.,² Sutton, H.,² and Haddadchi, A.²

¹ *University of Ottawa*

² *Earth Sciences New Zealand*

This study investigates the lateral distribution of bedload transport in the Rakaia gorge obtained from Acoustic Doppler Current Profiler (ADCP) measurement data. Both at-a-station (section by section) and moving boat ADCP transects were collected from the gauging station cableway on the falling limb of a significant flood event on October 24, 2025. Two moving boat measurements were performed with four repeat transects each, and one at-a-station (section by section) measurement was performed with a total of five 10 minute verticals. RTK GPS was used on the ADCP to correct for boat motion. The ADCP data were processed to extract both stationary time series and lateral spatial distributions of apparent bedload velocity (v_a), which is the bias induced in ADCP bottom track velocity (Doppler sonar) due to bedload transport. Based on differences in v_a between stations the relative intensity of bedload transport across the section during this event is assessed. The bedload time series data are also examined to determine if intermittency (or periodicity) of transport can be ascertained.

This study highlights how ADCPs can also be used for sediment transport monitoring applications, extending their utility beyond discharge gauging and measurement of velocity profiles.

Environmental data validation and the emerging use of A.I.

Shane Buswell
KISTERS

Development of water level prediction model using ISTM

Lee, SangYu,¹ Lee SungHo,¹ Baek, GyungHo¹, Kim, SamEun¹

¹ KIHS(Korea Institute of Hydrological Survey)

Recent increases in the frequency of extreme rainfall events have led to a growing number of observation sites requiring flood discharge measurements. However, due to limitations in equipment and manpower, there are constraints in conducting on-site discharge measurements at all stations during simultaneous heavy rainfall events. Therefore, accurate prediction of river water level fluctuations is essential to enhance the efficiency of field operations. Conventional statistical methods, however, have limitations in adequately representing nonlinear characteristics of water level variations.

This study aims to develop a Long Short-Term Memory (LSTM)-based water level prediction model capable of reflecting nonlinear hydrological characteristics and to implement it within a real-time operational system. The model was established based on historical hydrological data and trained using input variables affecting water level variations at the target site, including water levels from nearby observation stations, rainfall data, and dam release records. A time-series-based architecture was adopted to account for time-lag effects and nonlinear interactions among input variables.

The performance of the constructed model was quantitatively evaluated using the root mean square error (RMSE) and the coefficient of determination (R^2), and predictive capability was validated through comparison with observed data from 2025. The results indicated that 21 out of 22 models achieved reliable predictive performance, with R^2 values exceeding 0.80 at most stations. The proposed model demonstrated stable performance during peak flood stages and effectively captured rapid nonlinear water level fluctuations. Furthermore, the developed model was implemented as a real-time operational system, and its practical applicability was confirmed through field application cases, resulting in improved operational efficiency during heavy rainfall events.

Automated data quality auditing and visualisation.

Nandakumar Thachapilly

Marlborough District Council

This presentation outlines the automated data quality checking processes developed for environmental monitoring data stored in our Hilltop data archive. Using R scripts, various data types are systematically checked for anomalies such as missing values, incorrect quality codes, and erroneous comments. The results are visualised in Power BI dashboards, enabling efficient identification and resolution of data integrity issues. This approach enhances data reliability and supports robust environmental reporting and decision-making. This covers Annual and five-year data audits.

Sorting the good from the bad: real-time continuous optical nitrate data grading

Lucy McKergow¹, Alex Vincent¹, Brandon Goeller¹

¹*Earth Sciences New Zealand, Gate 10 Silverdale Rd, Hamilton.*

Optical nitrate sensors can provide detailed insights into water quality dynamics, but under certain conditions they can output spurious numeric values. This can occur when interferences reduce light transmission across the measuring window and/or the calculation algorithm performs poorly. However, when a sensor logs metadata, it is possible to assess the validity of each value recorded. Sensor metadata commonly includes absorbances (or raw counts) for each wavelength measured and/or a proprietary quality code. Alongside field metadata and lab reference samples, sensor metadata is useful for assessing data quality. We developed a data grading method for TriOS NICO and OPUS sensors which uses data quality information contained in absorbances and the spectral quality index (SQI). Absorbance thresholds and SQI are good for data grading individually, but together they can create a more powerful data grading system for unattended sensors. We will illustrate the range of conditions which can downgrade data quality from good to fair to poor. We also present draft NEMS data standards for the measurement of high-frequency nitrate concentrations using optical sensors. A key criteria in optical nitrate sensor selection is the provision of absorbances and/or a proprietary quality code. In the draft NEMS for optical nitrate sensors, sensors that do not supply metadata for data grading are not eligible for QC600. The HFWQ Field Ops Envirolink Tool underway provides a pathway for testing and refining the draft NEMS tables for continuous optical nitrate.

