FLOW

manatiaki kōawa
rivers
GROUP
A joint technical interest group of
Engineering New Zealand & Water NZ

INSIDE THIS ISSUE

NEWSLETTER

Issue 37 | September 2022

MESSAGE FROM THE CHAIR

Selene Conn

Kia ora koutou

It has taken me a long time to write this quarters Chair update. I started writing about the recent event in Nelson/Tasman, but realised I was starting to sound like a broken record. The last two chair updates both covered 'extreme' or 'unprecedented' events that caused widespread damage, and stress for our communities and those of our members in the flood management space.

As always, our hearts go out to those who have been affected by recent flooding. And I am once again overwhelmed by the resilience of our communities and the amazing support offered to those affected by some of our Rivers Group members.

While devastating to the Nelson/Tasman community, the recent event has reignited the national discussion about living near rivers, and how we can do this moving forward.

A recent article on CNN introduced the concept of the 'megaflood' driven by atmospheric rivers. The authors state that this type of 'megaflood' has the potential to turn parts of California into an inland sea. Researchers have known about the phenomenon for a while now but believe that climate change is increasing the likelihood of these events, and the frequency in which they will occur. The prediction is that a flood like this would result in $1 trillion (yes...trillion) in losses and damage.

We have seen the devastating effects of atmospheric rivers in New Zealand recently. We have seen that our efforts to 'manage' flooding in our highly dynamic rivers has often fallen short with the volume and intensity of rainfall these atmospheric rivers bring. It raises the question, can we manage our way out of flood risk in all situations? And have we been too myopic in how we look at fluvial flood risk, without considering the impacts and effects of sediment?

RNZ's Checkpoint released an article recently regarding the option of moving our communities away from flood prone areas. The National Adaptation Plan defined 'managed retreat' as the "process of abandoning places where the risk from hazards like flooding or erosion make it no longer viable to live". The article highlights the proposed cost-sharing of managed retreat, as well as the requirement for new legislation to support managed retreat processes. Checkpoint cite the RMA reform as the vehicle to do this. And as we saw playing out in Buller District last year, such legislative changes will be needed to drive meaningful change, but they will need to be collaborative, well thought out, and robust to ensure they are accepted by everyone. However, the successful move of Grantham (in Australia) has shown us that managed retreat "has to be grassroots community driven, and the community have to own it". Policy makers, please take note.

Managed retreat is a hard subject to talk about, and it's an even harder process to work through with our communities who are at risk. The managed retreat process in Matatā was possibly one of the first. Napier City Council, Hastings District Council, Hawke's Bay Regional Council and local iwi groups are currently looking at this option for a coastal community. Both processes have been hard on councils and communities alike.

MESSAGE FROM THE CHAIR

Selene Conn

We are yet to see how managed retreat will work for those communities living beside our rivers. But it is a conversation that can no longer put off. I invite policy makers and planners to come along to this year's Rivers Group conference 'Making room for Rivers' being held in Lower Hutt. I also encourage all our members involved in flood or river management to attend. We are looking forward to discussing the challenges of 'how do we implement room for the river' with you all. Now is the time to come together as a 'Rivers Group', and help our communities, and our country, find ways to live with our dynamic rivers in a future where 'atmospheric rivers' may become the norm.

Nga mihi nui

Selene Conn
Chair

ARTICLE:
NIWA RESEARCH UPDATE: BRAIDED RIVER MORPHODYNAMICS

This article is a brief summary of recent braided river morphodynamics research conducted by the NIWA sediment processes team in Christchurch.

