Workshop Program

Tuesday 9th March			
Time	**Item**	**Speaker**	**Organisation**
09:30	Registrations		
10:00	Formal Welcome	Tim Davie	Director Science, Environment Canterbury
10:15	History of Hydrology in New Zealand	Charles Pearson	NIWA
10:30	**Morning tea**		
11:00	NEMS for Freshwater Periphyton and Macroinvertebrates	Juliet Milne	NIWA
11:20	Acoustic Doppler Devices and Number Nuances	Phil Hook	Pattle Delamore Partners
11:40	High frequency water quality	Lucy McKergow	NIWA
12:10	Nitrate Monitoring	Lee Burbery	ESR
12:30	**Lunch**		
13:30	NIWA Rating Tank	Alec Dempster	NIWA
14:00	Essential Freshwater Implementation – Working Together	Christina Robb	Happen Consulting Ltd
14:20	Increased demand for data and water quality monitoring	Micah Dodge	Horizons Regional Council
14:40	Surface Velocity Measurements – An Aussie Update	Mark Randall	Department Natural Resources Mines and Energy
15:00	**Afternoon Tea**		
15:30	Exhibitor presentations (5 minutes each)		
16:30	**Field day details**		**Environment Canterbury**
18:00	**Social Event - Sponsored by NIWA**	**Savoy West & 2, Rydges Latimer**	

See Appendix 1 for venue details.

Wednesday 10th March		
Time	**Item**	**Venue**
09:00 - 17:00	**Field Day**	Silverstream Reserve, South Eyre Road, Clarkville NIWA Rating Tank Further details to be discussed at the workshop

Thursday 11th March			
Time	**Item**	**Speaker**	**Organisation**
09:00	Oteha Weir Have All the Fish Gone?	Amber Taylor	University of Waikato
09:20	Monitoring Piha Trials (and Tribulations)	Jonathan De Villiers	Auckland Council
09:40	Low-cost open-source monitoring	Ed Clayton	Mote
10:00	Superficial Flow Measurement	Graeme Smart	NIWA
10:30	**Morning tea**		
11:00	Tracing Water through Karst Systems	Morgan Harvie	Pattle Delamore Partners
11:20	Unexpected insights and applications of subterranean time series stage data	Carl Fischer	NIWA
11:40	Irrigation network efficiency crucial for ensuring sustainable water resource	Daniel Wagenaar	Xylem Water Solutions
12:00	The 'Drone flow' project and methods for determining surface alpha	Hamish Biggs	NIWA
12:30	**Lunch**		
13:30	Monitoring Canterbury Lakes – a clearer picture of murkier waters	Alex Ring	Environment Canterbury
13:50	NRC Region-wide River Flood Model	Bertrand Salmi	Water Technology
14:10	Responding to challenges of a changing climate	Max Mackay	Bay of Plenty Regional Council
14:30	Calibration of tipping bucket rain gauges – expectation vs reality	Sam Edwards	NIWA
15:00	**Afternoon Tea**		
15:30	Hydrometric Network Review	Phil Downes	Environment Canterbury
15:50	New Zealand Water Model	Christian Zammit	NIWA
16:10	Vietnam National Flood Forecasting	Christian Michl	Kisters
18:00	**Dinner & Drinks – Savoy West & 2, Rydges Latimer**		

Friday 12th March			
Time	**Item**	**Speaker**	**Organisation**
09:00	Optical Bathymetry Toolkit	Matthew Gardner	Land River Sea Consulting Ltd
09:40	Space Time Image Velocimetry (STIV) use in Southland	Michael McDonald	Environment Southland
10:00	A new AI tool for autonomous underwater weed surveillance	Jeremy Bulleid	NIWA
10:30	Morning tea		
11:00	Environment Canterbury River Network Tool	Ben Throssell	Pattle Delamore Partners
11:20	Micro purge techniques for Groundwater sampling	Dirk van Walt	Van Walt
11:40	Evolution of gas bubbler & dry transducer sensors for accurate water-level measurement	Anastasia Ponomareva	Scott Technical Instruments
12:00	**Prize Giving and Close**		

Abstracts – Tuesday

NEMS for Freshwater Periphyton and Macroinvertebrates

Juliet Milne – NIWA

The need for nationally consistent monitoring of our freshwater resources has never been stronger, a point hammered home with the Parliamentary Commissioner for the Environment's release of *Focusing Aotearoa New Zealand's environmental reporting system* in November 2019. The National Environmental Monitoring Standards (NEMS) is one initiative that is helping to improve the consistency and robustness of environmental monitoring. After an initial focus on hydrological and water quality monitoring standards, new draft standards on the collection and processing of periphyton and macroinvertebrate samples were released for comment in late 2020.[1] These standards focus primarily on long-term State of the Environment monitoring in wadeable reaches of rivers but also provide guidance on sampling under the National Policy Statement for Freshwater Management (NPS-FM) and in relation to resource consents. Both standards were prepared by a multi-agency team comprising experienced science and monitoring staff across regional councils, crown research institutes and commercial laboratories. The standards revisit and will supersede existing sampling periphyton and macroinvertebrate protocols prepared by Biggs and Kilroy (2000) and Stark et al. (2001), respectively. They present protocols for: sample point selection, visit metadata, sampling equipment, on-site measurements, sample collection and handling, laboratory processing, and data quality assurance (QA) and archiving. A matrix-style scoring system is included to enable a quality code to be assigned to individual periphyton sample measurements and macroinvertebrate metrics, taking into account key aspects of sample measurement/collection and laboratory processing that have the potential to influence data quality. This presentation will highlight the importance of these standards in relation to the mandatory requirement enshrined in the NPS-FM that all rivers (and lakes) are managed for ecosystem health and briefly overview some of the key requirements of each standard.