Image Velocimetry Tools (IVy)

Frank Engel

United States Geological Survey (USGS)

Non-contact streamflow measurement techniques, including image velocimetry, have revolutionized hydrological monitoring by enabling safe, efficient data collection during hazardous conditions. The Image Velocimetry Tools (IVy) application, developed by the USGS, translates research into operational tools that hydrographers can use to process videos into accurate streamflow measurements. IVy bridges the gap by offering a standardized, reproducible workflow to ensure data consistency and reliability. The Image Velocimetry Tools (IVy Tools), or IVy, is a Python application that provides workflow support for processing video and imagery into water velocity and streamflow measurements. The program provides tools that produce consistent imagery input. The application also supports processing imagery sequences using Space-Time Image Velocimetry (STIV) algorithms.

Rectification of Image Velocity Results (RIVeR) - Open source LSPIV software

Antoine Patalano

National University of Córdoba (UNC), Argentina

RIVeR = Rectification of Image Velocity Results. Open-source LSPIV software, user friendly with best practice guidelines. Developed in collaboration with the University of Argentina, free software, multi-language, Python backend, basic/advanced processing options, automated reporting. Widely used and preferred in South America.

Hydro-STIV incorporating low-cost cameras

Logan Cameron

Queensland Government Department of Local Government, Water and Volunteers & Australian Hydrographers Association Representative

Hydro-STIV is an image velocity software that measures flow velocity and discharge using video and water level information. In North Queensland, we have been using the Hydro-STIV software and incorporating low-cost cameras to capture video, which we process and compare to existing rating and build a more accurate new rating curve.

The main issues are the distance to travel, limited access due to weather, and safety concerns at sites, which make it impossible to reach some areas during events. As a result, we were limited to collecting low to medium measurements in person, and we had very little knowledge of what happened during high-flow and flood events. We set up low-cost cameras and recorded video on the Pascoe River and the Jardine River. By setting up cameras at a site and leaving them in place for up to a year, we were able to record video over a wide range of water levels throughout the entire season. We then used an RTK drone to map the area, which was used to calibrate the video from the cameras. Discharge was calculated across a full range of water levels, and we built a more comprehensive rating curve, producing some really great results.

This presentation shows how STIV and low-cost cameras have been an excellent tool for producing results in remote areas and how it has been extremely useful for creating new ratings.

Tracer Dilution: a case study in a super dynamic environment

Christoph Sommer
Sommer Messtechnik

Tracer dilution measurements are widely recognized as effective tools for determining discharge in rivers and streams in a mobile and rapid manner. However, challenges arise when base conductivity and water levels fluctuate constantly. Under such dynamic conditions, obtaining accurate flow measurements becomes nearly impossible—not only for tracer dilution but also for traditional methods such as current meters. Water level variations often render other technologies unreliable, leading to significant discrepancies in reported values.

This case study examines these challenges through ten measurements conducted within a four-hour window, aiming to demonstrate how tracer dilution can still be applied in highly dynamic environments. These rivers and streams exhibit continuous changes in both water level and base conductivity, making interpretation and comparison of results extremely complex. To address this, the study explores three distinct perspectives.

First, we analyze the variability among the ten measurements and the difficulties in establishing consistency within such a short timeframe. Second, we present a focused comparison on the use of salt as a tracer, particularly examining the relationship between the amount of salt added and the resulting peak conductivity increase. This topic has sparked considerable debate among practitioners, and our findings reveal surprising patterns when comparing artificial peaks to natural background fluctuations. These insights may challenge existing assumptions about salt-based tracer dilution methods.