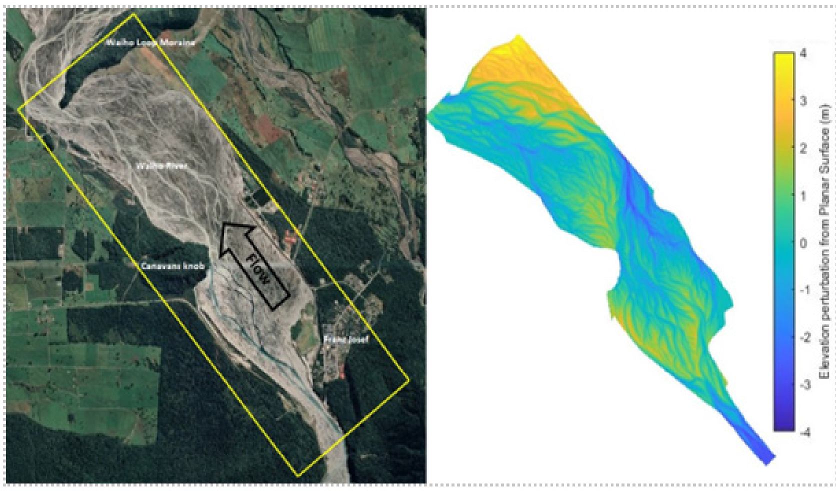
Modelling the effect of river confinement in aggrading rivers

The Waiho River (West Coast) has become increasingly flood-prone in recent years due to rising bed levels. A few notable flood events have threatened Franz Josef and washed out the SH6 bridge.

As part of a MBIE funded 'smart ideas' research project John Montgomery and Gu Stecca have been testing physics-based numerical modelling as a tool to inform decision making in aggrading rivers such as the Waiho. Most existing 2D braided river modelling has focused on rivers in morphodynamic equilibrium in which flood events alter channel configuration but result in minimal net vertical change to bed levels. Modelling a depositional braided river presents additional complexity compared to modelling rivers in equilibrium, but also presents additional degrees of freedom that can be exploited for model calibration increasing confidence in model performance.

John and Gu have developed an iterative process to model a depositional reach. The modelling process involves starting from a smoothly sloping domain and simulating an extended period of morphodynamic evolution to generate a braided planform topography. Due to the inherent challenges associated with collecting data during high flow morphologically significant events, observational information for model calibration is limited to low flow Digital Elevation Models (DEMs) collected via LiDAR surveys. Morphological model calibration is reliant on comparison of model outputs to observed sedimentation rates and patterns, and comparisons of summary metrics describing the low-flow hydrodynamics and topography of the surveyed and model-generated rivers.

We have created a model that faithfully recreates observed morphological change in the Waiho, beginning from a planar surface, and accurately describes aggradation observed in the Waiho between temporally spaced LiDAR surveys. The model is suitable for investigating river management strategies (primarily the influence of river confinement with stop banks) or the effect of environmental changes on aggradation and flood risk. The model development/calibration process has highlighted the importance of bank erosion, sediment transport, and variable flow to braided river morphology and has improved the capability to model braided rivers in general.