Acoustic Doppler Devices and Number Nuances

Phil Hook – Pattle Delamore Partners

Do you have hydrometric stations with complex hydrology? Issues with reverse flow and tidal water levels affecting your stage/discharge relationships? PDP may have the solution for you!

Acoustic Doppler Profilers (ADPs) are becoming increasingly utilised in remote environmental monitoring situations to enable stakeholders to understand complex flow relationships in real time. Pattle Delamore Partners (PDP) have installed and operated ADPs in a large monitoring network (covering a catchment area of 48,900ha) which includes complicated stage-flow relationships.

These monitoring locations, where loop ratings (Hysteresis) would have previously been used to understand the stage-discharge relationship, are now able to be accurately measured using ADP technology.

Hysteresis is complex and requires large amounts of time and therefore expense to determine an accurate stage/discharge rating,

Advantages of using ADPs include:

- flow ratings can be used for other determining other relationships such as sediment flux;
- ADP automatically calculates the flow rate, which can be telemetered back to user providing

real time data;

- Reduced amount of time needed to develop a rating for the monitoring location
- Can be a more cost-effective solution
- if calibrated to gaugings and operated correctly, velocity indexing can be accurate to within 1%.

There are also a few disadvantages show that this technology is not always fit for purpose i.e. in areas with particularly weedy rivers.

This presentation will discuss in more detail a Whangamarino case study, detailing the advantages and disadvantages of using this technology and how this technology was used to provide real time sediment flux movement.

High Frequency Water Quality

Lucy McKergow – NIWA

High frequency water quality information can be valuable for assessing waterbody health, comparative studies and revealing ‘science unseen’. Understanding sensor comparability, sensitivity and performance in the field is critical when choosing an appropriate sensor to meet data and information needs. With growing awareness of how different sensors perform, and with new sensors entering the market, there is a need to continue evaluating sensors under field conditions. Using Envirolink funding we compared ISO 7027-compliant turbidity sensors over a 100-fold range of concentration in three test suspensions (river silt, kaolinite, and green algae laden pond water). The responses of the four different field sensors (WTW, Observator, Hach Solitax, YSI EXO) and two cuvette instruments were strongly linearly related, but their numerical output ranged about two-fold. This variation in sensor output suggests that turbidity (in FNUs) should not be treated as an absolute quantity, for example in environmental standards or consent conditions. In other work within NIWA, we are planning a nitrate sensor comparison with the arrival on the market of the YSI EXO NitraLED sensor. We anticipate lab testing and short term field deployments of commercially available sensors suitable for rivers (YSI, TriOS and s::can), including the key interferences – particle scattering and absorption by dissolved organics . We are also working on updating and/or developing Standard Operating Procedures (SOPs) for high frequency water quality sensors and plan to test adaptive monitoring to ensure we are able to provide information during critical periods (e.g. floods, spills, droughts), while minimising data volumes and lamp wear in spectral sensors.

NIWA Rating Tank

Alec Dempster - NIWA

NIWA owns and operates New Zealand’s only Rating Tank - one of only five such facilities in the world. The manually operated velocity-rating car provides an accurate velocity reference to calibrate and verify sensors used to measure open channel velocity. Regularly verified instruments are an integral component of the current NEMs standards.

To ensure that the rating process remains accurate, we carry out quarterly verification tests using the reference Mini Seba propeller current meter that is independently calibrated at Switzerland’s rating facility. This approach is part of a worldwide collaboration to ensure that all rating tanks produce consistent and similar results – that is, if a given meter were to be calibrated at all of these tanks, the calibration relationships would lie within an acceptance threshold.

Over the years, the NIWA Kainga facility has been upgraded progressively, including to an electronic measurement system that has provided a higher level of precision and safety than the original which was built in Germany in the late 1950s. These improvements have enabled NIWA to continue producing reliable calibrations for mechanical current meters while retaining the attributes that are necessary to retain the integrity of the standard. More recently, with the advent of acoustic velocity instruments, our rating tank verification procedures have been expanded to also include methods for testing the accuracy of ADCP & ADV instruments.

While most sensors pass these verification tests, it isn't un-common to have older sensors fail due to aging electrical componentry or physical damage. This highlights the importance of regular verifications on all sensors used to record open channel velocities.

The current NEMs standards are 2-yearly Current Meter calibrations, 3-yearly verifications for ADCP's and 5-yearly verifications for ADV's.

Essential Freshwater Implementation – Working Together

Christina Robb – Happen Consulting Ltd

Christina is contracted to the Regional Councils to co-ordinate our responses to Essential Freshwater – the National Policy Statement, National Environmental Standards, s.360 regulations and freshwater farm plans. Co-ordination involves linking with a suite of projects led by Ministry for the Environment and Kahui Wai Māori; and also looking at where councils can work together, share resources and information. I will give an overview of the Essential Freshwater package and the main changes for councils, and then narrow down to specifics on implications for hydrologists. I will then talk about the national implementation projects, how I see them evolving over the next three years, and, as before, pick out aspects most relevant to hydrologists.