Finally, we investigate time-series data collected during the measurements and correlate these with concurrent water level changes. This perspective highlights the role of emerging software tools in improving data interpretation and underscores the need for advanced analytical approaches to better understand dynamic systems. Through these analyses, the study seeks to provide practical insights and innovative solutions for discharge measurement in environments where traditional methods often fail.

Hydrometric-Data Uncertainty: Stage-Discharge Method

Terry A Kenney

Aquatic Informatics, Salt Lake City, USA

The absolute true value for anything measured or computed is uncertain. Estimating the amount of uncertainty provides practitioners and data users a better understanding of the data. Quantified, or Type A, uncertainty is determined through statistical analysis, while Type B uncertainty, commonly referred to as qualitative, is determined using “any other information.” The general sources of hydrometric-data uncertainty will be presented in context with the stage-discharge method for computing streamflow. Type B uncertainty is common throughout hydrographer data-workflows and methods for Type A uncertainty for measured and computed hydrometric time series data are being conceptualized. This talk will present the current state of hydrometric data uncertainty with a focus on the stage-discharge method to compute streamflow.

Insights from the 15th Biennial National Hydrologic Warning Council Conference

Nicholas Holwerda
Basins Environmental

This presentation provides an overview of key learnings from the 15th Biennial National Hydrologic Warning Council (NHWC) Training Conference & Exposition, held in Tucson, Arizona, in June 2025. Supported by a travel grant from the New Zealand Hydrological Society, I attended the event to explore the latest developments in hydrologic monitoring, flood warning technology, and operational challenges across the United States.

Tucson is situated in the arid Southwest and receiving only 200–300 mm of annual rainfall, mostly during a short monsoon season. The region's heavy reliance on groundwater and declining flows in the Colorado River highlight the pressures facing U.S. water systems, where major perennial rivers are increasingly intermittent and over-allocated. These conditions present significant challenges for flood managers, particularly in issuing timely public warnings during fast-moving flash flood events.

A major theme of the conference was the nationwide dependence on ALERT and ALERT2 radio-based telemetry systems, widely used by federal, state, and county agencies for real-time rainfall and stage monitoring in areas with unreliable cellular networks. Exhibitors showcased innovations in sensors, loggers, and flood-warning software, alongside products from leading organisations such as USGS, Xylem, OTT HydroMet, Campbell Scientific, and AEM.

Technical sessions highlighted emerging forecasting tools for atmospheric river events, lessons learned from California's 2025 wildfire flood sequence, workforce and training development, camera-based flow estimation, and new approaches to sensor calibration and data quality assurance. A notable comparison was the higher nationwide consistency achieved in New Zealand through NEMS, contrasted against the U.S.'s more diverse, decentralised flood warning networks.

A key innovation presented was the use of drone-based Particle Image Velocimetry (PIV) for slope area flood gaugings. Agencies in Arizona demonstrated how dynamic Manning's roughness values ranging from 0.01 to 0.05 across dry sand channels and vegetated floodplains improve flood flow estimation compared to traditional static coefficients.

The conference also provided insight into USGS operations, including the celebration of their 1000th stream gauge with over a century of continuous data, and growing concerns around potential 30% federal budget cuts affecting national hydrologic services.

Following the conference, a visit to SONTEK in San Diego offered a behind the scenes look at the manufacturing and calibration of key ADCP instruments widely used in New Zealand.

Overall, the NHWC conference proved to be exceptionally well organised, technically rich, and highly relevant to both operational hydrology and flood-warning practitioners.

Continued engagement between New Zealand and U.S. agencies offers valuable opportunities for collaboration, data improvement, and the adoption of emerging technologies.

Direct-to-device (D2D) satellite connectivity

Ron Schop

Unidata Pty Ltd, Australia

Direct-to-device (D2D) satellite connectivity is emerging as a new option for environmental monitoring, allowing standard cellular IoT devices to communicate via satellite when terrestrial coverage is unavailable. This presentation describes recent testing of Unidata loggers by ESNZ on the OneNZ direct-to-device network, using unmodified cellular hardware and firmware designed for low-power remote monitoring applications. We outline the technical architecture, test methodology, and observed performance, including connectivity behaviour, power implications, and practical deployment considerations. The results demonstrate how D2D can complement existing cellular and satellite solutions, simplifying device design and potentially reducing cost and complexity for remote hydrological and environmental monitoring stations. The presentation also discusses current limitations, expected network evolution, and where D2D fits within a broader telemetry strategy alongside traditional satellite and cellular technologies.