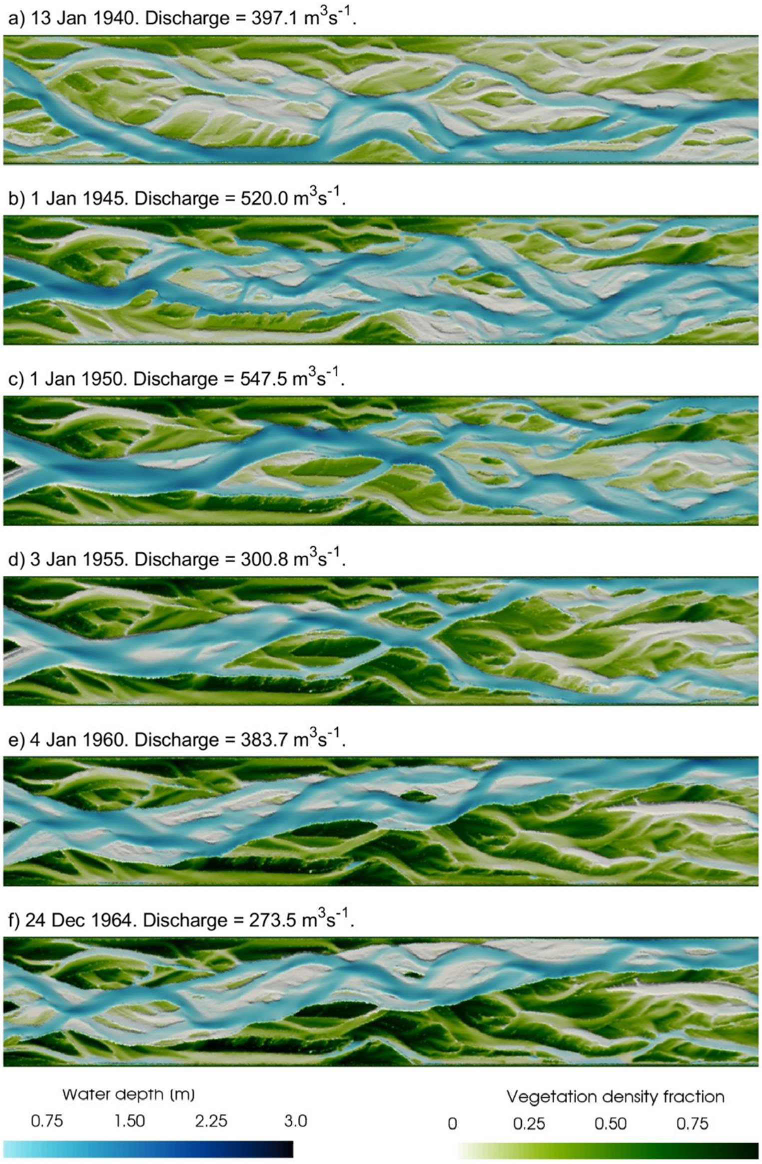


Aerial photo of Waiho River showing model domain (left) vs model generated braided planform (right).

Modelling the interaction of exotic vegetation and floods in braided rivers

Willows are a useful tool for managing bank erosion but the uncontrolled spread of willows and other quick growing exotic vegetation such as gorse, broom, wattle, tree-lupin and other woody species can choke riverbeds. As part of previous research Gu Stecca developed and applied modelling approaches to simulate the interaction of vegetation and river morphodynamics in the Waitaki and Waimakariri Rivers (this modelling was originally funded by a grant from the European Union and has subsequently been supported by Meridian Energy Ltd and the NIWA Environmental Flows Research Program).

Over the last year efforts have focussed on publishing this work in scientific papers, and on generalising the outcomes of the modelling for other vegetated braided rivers in New Zealand. One paper, recently accepted for publication, describes the model and demonstrates its capabilities by simulating vegetation encroachment on the Waitaki River between 1936 and 1974. Another paper, currently being drafted, highlights the different response of the Waitaki and Waimakariri Rivers to vegetation due to their different hydrological character. This research was also presented in a Rivers Group webinar in April 2021.