Increased demand for data and water quality monitoring

Micah Dodge – Horizons Regional Council

Hydrology has had a significant change in scope in recent years, over the last 10 years in particular we have seen a significant increase in the monitoring of water quality. Alongside this, the introduction of new monitoring technology and procedures has changed not only what we do, but how we do it.

Horizons has been working on developing bespoke solutions to the conditions and challenges in these areas using remote sensing as well as 3D printing and design developed and tested in-house to meet the increased demand for data and an increased water quality monitoring network.

Abstracts – Thursday

Oteha: Weir have all the fish gone?

Amber Taylor - University of Waikato

Oteha is a water level site that has over the years, provided the Auckland council with high quality, long term river flow monitoring data. Oteha has also been utilised for monitoring the effects of urban land use upon water quality. This has been of great importance with the rapid land use changes around the stream that has occurred over the past years. Furthermore, this stream is home to a number of native migratory fish. The weir that was installed with the establishment of the site in the late 1970's has proved to be a barrier for these migratory fish, significantly reducing the populations found upstream compared to that found downstream. After two failed fish passage installation efforts and alterations to the weir, it has been decided that the weir is to be removed in order to safeguard the fish. The question thus stands, what impacts will the weir removal pose upon the flow monitoring at Oteha, and what other implications will arise in the future with the removal of this engineered structure?

Monitoring Piha Trials (and Tribulations)

Jonathan De Villiers – Auckland Council

After the 2018 flooding event at Piha on Auckland's west coast, there has been a drive to increase hydrological monitoring within its catchment. This talk will give an overview of the flooding event, the instrumentation that has been trialled in the catchment since, and how effective those trials have been.

Low-Cost Open-Source monitoring: Building an Arduino Light Attenuation Unit to Estimate Suspended Sediment and Visual Clarity

Ed Clayton – Mote

The process of public engagement in data collection, research and analysis is known as citizen science (Buytaert et al, 2014). It is not a new concept as the engagement of public for empirical observational data is well documented, although collection of hydrological data often requires the use of complex, expensive scientific equipment (outside of collection of manual water quality samples) and has excluded effective citizen science participation (Buytaert et al, 2016). Yet "formal", traditional hydrometric networks typically represent coarse catchment scale spatial dynamics, not necessarily capturing the complex heterogenous nature of freshwater systems and associated contamination (Buytaert et al, 2014). The development of low-cost "informal" networks utilize cheap open-source technology to generate time-series information to complement traditional formal hydrometric measurements (Storey et al, 2016).

This presentation sets out the philosophy and methodology behind the design of an Arduino powered light attenuation sensor to estimate suspended sediment concentration and visual clarity of water bodies. The rationale behind the sensor was to provide a low-cost measurement system suitable for use in catchment scale diffuse sediment pollution or erosion investigations, with the intention that any person can download the code and instructions for assembly and purchase consumer grade materials from electronic stores. Ideally this will include community groups and citizen scientists. While other low-cost units have been trialled in other studies (see Trevathan et al, 2020), they have repurposed composite parts from such machines as dishwashers and washing machines or used hobbyist components (e.g. DFRobot) with limited success. From the authors research, this is the first time a low-cost open-source light attenuation unit has been built from the ground-up. While it differs from National Environmental Monitoring Standards for turbidity measurements (90° backscatter), attenuation of a collimated light beam is identical to how visual clarity is perceived (Davies-Colley and Close, 1990). Therefore, it is hoped that the attenuation method of measurement will closely correlate to clarity measurements, in accordance with the updated National Policy Statement on Freshwater Management (Ministry for the Environment, 2020) where clarity is the measure of suspended fine sediment.

To measure attenuation the Arduino powers four different 850nm infrared LED's which send beams through the water via four different pathlengths. The resultant transmitted beam intensities are measured at chosen time intervals using infrared phototransistors connected to Arduino analog inputs in parallel with resistors to earth. The voltage levels obtained at the Arduino inputs are converted (using their logarithms and the measured pathlengths) by a simple program to give attenuation values. Having four beams makes it possible via the software to determine attenuation allowing for biofouling on the sensor surfaces. Software cross-checking enables monitoring of accuracy. Data is recorded (CSV files on SD card) by an Arduino SD shield, with an upgraded version planned that can send data via Bluetooth, LoRAWAN or wifi network to a central hub in a hub/node mesh network.

Currently the device is undergoing bench testing prior to field deployment. Jar tests against dilutions of a nominal "reference" clay stock solution have shown excellent correlation between dilution series and measured attenuation (Figure 1). Next steps will include laboratory testing against industry reference solutions alongside proven turbidity sensors and a field test platform combining two attenuation sensors, a turbidity sensor and grab samples for laboratory analysis of clarity and suspended sediment.