Industry Updates

Mike Ede¹ and Tara Matthews²

¹*Tasman District Council*

²*Australian Hydrographers Association Representative*

A session containing updates on the following topics:

- NEMS
- NZ Diploma in Field Hydrology
- Korea Institute of Hydrological Survey MOU
- Australian Hydrographers Association (AHA)

NEMS Topics - How are we going? Gaps, Grading, updates on NEMS for Open Channel Flow Measurement

Evan Baddock¹ and Alex Ring²

¹*Earth Sciences New Zealand*

²*Environment Canterbury*

This will be a short presentation on revised NEMS documents, including the Open Channel Flow and Data Processing NEMS standards, focussing on grading of data. This will then lead into break out discussion groups on these and any other NEMS subjects, with a view of giving feedback to the steering committee and future revisions.

Dusty Things - Do You Still Have them Hanging Around (Annoyingly)?

Mic Clayton (FAHA, CPH)
Snowy Hydro Ltd

Many of you may have a Dusty Thing in your office. That Dusty Thing may be an old paper file, an odd piece of equipment that no one knows the purpose of – until it is needed, a weird rating table in your water database system that no one has any idea of its relevance, or a folkloric hydrological practice that everyone either ignores or is ignorant of. That Dusty Thing might be that annoying but passionate hydrologist in the corner of your office! Dusty Things could also be called Corporate Knowledge which, unfortunately, often fades over time with potential eventual loss unless it is actively reviewed, preserved and promoted in the organisation. Mentoring newer team members in the corporate knowledge is an important process in your organisation.

Equally important though is that sometimes piece of knowledge may need to be let go if it is recognised that its purpose has been served and is replaced by a new way of doing something.

ISO 748 – 1979 Section 8.2 - Measurement of velocity using floats, qualified the use of the technique stating, 'This method shall only be used when it is impossible to employ a current meter because of excessive velocities and depths, etc'. Over 40 years later surface velocity measurement have become a New Black. We haven't thrown the ISO - it has evolved, albeit slowly, but what is important is that the foundations underlying that original, now obsolete (?), qualification statement are still applicable to this New Black.

While not as aged as ISO 748 -1979, "Roughness Characteristics of New Zealand Rivers" at the time was designed for a different purpose, but the theories inside it are helping us understand how to potentially utilise our New Blacks more effectively.

Some examples are presented here where previous documented knowledge and learnings have been "unearthed" from dusty corners:

- to improve winter data quality at an alpine stream monitoring site,
- correct a misconception of accountable losses from a water transfer system, and
- potentially reducing the need for expenditure to conduct an investigation, where looking in that dusty corner uncovered work already done dealing with the issue.

Preserving, somewhere or somehow, the necessary Dusty Things before someone with a lesser understanding of the nuances of hydrological monitoring and interpretation eliminates their existence is a challenge for all organisations.

Recognising that those old Dusty Things are often core to the all the shiny and distracting things in the 'New Era', it is important to take the time to enrich your knowledge of the how and why of these old Dusty Things which in turn will, hopefully, contribute to your hydrological journey.

Flood Warning System Implementation and Performance - Arnold Dam Construction

Thomas Jamieson-Lucy
Riley

The purpose of the project was to provide contractors working at the Arnold Dam advanced warning of flood events. The dam strengthening works undertaken at the Arnold Dam required contractors to work within the active river channel downstream of the dam. The dry working area was maintained via an earth bund. In the event of a flood large enough to overtop the diversion bund, the contractors required 4 to 6 hours of advanced warning to extract their equipment and prepare the working area for inundation.

This presentation will provide a brief overview of the work completed including:

- Installation of temporary flow and rainfall monitoring sites.
- Derivation of rating curves using trail cameras and LSPIV.
- Development of a traffic light flood warning system.
- Operational challenges and lessons learned.

The Arnold Dam is located on the Arnold River, downstream of Lake Brunner in the West Coast Region. Several tributaries enter the Arnold River downstream of Lake Brunner which can cause the river to rise quickly at the Dam site. Temporary flow and rainfall monitoring was installed at two of these tributaries in October 2021.