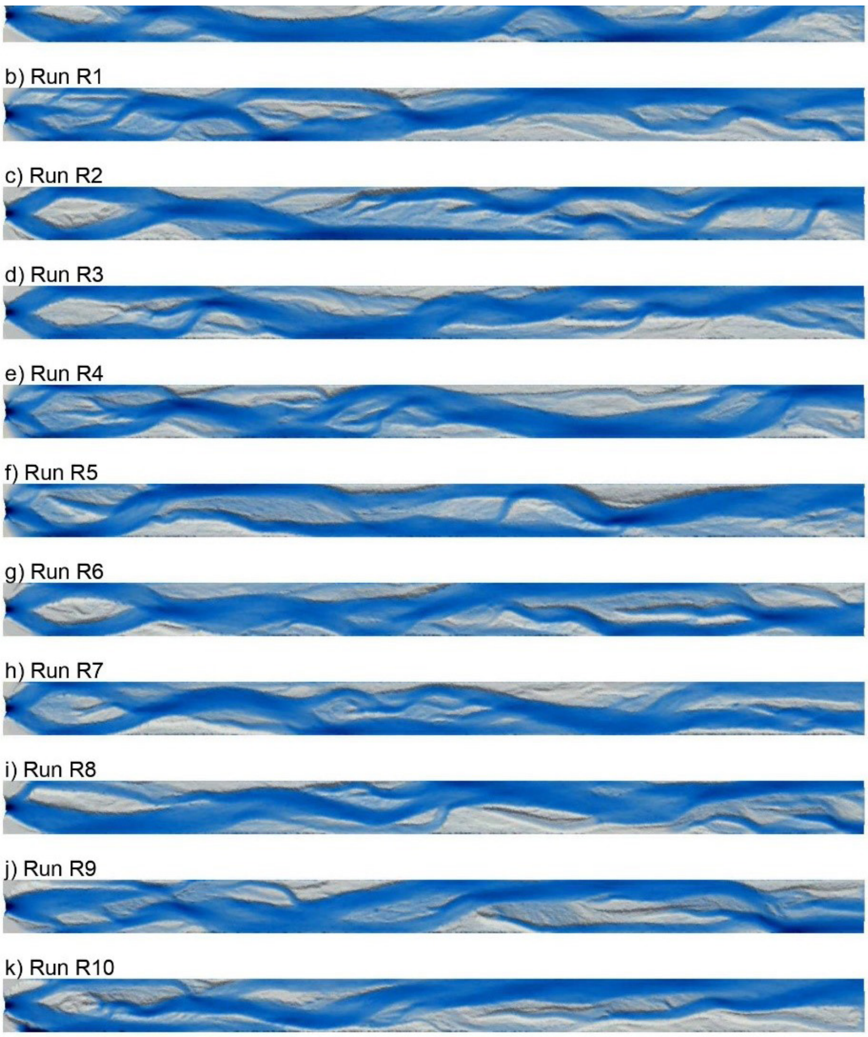
Modelled evolution of the Waitaki River planform 1940-1964.
Shaded-relief bed topography with overlain inundation and vegetation density.

Guglielmo Stecca, Davide Fedrizzi, Richard Measures, D. Murray Hicks, Jo Hoyle, Guido Zolezzi (2022) Development of a numerical model for braided river morphology and vegetation evolution with application to the Lower Waitaki River (Aotaroa-New Zealand), Advances in Water Resources, 166,104236. https://doi.org/10.1016/j.advwatres.2022.104236.

Understanding the chaotic nature of braided river evolution

Predicting future changes in braided rivers, either through traditional empirical approaches or using numerical models, has long been hampered by their inherent unpredictability. For example, models of single thread rivers can accurately replicate multi-decadal river morphodynamics, but models of braided rivers struggle to replicate their planform morphological change over any longer than a single flood event.

Last February, Gu Stecca and Murray Hicks published a scientific paper, where for the first time the chaotic nature of braided river morphological evolution has been demonstrated. They demonstrate that deterministic models of braided river morphodynamics suffer from extreme dependence on the initial conditions, i.e. that infinitesimally small perturbations of river bed elevation result in completely different river planforms. This means it is impossible to deliver exact predictions of morphological pattern change – in a similar way as weather forecast models cannot be trusted to deliver an accurate prediction at a time distance of more than a few days. However the research also highlights that models provide consistent predictions if the results are time-averaged (over long time periods) or ensemble-averaged (across multiple simulations with perturbed initial conditions). This demonstrates that predictive modelling can be useful provided the results are interpreted correctly.



Variability in braiding pattern at the end of identical model simulations initialised with tiny perturbations in bed elevation. Bed topography shown in grey and water depth in blue.