Superficial Flow Measurement

Graeme Smart - NIWA

Remote discharge measurements based on surface velocity radar (Welber et al., 2016), drone imagery (Detert et al., 2017) and bankside photogrammetric techniques (Le Coz et al., 2010; Fujita et al., 2018) are increasingly being used. Typically, for these non-intrusive methods, a coefficient (α) is used to relate depth-average velocity to surface velocity. Following current best practices α can be estimated empirically or theoretically (Le Coz et al., 2010) with a default value of around 0.857 (Rantz, 1982). As α depends on the underlying velocity profile it is possible to relate α to physical parameters such as bed shear stress or fluctuations in the surface velocity (Smart & Biggs, 2020). In this talk we graphically explore velocity profiles and how and how wind and low depths (relative to bed material size) can severely affect the α ratio.

Tracing Water through Karst Systems using and Rhodamine and Fluorescein Dyes

Morgan Harvie – Pattle Delamore Partners Ltd

Water tracing techniques have been used to successfully trace the emergence locations (springs) of water from karst systems. The Waitomo region is characterised by a karst landscape in which the limestone rock has naturally dissolved from acidic rainwater creating an underground drainage system which discharges to streams further downgradient in the catchment. The water that re-emerges at the

surface comes from two sources, subterranean streams and rainwater that infiltrates through the catchment and at recharge zones known as dolines or sinkholes.
A dye tracing technique was proposed using rhodamine and fluorescein dyes. Water sampling was undertaken in downgradient catchments in likely emergence springs. Two logging fluorometers were deployed, one in the Mangawhitikau Stream catchment and the other in the Mangapu River catchment. These loggers recorded dye concentrations at 15-minute intervals to capture the breakthrough curve of the dye tracer using optical sensors set at specific wavelengths.
The G-GUN-FL24 (G-Gun) had optics for detection of both fluorescein and rhodamine dyes. This logger was deployed in the Mangawhitikau Stream catchment before the convergence of the Mangapu River. A Turner Cyclops-7F (Cyclops) with rhodamine optics only was installed in the Mangapu River before the convergence with the Mangawhitikau Stream to measure dye presence on a broad catchment scale.

A separate manual sampling regime using a Turner Designs AquaFluor Handheld Fluorometer was completed to provide data for specific locations of interest at a coarser temporal resolution. This device had dual channel capability to easily measure both rhodamine and fluorescein dye tracers. This field technique was low maintenance and simple to use.
Two pounds of rhodamine and fluorescein dye were each mixed into 20 litres of rainwater and added into the chosen doline features. The dye was injected instantaneously and followed by approximately 10,000 litres of water to flush the dye into the groundwater network.
The monitoring program successfully detected the two dyes and downgradient emergence spring within the Mangawhitikau stream. A breakthrough curve for the rhodamine dye showed a typical hydrograph with a rising limb reaching peak concentrations faster than the falling limb. The fluorescein tracer had a slower rising limb in comparison. The rhodamine dye emerged in the Mangawhitikau Stream approximately two and half days after dye injection and fluorescein emerged approximately seven days after injection.

Peak concentrations of 23 ppb and 16 ppb were measured by the handheld fluorometer for rhodamine and fluorescein, respectively. The dye was significantly diluted when it reached the emergence location with a dilution ratio of 1:5600 for the fluorescein dye tracer and 1:3900 for the rhodamine dye tracer. This dilution of the dye tracer meant there must be enough dye added into the doline features in the first instance so that it could be detected in the downgradient locations as much of the water gets filtered through the groundwater system.

This presentation will discuss the methodology undertaken, results obtained, and challenges confronted during the dye tracing programme.

Unexpected Insights and Applications of Subterranean Time Series Stage Data: A Waitomo Glowworm Cave Case Study

Carl Fischer – NIWA

The Waitomo Glowworm Cave has a long and storied history of environmental monitoring. Integral to this history has been the development of a comprehensive cave climate, biota and hydrological dataset.

This dataset has informed unique consent conditions, driven management innovation and resulted in novel insights into the complex anthropogenic and natural interactions occurring within the cave environment.

In particular, the Waitomo stream (which flows through the cave) stage time series has proved useful for: informing operational decisions related to the stream; further understanding the interaction between the stream and cave climate; and contributing to a more data-driven knowledge of glowworm bioluminescence and population dynamics.

The aim of this presentation is to describe this dataset, share these applications and insights and, more generally, to serve as a reminder as to the many, varied and sometimes unexpected value of hydrological data.

Irrigation network efficiency crucial for ensuring sustainable water resource

Daniel Wagenaar – Xylem Water Solutions

Irrigation network efficiency is a fundamental component in ensuring sustainable water resource and this has become more pertinent with the expansion of irrigation areas, aging infrastructure and global warming. There are number of aspects that drives an efficient irrigation network, with water resource planning, maintenance programs and flow monitoring network that forms the key components. The knowledge of water lost due to evaporation, leakage or unauthorized abstractions as a result of well-designed monitoring network is invaluable as this assist in decision making process for future expansion or maintenance of irrigation network.

The ability to accurately monitor flows within irrigation network even under stress during peak demand can highlight structures that exceeds their hydraulic limit during certain flow conditions. Most importantly, it gives both the customers and operators the confidence that the flow and associated billing from water releases are accurate.