Rating curves were derived using videos recorded by trail cameras at each site. The cameras recorded 20 second videos every 15 minutes. Site visits were undertaken to replace camera batteries on a monthly basis and following floods to download the camera memory cards. Videos were processed using the freely available Fudaa-LSPIV software.

A flood warning system was developed based on the collected rainfall and flow data and implemented at the start of construction in mid 2023. The system provided "traffic light" warning levels to the contractor as well as a dashboard displaying the real time data from the installed monitoring sites and other relevant WCRC data. The system used recorded data only and did not incorporate forecast data.

The system operated throughout the duration of construction (completed late 2024). As the system forecasted near real time flood events (4 to 6 hours ahead), a major challenge were flood events which occurred outside of working hours. While the automated system sent alerts during this time, no one was present onsite to undertake flood preparations. Enhancing the system to incorporate forecast rainfall data to increase the forecast horizon would have helped the contractor be better prepared for flood events outside of working hours.

Slippery Slope: The Development of Technology

Phil Downes

Environment Canterbury

If you had said to me 10yrs ago that you can point a gun at the river and get a discharge my answer would have been “Yeah Right”.

We have fantastic new technology and techniques for recording and measuring water level and flow BUT let’s not forget first principles that old technology/techniques are based on and have been proven over time.

I will demonstrate the importance of utilising old technology and techniques to complement new technology.

So, we must embrace old technology and techniques to support and verify the new technology and ensure we continue to collect the best data we can. My wish is not to forget the old stuff!!

Using the Same Data Differently: Hydrology's Role in Operational and Strategic Decision-Making

Sarah Innes
Watercare

Hydrological data collection is often undertaken with a bias towards our own requirements and the way we see data being used. As predominantly councils and utilities, we tend to focus on the creation of a long-term record or meeting short term compliance requirements. But how else is the data used? In the water resources industry, this can lead to a narrow, task-focused view of data collection and analysis, where hydrological datasets are used in isolation and within defined organisational boundaries. While this approach ensures data quality and continuity, it can limit opportunities for broader critical thinking and cross-sector application.

This presentation explores how hydrological data can be used more effectively across a wider range of decision-making contexts. Drawing on examples from practice, including Watercare's operational and planning environment, this presentation demonstrates how the same core hydrological datasets are relied upon across a wide spectrum of decision-making contexts, each with differing time horizons, risk profiles, and tolerance for uncertainty. In organisations, these datasets are most visibly applied in consenting, compliance, and real-time operational response, where regulatory thresholds, triggers, and event-based decision-making drive a strong focus on data accuracy, timeliness, and defensibility.

Less visible, however, is how these same datasets support tactical and strategic decisions, such as infrastructure prioritisation, system resilience planning, and long-term investment under climate uncertainty. These longer-term decisions often require hydrological data to be interpreted beyond single events or thresholds, placing greater emphasis on trend analysis and an understanding of uncertainty rather than precise values. The presentation highlights the importance of recognising these differing uses, and the risk that data collection and analysis become optimised for short-term or compliance-driven needs at the expense of broader system understanding and future-focused planning.

By tracing how hydrological data moves from field collection through to operational dashboards, planning tools, and strategic frameworks, the presentation illustrates the value of deliberately designing monitoring networks and data-sharing practices that support both current regulatory responsibilities and emerging challenges facing organisations, including climate change adaptation, increasing demand pressures, and expectations of resilient infrastructure.

Where I've been and where I'm going. A Technical Report from Greater Wellington Regional Council

Hamish Ogilvie

Greater Wellington Regional Council

Like many other regions, Cyclone Gabrielle caused catastrophic damage to buildings, infrastructure, and landscapes of the Greater Wellington Region. Particularly affected, were the Eastern Hills of the Wairarapa and the rural community around Tinui. Mid 2024 funding was made available by the Cyclone Recovery Office to invest in upgrades and repairs to the early flood warning network. The timeframe was short and there was a range of outcomes to achieve. First part of this presentation will discuss some interesting elements of the project which include; development of WFLOW & HYDROL flood forecast models for the Whareama River catchment, building a 115m gauging cableway from scratch, remotely managed variable message flood warning signs, and 'automated' flood warning alerts.