Stecca G., Hicks D.M. (2022) Numerical simulations of confined braided river morphodynamics: display of deterministic chaos and characterization through turbulence theory. Journal of Geophysical Research: Earth Surface, 127(3). https://doi.org/10.1029/2021JF006409

Investigating the effects of flood harvesting on river morphology and fine sediment deposition

With river baseflow and groundwater resources fully allocated (and controlled by minimum flow rules) in most catchments, there is increasing demand for extraction into large off-river storage ponds. This extraction is often seen as having lower environmental impacts as it occurs during higher flow periods, so does not impact minimum flows. However, floods and freshes serve the very useful function of transporting the braided rivers' gravelly bedload to the coast. Even a proportionally small take of flood water can alter the balance between bedload supply and transport capacity, which, over time, can induce a long-term change in braided river bed morphology – the expectations are a fining of the riverbed surface material, reduction in channel relief, and ultimately – if the take is large - riverbed aggradation. Floods also naturally help control riverbed woody vegetation, which, if left unchecked, can begin to take control of the river morphology. Such geomorphic responses can change the physical habitat template (velocity, depth, substrate) with consequent effects on braided river biota.

The NIWA team have been investigating these impacts in the Rangitata River to try and develop approaches which can be used to quantify the impacts of existing or proposed water extraction during high-flows. These investigations have included:

- Monitoring the concentration and size distribution of suspended sediment load upstream of the main irrigation intakes.
- Developing a conceptual model for quantifying increased deposition of suspended sediment.
- Repeated surveys of surface sediment grain size in a range of riverine habitats and comparing this data against data collected in 2001 to investigate changes over various timeframes.
- Fixed-bed modelling of suspended sediment deposition under the influence of a range of water extraction regimes.
- Morphodynamic modelling of river morphology (bed-form and grain size distribution) under the influence of a range of water extraction regimes.

This research is ongoing. Results from the suspended sediment monitoring and conceptual model suggest the results of existing extraction on suspended load deposition are potentially significant. Analysis of the sediment survey data shows a reduction in the median surface grain size (excluding sand) and an increase in the proportion of the bed surface covered by sand. However the data also shows high year to year variability suggesting that these metrics are highly dependent on antecedent flow conditions. Initial results have been presented at the 2021 Hydrological Society conference and the Braid symposium.

Understanding how river management influences groundwater recharge

Braided Rivers contribute a major component of the groundwater in NZ's east coast plains. Despite their hydrological importance, little is known about how river-groundwater exchange processes actually occur and whether changes in surface morphology (such as bed level change or braidplain narrowing) might impact rates of hyporheic exchange or recharge to groundwater. The NIWA Sediment Processes group are part of a multidisciplinary research team, led by Lincoln Agritech and including a wide range of NZ and international expertise, working to fill this knowledge gap through a five-year MBIE-funded research programme.

This programme has three research aims:

(1) Developing conceptual understanding of the river saturated footprint, and characterising hyporheic exchange and river subsurface water storage dynamics. This conceptual understanding is being developed through detailed field investigations requiring a broad range of field methods.

(2) Simulating river subsurface dynamics and leakage to groundwater. This research aim builds on the conceptual understanding developed in research aim 1 and involves the development of coupled surface water – groundwater models.

(3) Understanding the implications of river management approaches. This research aim uses the models developed in research aim 2 and involves simulating a range of scenarios to quantify the impacts of bed level change (e.g., as may occur due to over extraction of gravel or large inputs of bed material from landslides) and braidplain narrowing (e.g., as may result from the development of flood defences or agricultural encroachment). This research aim also has an economic component, involving quantification of the market and non-market costs and benefits of alternative scenarios.

The research is focusing on three study rivers; the Selwyn/Waikirikiri (Canterbury), the Wairau (Marlborough) and the Ngaruroro (Hawkes Bay) but the aim is that the knowledge gained from the research will be able to be applied to other braided rivers to understand the influence of river management interventions on different aspects of the river water balance.