Murrumbidgee Irrigation implemented a verification process to review the flow monitoring network at strategic points over a 3-month period. The verification process consisted of temporary installation of SonTek SL1500-3G acoustic Doppler instruments at ten predefined measurement sites. An index velocity rating was developed that is based on velocity measurements from SonTek SL1500-3G instrument and discharge measurements from RiverSurveyor M9 acoustic Doppler current profiler. The index velocity rating is robust against variable backwater conditions, normally encountered during peak demand.

The process implemented by Murrumbidgee Irrigation to automate the data collection, audit and index velocity rating development is sophisticated to ensure accurate assessment of the flows. The SL1500-3G instruments sends velocity and diagnostic data at fixed sample intervals via serial output over TCP/IP to an SQL data base. The RiverSurveyor M9 discharge measurements performed during the week is processed at the office, from where the information is captured into custom designed application. The application compares the data captured from the discharge measurements against the velocity data stored on the SQL database. Index Velocity rating is developed based on information entered, from where a detailed assessment is performed to determine if the index velocity rating is valid. During the verification period, field personnel has the option to request that no flow changes are made during the discharge measurements. This ensures that the flow in the channel is relative stable during the discharge measurements.

The flow results from the index velocity ratings are used to further improve the existing stage-discharge relationships at each of the flow measurement sites selected within the irrigation network.

The 'Drone flow' project and methods for determining surface alpha

Hamish Biggs – NIWA

Drones are a useful tool for field hydrologists. They can be deployed to measure flows in situations where traditional techniques struggle. For example, during large floods where instream equipment cannot be deployed, during low flows where ADCP blanking distances prevent reliable measurements, or during rapidly varying flows. However, uncertainties remain around how best to convert from surface velocity to depth averaged velocity (known as the alpha coefficient) and what effect wind loading may have on alpha. This talk provides an update on progress in the 'Drone flow' project, and recent results from a collaborative study to assess the accuracy of different methods for determining alpha. Preliminary results from a detailed field campaign to assess the effects of surface wind on alpha will also be presented.

Monitoring Canterbury Lakes – a clearer picture of murkier waters

Alex Ring – Environment Canterbury

With over half of the country's allocated water coming from the Canterbury region, the question of whether to monitor is an easy one. The question of how and where to direct the limited monitoring resources is much trickier.

Our lowland lakes have been seriously degraded over generations. Monitoring efforts here are hoping to capture improvements in water quality through better catchment management.

Our high-country lakes have had less attention, partly because of their traditionally healthy status. Healthy does not mean resilient though. These lakes can be very susceptible to change, acting like a Canary in an old mine shaft. These "Canaries" are showing signs of stress, and we need to take a closer look than just the summertime SOE helicopter sampling. The newly established monitoring programme in the high country is hoping to capture information about the processes involved in a lakes decline. With this knowledge we will then be in a better position to advocate for better land and lake management.

Three high-country lakes will be chosen as recipients of continuous water quality monitoring stations. The first lake chosen was lake Pearson, with the station going live in September 2020. The next two lakes are yet to be finalised, with design discussions currently underway.

This talk will focus on the rationale behind this monitoring programme, the methods employed and the technical challenges met along the way so far.

NRC Region-wide River Flood Model

Bertrand Salmi – Water Technology (NZ) Ltd

Northland Regional Council (NRC) is making a concerted effort to infill gaps in its flood intelligence across the municipality. Water Technology was commissioned by NRC to undertake a region-wide flood modelling study encompassing the entire Northland Regional Council area, which covers an area of over 12,500 km^2. The aim of this project is to map flood hazard zones across the entire Northland region, update existing flood intelligence and provide design flood levels for use in planning and emergency management.

A 2D Direct Rainfall (also known as Rain on Grid) approach was adopted for the hydraulic modelling and will provide flood extents for a defined range of design storms. TUFLOW software was chosen, to take advantage of Sub-Grid Sampling (SGS), a recently released feature of the software. SGS allows a much richer description of the hydraulic behaviour of a DEM cell compared a traditional grid that has a single topographic elevation, without the need to compromise on model simulation time. By accounting for topographical variation within each cell, allows user to produce models with coarse grid resolution whilst still make use of the high detail LiDAR without the need for a finer grid resolution. This allows to reduce computation time without necessary compromising model accuracy.

Calibration of catchment wide-modelling using rain-on grid is a relatively new approach across NZ. The presentation will focus on the different tests undertaken to parametrise the hydraulic model for the calibration of catchments to gauged flood records. The calibration not only utilised streamflow and water level records, but was also validated against existing flood levels from several large flood events including 2011 and the recent July 2020 flood event. The presentation will explore how rainfall was modelled both spatially and temporally across the catchment, as well as how rainfall losses/infiltration were derived to represent land use types and soils. It will provide an overview of the calibration results for streamflow gauges, looking at water surface elevations, peak flows, flood volumes and timing of peak. It will also further broach on factors influencing the calibration, including uncertainty associated with existing rating curves. Current results have shown the hydraulic model is able to replicate the flood behaviour extremely well and will allow for the production of sounds design modelling outputs.

The calibration of these hydraulic models determined a range of model parameters (rainfall/infiltration losses, roughness) to be adopted for the validation of other catchments within the study area and design modelling. The presentation will provide an overview of how design events have been modelled for a range of AEP event across the Northland region and discuss the uncertainty associated with the overall approach. Despite some of the modelling challenges and limitations (compared to a detailed river-scale model), this project will provide, in a very short timeframe, fit-for-purpose hazard mapping across the entire NRC Region. These maps will replace the existing flood susceptible layer and be published as part of NRC’s natural hazards maps and included in the regulatory framework for inclusion in Regional and District Plans.