With that project wrapped up it's time to look forward, and following on closely, is the National Telemetry Project. GWRC has committed to a programme of general improvements at rainfall and flood warning sites that will complement our internal Flood Warning Network Performance Standards workstream. Alongside improvements to remote installations, our IT Team is showing increasing interest in telemetered data pathways and the platforms available for consuming the data. Challenging the norms and viewing the possibilities through a lens of 'modern computing' is a conversation that's becoming a more common thread. Second part of the presentation will briefly discuss the network improvements programme, and some concepts for maximising function of our industry specific hardware and how the data interface for consumers could look in the future.

The power of machine learning in optical flow measurements

Daniel Wagenaar
Xylem

The learning applied during the computation process is based on the analysis of all new measurements across several stages of system operation. Cross section geometry, surface velocity distribution, and discharge rating form the three primary learning components. During the initial steps of video analysis, the system verifies that global lighting conditions are adequate; only data points with sufficient illumination are included in the computation. The criteria used within each learning stage are functions of the number of observations, optical measurement coverage determined by lighting and tracer conditions, water level estimation, and the degree of convergence and self-consistency between the current measurement, the learning velocity distribution, the fitted surface velocity profile model, and the adaptive discharge rating.

Cross Section and Water Surface Characterisation:

A point cloud of the near bank and water surface is generated using stereophotogrammetry. This process incorporates stereo camera data, inertial measurement unit (IMU) readings, camera elevation and orientation, and defined cross section analysis boundaries. The resulting point cloud is used to determine camera elevation, cross section profile, and water surface elevation.

Optical Flow and Velocity Computation:

Net optical flow displacements between consecutive frames are computed using the Farneback optical flow algorithm, producing a dense flow field with high accuracy and low noise sensitivity. Raw planar surface velocities are rectified at 0.1 m resolution across the analysis domain using water level relative to the camera, IMU data, camera orientation, flow direction, and velocity analysis boundaries. For each 1 cm increment in water level, the system constructs an adaptive database containing measured surface velocity distributions and fitted surface velocity profile models. New measurements are continually assessed against global lighting constraints and upper/lower velocity envelopes to determine whether they are suitable for updating the learning models.

Discharge Computation and Learning Rating Curve:

Raw discharge is calculated at 0.1 m intervals using rectified surface velocity, local water depth, and alpha coefficients. Total discharge is obtained by summing all interval contributions across the section. The system generates an adaptive learning discharge rating informed by the evolving surface velocity distribution and velocity profile model.

Quality Assessment:

All real time optical flow measurements are evaluated using a comprehensive quality matrix. This matrix considers learning convergence, optical flow coverage, agreement with raw measurements, internal optical flow analysis checks, alignment with observed ranges, water stage estimation, and the availability of cross section information to support internal stage discharge rating development.

Panel Discussion- Core Principles for a New Era

Facilitated by:

Joe Gendall, Watercare.

Panel Members:

Marissa Hughes, UNC at Chapel Hill

Georgia Spankie, Greater Wellington Regional Council

Nick Holwerda, Basins Environmental

Mike Ede, Tasman District Council

Aligning with the workshop theme, this panel takes a step back to examine the fundamental principles that should guide our profession as it evolves. With rapid advances in automation, AI, and data collection, what core concepts and practices remain essential? And which established practices may no longer be fit for purpose? The panel will examine critical questions about professional practice, knowledge transfer, and the balance between specialisation and foundational understanding. By grounding ourselves in core principles while embracing innovation, we can build a more resilient and effective profession capable of meeting future water challenges.

There will be four panellists, and three or four pre-arranged questions to guide the conversation, with questions/comments from the audience encouraged. Pre-arranged questions will be finalised by the panel prior to the session, below is a starting point for questions to be picked from/improved upon:

- What core principles or concepts should every hydrology professional understand deeply, regardless of technological advances or career specialisation?
- When mentoring early-career scientists, what fundamental skills or ways of thinking do you prioritise, and why?
- What fundamental skills or observational practices risk being lost to automation, and should we hold onto them?
- If you could revise the "hydrologist's toolkit" for the next generation, what fundamentals would you insist on, and what conventional wisdom would you challenge?
- Looking at hydrology training today, what core principles or foundational knowledge are missing or under-emphasized for the challenges ahead?
- How do we maintain rigorous quality assurance and professional standards when technology makes data collection and analysis appear deceptively simple?