Wairau River study reach *– Photo credit: Hamish Sutton*

Mapping changes in braidplain margins

The NIWA sediment processes team are working with Environment Canterbury to delineate natural braidplain margins for all braided rivers in Canterbury. The motivation for this work is to understand what proportion of the natural braidplain is currently active braidplain, how this varies spatially both within and between different braided rivers, and how this has changed over time (for example as a result of agricultural encroachment, vegetation encroachment, stopbanking, or changes in flow regime or sediment supply). Understanding these changes in our braided rivers is important for understanding how aquatic and terrestrial biodiversity may have changed due changes in habitat assemblages, and where we should focus our efforts to restore this biodiversity.

This braidplain mapping builds on a methodology developed by Jo Hoyle and Jo Bind in 2017 which delineates the braidplain using two approaches. The first approach involves digitising a boundary around where we know the active channels of a river have been since European arrival, by delineating the 'active braidplain' (outside extent of bare gravel and water) on all available historical aerial photographs and maps. By overlaying all active braidplain extents, the total width of observed adjustment over time can be determined. This is referred to as the 'historical braidplain'. The second approach involves analysing a LiDAR-derived digital elevation model (DEM) and assessing the area that the river channels could adjust within, based on elevation and topography, by identifying existing river terraces which restrict river adjustment. We refer to this area as the 'contemporary braidplain'. The historical braidplain approach is more objective than the contemporary braidplain approach, as active riverbed can be identified on a map or photo at some point in the past. However, it's also more conservative. The LiDAR-based approach is more subjective but also more likely to capture the true extent of the natural braidplain under contemporary geomorphic controls (flow regime, sediment supply etc.). However, where LiDAR data are unavailable, we can only use the historical braidplain approach. Due to the advantages and disadvantages of these two approaches, we aim to use a combination of these approaches where possible.

Braidplain delineation for a reach of the Waimakariri River. *Top image shows the 1899 map and bottom shows the 2019 aerial with historical braidplain in red.*

For further information about any of the above research please contact: Jo Hoyle or Richard Measures.

ARTICLE:
FISH PASSAGE ASSESSMENT TOOL

The National Policy Statement for Freshwater Management (NPS-FM) requires regional councils to identify all existing structures that may be barriers to fish passage in local waterways. The Fish Passage Assessment Tool (FPAT) is a user-friendly mobile reporting tool included in the NIWA Citizen Science app free to download in the Apple & Google Play stores. The FPAT enables users to capture and meet the information requirements of the National Policy Statement for Freshwater Management (NPS-FM) and the National Environmental Standards for Freshwater (NES-F). The FPAT can be used to gather all the information required on existing structures (NPS-FM) and an easy and consistent way to monitor (and maintain) new structures (NES-F). The FPAT data, which is held in a national database that can be viewed and downloaded via desktop, contributes to an improved understanding of fish passage at a local, catchment, regional and national scale. The FPAT also helps to ensure that fish passage data is collected in a consistent way. FPAT records can be viewed on the NIWA website.

Learn more about the fish passage freshwater implementation guidance.

EVENTS:

Connecting with the future generation of river scientists

By Jacqui McCord

How we interact with and manage our rivers in Aotearoa New Zealand has been changing, and recent flooding events have highlighted the legacy issues from past river management attempts. For those working in the river space, they have never been busier, but it also comes at a time where many river courses in our universities are being removed. The Rivers Group committee has recognised this as an issue going forward and are looking at ways that they can showcase how rewarding, exciting and dynamic a career in the rivers space can be and inspire the next generation.

To kick off our Out-Reach initiative, Selene Conn gave a presentation at the University of Auckland about what it's like to work with rivers in Aotearoa New Zealand, from her days as a student to senior fluvial geomorphologist at Tonkin+Taylor. The talk was transmitted via zoom to other institutions around the country where students gathered to watch the presentation. A recording of the presentation is available in the members section of the Rivers Group website.