Responding to the big dry in the Bay of Plenty

Max Mackay, BOPRC

Climate change is bringing hotter, drier summers to our region, and our natural water sources are already showing signs of stress. Flow levels in some western Bay of Plenty streams dropped to record lows in March – May 2020, following several months of exceptionally dry weather.

On the 10th of March 2020, at an extraordinary council meeting, regional council elected members approved a process for issuing water shortage directions.

The BOPRC has always monitored water levels closely, especially during dry weather, but had never been close to considering water use restriction action at this level – it was a first for our region and quality data used to present clear indicators was the key.

As a Data Services team, we needed to develop tools and reporting that better enabled us to communicate the current state of play with regard to rainfall deficits and river flows.
Some of the reports that were developed to help the Regional Council respond to the drought conditions were:

1. Standardised Precipitation Index – Heat Maps and plots

The Standardised Precipitation Index (SPI) is a simple measure of drought, or very wet conditions, based solely on the accumulated precipitation for a given time period (e.g. over the last 30, 90 or 365 days), compared with the long-term average precipitation for that period.

Our SPI datasets are updated at the end of each month and allowed us to visually show the extent of the rainfall deficit at many of our sites.

2. Daily Mean Flow Plots

Another useful tool we adapted from other sources, Daily Mean Flow plots are now created every morning for all of our rating-derived flow sites.
The plot is useful for showing the current flow in comparison with the historic range of flow for the same time every year, as well as in relation to the Q5/7day statistic for that record.

3. Rating Review Report

With the increased scrutiny on the flow being reported at our continuously monitored river level sites, we wanted to find a way to make sure Stage-Discharge Ratings were accurate and up-to-date. A fortnightly report enabled our team to see when all of our derived flow sites were last gauged, and how far off the rating (as a percentage) each of the last three gaugings are.

Positive outcomes and observation:

- Increased reporting on gaugings and flow ratings drove us to target rivers for extra gaugings when it looked like a rating change might be required, of the flow being reported seemed extra low

- As a team were quicker to answer questions about the state of rivers in the region.

- We were able to quickly provide data and graphics to comms team, who were communicating to the public through our website and facebook page.

- The Water Shortage Event Manager was able to use the reports in meetings with the Bay of Plenty Primary Sector Co-ordination Group, which includes agencies such as Ministry for Primary Industries (MPI), Rural Support Trust, Fonterra, and NZ Kiwifruit Growers. Feedback from these meetings was that extra reporting was well received by the primary sector and helped foster positive relationships and communication channels. The same happened in meetings with the district councils in the region.

- Use of standardised reports has allowed us to minimised interpretation and own delivery to users. We are seeing a change from being just data collectors, but also enablers of storytelling and decision making using accepted tools.

Calibration of tipping bucket raingauges – expectation vs reality

Sam Edwards - NIWA

The suitability of a raingauge for an application will depend on the local climate, desired measurement resolution and accuracy, raingauge reliability, and whether the data will be used estimate accumulations and/or rainfall intensities. Different tipping bucket raingauge models have different characteristics. Understanding the differences will assist network decisions and give users greater confidence in the data quality.

Currently NIWA calibrates raingauges at 12.5 ± 0.5 mm/hr. A new raingauge calibration facility has been developed that makes it much easier to calibrate raingauges at a range of (apparent) rainfall intensities, from 3 to 300 mm/hr.

Tipping bucket raingauges are known to underestimate rainfall at high intensities. The ability to perform a dynamic calibration with the new facility means that calibration results could be used to apply an intensity-dependent correction to rainfall data.

The function and utility of NIWA's new calibration system will be described. Preliminary results have highlighted known differences between raingauge types. The calibration of 0.2 mm and 0.5 mm OTA and TB3 tipping bucket raingauges will be discussed, with an emphasis on differences in measurement accuracy as a function of rainfall intensity, and the effect of siphons.

New Zealand Water Model

Christian Zammit – NIWA

Over-allocation of water and water quality degradation are key issues in New Zealand. To address these issues, the National Policy Statement for Freshwater Management requires Regional Councils, in collaboration with iwi and communities, to set limits on water use and water quality, and establish allocations to stay within these limits.

Effective and efficient limit-setting and allocation require tools that can accurately predict the transport of water and contaminants, such as nutrients or sediment, from their source areas to the receiving water bodies where their effects occur. The scarcity of direct measurements of surface and groundwater flows and contaminant concentrations at spatial and temporal scales suitable for limit setting, means simulation models are urgently needed. These models are used to make predictions and develop scenarios of the future by combining scarce measurement data, information about processes like runoff and nutrient leaching, and detailed maps of streams, aquifers, soils and other catchment properties.

One of the challenges for modelling flows and contaminants is the complex arrangement of land and receiving waters in NZ catchments. Another challenge is posed by the time and effort needed to build models for the many places that require limit setting. The New Zealand Water Model – Hydrology (NZWaM-Hydrology) was set up by NIWA in December 2016 to answer those challenges and needs, through the development of a single, highly adaptable system focused on determining the key environmental controls of water movement across the landscape at relevant scales (Figure 1). Another objective is to develop a model that is transferable, scalable and can be simplified based on data availability. The NZWaM-Hydrology aims to provide essential information for the implementation of the NPS-FM, as well as key knowledge for the success of the National Science Challenge programmes that aim to relate pressure on New Zealand eco-systems to ecosystem responses (e.g. Our Land and Water Challenge and Deep South Challenge).

This paper aims to illustrate how the critical hydrological information collected by field team across New Zealand is used within NZWaM to continuously develop improved understanding of hydrological processes across New Zealand.

Vietnam National Flood Forecasting

Christian Michl - Kisters

Challenges in Design and Implementation of Operational Water Management & Forecasting Systems: A case study of the National Flood Forecasting System Vietnam

Effective management of natural hazards is a worldwide increasing activity especially in combination with changes in ecosystem behavior due to climate change. This requires systems to integrate scalar and raster observations and forecasts from meteorology and hydrology with analytics, reporting and dissemination components. However, even if the rapid development of modern information technologies offers many state-of-the art systems, its introduction requires a careful integration with well-established business procedures of the hydro-meteorological community to safeguard existing knowledge and secure the consistency of long-term observations.

This presentation looks at the technical and organizational objectives and challenges in the system design and implementation of such a forecasting management system for the HydroMet Service in Vietnam. The system was built as an infrastructure project within the World Bank project 'Vietnam - Managing Natural Hazards Project (VN-Haz)' and had the focus to strengthening the existing weather forecasting and early warning services. The new forecasting components are running since 1st February 2021 in parallel operation to the recent forecasting practices.

The overall architecture includes several building blocks combining a central data hub and sub systems for hydrological, coastal and meteorological forecasting in a web-based service layer infrastructure. Key factors are (i) the available data sets of observation networks, (ii) global and regional NWPs, (iii) calibrated models and forecasting systems and (iv) a highly integrated environment to deliver the data and information to several stakeholders of Vietnam.

Abstracts – Friday

Space Time Image Velocimetry (STIV) use in Southland

Michael McDonald – Environment Southland

Space Time Image Velocimetry (STIV) is a relatively new method in New Zealand, providing the opportunity to process water surface velocity results from video. Recently COVID-19 and a Southland flooding event in February 2020 have demonstrated the potential of STIV to complement the existing hydrology program. A benefit STIV techniques offer is the ability to remotely capture video at any time without sending staff out into the field, with cameras stationed in the field allowing the remote capture of video. Environment Southland trialed two sites during 2020 and has since installed a small number of fixed cameras. The intention is to use STIV methods to assist establishing new flow ratings for new and existing hydrometric sites, as well as capturing high flow events at sites without access during high flow events.

There have been some challenges and lessons learnt with installing, maintaining and collecting data for image velocimetry purposes. Video to date has been captured either from fixed cameras, handheld cameras or drone footage. Image velocimetry video is then processed in software to give a discharge result when the cross sectional data is applied. A number of image velocimetry videos are collected alongside conventional gauging techniques to compare the image velocimetry result to the gauged flow. These comparisons have resulted in similar flow calculations to date…….

A new AI tool for autonomous underwater weed surveillance

Jeremy Bulleid - NIWA

<u>The problem</u>

Aquatic plants are integral components of freshwater ecosystems. However, when invasive species establish, there are few natural checks and balances to inhibit their growth and spread. Left unchecked, they can degrade water quality, slow water velocity, exacerbate siltation or flooding, and reduce species diversity and abundance, posing a serious threat to freshwater aquatic systems. Dense infestations can severely impact streamflow, drainage (causing flooding), agricultural productivity (impeding water delivery and on-farm irrigation) and hydroelectric power generation.

In the absence of control, these species will have increased impacts on New Zealand's environmental, social and economic values of freshwater resources and further spread is likely.

Early detection of invasive taxa makes the difference between being able to employ feasible offensive strategies (eradication) and retreating to a defensive strategy that usually means an infinite financial commitment. In 2010 the nationwide cost of management was estimated at $27 M per annum.

Effective management requires surveillance strategies that are operationally efficient and carried out on a national scale by multiple agencies.

<u>A solution</u>

As part of NIWAs Freshwater Biosecurity programme for managing incursions of freshwater invasive species, NIWA has developed prototype AI (Artificial Intelligence) invasive weed detection software. This software analyses underwater video, frame-by-frame in real time, to detect submerged invasive species. Given relevant training, the resulting software detector can resolve different species.

Our proposed solution is to build the capability to automatically detect and GPS-map targeted invasive species, in real-time, using underwater video cameras and hydroacoustic systems connected to a proprietary hardware module deployed on surface craft. To increase geographical coverage, these modules could be operated universally by semi-skilled operators utilising fully autonomous or manned surface vessels.

Our initial focus is to train the detector to 'recognise' Hornwort, (NZ's worst weed) and Lagarosiphon, both species are 'Unwanted Organisms'. Hornwort is not currently known to be present in the South Island and Lagarosiphon is actively managed.

The prototype system is providing good detection results achieved by post-processing the video taken during experiments and diver surveys in natural waterways.

However, detecting invasive species in water with low visibility, due to the presence of high turbidity/suspended sediment (or low light), using optical detection, is challenging. In these conditions, a hydroacoustic-sensor may be deployed.

Hydro-acoustic images can be more difficult to discern than video imagery and interpretation can be time consuming. Thus, target species identification accuracy, using hydroacoustic images, is currently dependent on the skill-level of the person carrying out a manual analysis.

The prototype AI software has now been tested by post-processing acoustic sonar records. Initial results are encouraging.

The presentation

We will:

- Describe the AI detection process;
- Show examples of detections under experimental and *in-situ* conditions;
- Show annotated video outputs;
- Introduce the concept of replicable, standalone, surveillance modules.

Environment Canterbury River Network Tool

Ben Throssell - Pattle Delamore Partners

The National Policy Statement for Freshwater Management 2020 requires regional councils to assess current pressure on their water bodies via accounting systems. Good organisation of existing data is critical for this. In partnership with ECan, PDP has developed a geospatial tool to assist with the management and sharing of surface water allocation data. The tool integrates planning information from regional plans, geospatial databases, and various algorithms to create a visualisation layer for surface water allocation.

The tool links the river network to a database containing the regional planning rules, attaches relevant allocation rules to the geospatial river layer, and outputs a visual representation of the river network. Upon interrogation of the geospatial layer, the user can identify all allocation blocks that apply and the associated geographic extent. The user also has options to run the tool for a future date, which returns rules for proposed plans, or to run for other limit types and plan statuses (e.g. proposed, notified, operative).

The tool also validates the river network and can trace from a discrete point, either upstream or downstream;, this means the tool could also be used to determine other attributes such as the sum of consented takes for respective river reaches or potential contaminant pathways. The Water Data Programme Team at ECan has been using this tool to maintain river network improvements, and as part of the transformation process between the core river network dataset and river allocation visualisation layer. Along with groundwater allocation zones, this river allocation output links to the Water Allocation Calculator, which provides plan allocation limits, consented allocation, and allocation status in one location.

The tool demonstrates how geospatial technology is an integral part of effective freshwater management.

Micro purge techniques for Groundwater sampling. A study of techniques, suitability, and standards in New Zealand.

Dirk van Walt – Van Walt

Recently micro purge methodology has been acknowledged in NEMS standards and many councils are already onboard with this practice. Meanwhile in the world of the environmental consultant this practice has been the bench mark for some time. So why the move? The following presentation covers the advantages and disadvantages of micro purge techniques and why this method has gained considerable respect in recent years.

Evolution of Gas Bubbler & Dry Transducer Sensors for Accurate Water-Level Measurement

Anastasia Ponomareva – Scott Technical Instruments

Aims

Bubblers are a non-submersible type of sensor for water-level measurements. They are widely used due to several advantages over other measurement methods. All bubble sensors *accurately* measure the pressure it takes to create a continuous airflow in an airline submerged in water but use different operating principles. New LevelVUEB10 bubbler with display from Campbell Scientific Inc., USA, was designed to meet the requirements of United States Geological Service (USGS); and it reduces the need of regular field maintenance.
Scott Technical Instruments assessed bubblers that use three different operating principles to determine their capabilities to meet *challenges* when deployed in field situations. We compared the *traditional gas bottle system* and commonly used *OTT CBS bubbler* with newest *CSI LevelVUEB10* method.

Methods

We investigated different bubbler devices of different ages which represent the "*evolution*" of the technology of dry bubble unit. Conventional is *gas bottle system* with Nitrogen bottle; HS23 gas bubble system; and WL2000 pressure sensor. Commonly used (10 years old) is the *OTT CBS bubbler* which utilises an "on demand" low volume compressor (the pump run continuously during measurements), with an internal pressure sensor and regulator within a compact self-contained enclosure. The newest technology is *Campbell Sci. LevelVUEB10* bubbler system which features heavy duty compressor with internal pressure vessel, pressure sensor, regulator; and automatic purge system. The pump only runs when the pressure vessel needs topping up. All devices output SDI-12 format data. The parameters that are important to remote operations were investigated, including the following: accuracy; temperature dependence; power consumption; site maintenance requirements; and durability. The testing was performed in Scottech's electronic workshop in Hamilton. The reference equipment used for testing included Campbell Sci. CR1000X data acquisition system; Campbell Sci. CH400 smart charging regulator; Paroscientific Model 1000-15D 15psi differential pressure transmitter; Paroscientific Model 6000-16B broadband barometer. Scott Technical experience of forty years with the use of bubbler systems in the field has contributed considerably to this investigation.

Results

The information obtained in the laboratory setup has expanded our knowledge about three methods beyond the specifications outlined in their operational Manuals. The bubbler dry pressure transducer method is time proven; and accuracy has been relatively good for all tested units. However, each of these types of bubblers have their strengths and weaknesses which will be presented during presentation and will be supported by numerical data. With improvements in technology featured by newest operating principles, additional functionality such as automated purging, and lower power consumption enable *longer durations between site visits*. Solar power supplies and the removal of the requirement to transport gas bottles are now normal practice. Combined with the convenience of a local display, automated purging, and crest stage measurements, all reduce the challenges of maintaining high accuracy, physically resilient reference sites even in the most remote and inaccessible locations.