A graduate of the University of Auckland, Selene completed a double major in ecology and geography, and began her career working on stream ecological restorations projects at a time when fluvial geomorphology did not have strong presence in river management in New Zealand. Wanting to extend her fluvial geomorphology skills further, Selene moved to Australia for five years where she undertook assessments and compliance monitoring of large scale waterway diversions, and geomorphic assessments to support large scale urban development and industry. Selene returned to New Zealand in 2016 where she eventually took up a position at Tonkin + Taylor as an ecologist, with the goal on integrating fluvial geomorphology into river restoration projects over a five-year period. However, it only took six months, for this goal to be achieved and a geomorphic assessment is now a standard part of river restoration projects for Tonkin+Taylor. Selene believed that the industry was at a turning point, where people working with rivers were realising that what was missing from the equation was an understanding of how rivers behave through time. Selene believes that people typically see erosion and sediment as 'bad', but these processes are actually fundamental to river health, and it's only when we tinker with the system and it gets out of whack (or we build too close to our dynamic rivers), that they become a problem.

Selene highlighted how fluvial geomorphology integrates with other disciplines and while you can't do everything, having knowledge in other areas, such as ecology, GIS, geology and hydrology can be useful. 'Geomorphologist' is not a description you'll readily see in job advertisements, so incorporating other skills that tie into geomorphology can be useful when considering future positions. At a consultancy, the type and scale of projects vary, and each will have its own unique set of challenges. While technical skills are important, other useful skills include oral and written communication, project management and teamwork.

The Rivers Group look forward to interacting with university students at future events and continuing to encourage students into pursuing careers in the river space. We also have scholarships and awards to assist students with their studies. We encourage any student who would like to learn more about careers working with rivers to get in contact with us. If there are any members who would like to be involved with future Out-Reach events, please get in touch with the committee.

River Managers Professional Development Programme

The Regional Sector River Managers Professional Development Programme was launched on 16 August. This is the first such specialist upskilling programme developed to meet the needs of regional sector council staff and others working with them in river management to provide flood protection resilience for our communities.

The aim is to provide people coming into and as well as those already within this sector career development pathways, as well as helping to attract and retain quality people, with succession opportunities as team leaders, management and in senior leadership roles. This will ensure a strong sector that delivers for our communities as well as an enjoyable and rewarding sector to work in.

The development opportunities offered are the culmination of input from within the sector over the last two years. The first tranche is particularly aimed at entrants to the sector including graduates and experienced staff joining from other sectors. The success of this programme relies on making the most of participation.

The Regional Sector River Managers have partnered to develop and deliver this programme with the Rivers Group and Engineering New Zealand and Water New Zealand.

A first opportunity for those keen to participate is the Cultural and Environmental Values Webinar Series. For those unable to watch a particular webinar live (it is recommended to watch this live) there will be a recording available for those who have signed up.

View and register for the upcoming sessions below.

Cultural and Environmental Values Webinar Series

Te Tiriti o Waitangi (the Treaty of Waitangi): meanings, principles, and importance for contemporary river management in Aotearoa New Zealand

7 September, 11.00am (1 hr)

VIEW RECORDING.

The NPS-FM and Te Mana o te Wai (Te Ao Māori & River Ecosystem Management)

13 September, 11.00am (1 hr)

VIEW RECORDING.

Navigating towards Te mana o te Wai

21 September, 11.00am (1 hr)

REGISTER NOW.

Cultural and Environmental Values Series | Mana Whenua Statements (cultural impact assessment)

29 September, 11.00am (1 hr)

REGISTER NOW.

Further online training courses will be announced in due time.

GENERAL INFORMATION

Call for contributions

For our newsletter FLOW we are always looking for articles from our membership. Please consider submitting an article, case study, update or notice for the next issue of FLOW.

The upcoming submission deadlines for 2022 are as follows:

Issue	#	Deadline for contributions
December 2022 issue	#38	Monday, 14 November 2022

Please format your contribution as follows:

- Length of around 500 – 1,500 words, preferably in Microsoft Word format (Articles should include: title, name of the author(s), affiliation(s), and section headings; illustrations and/or tables are strongly encouraged)
- If possible, attach images in jpg (file size 300KB-1MB) and at high-resolution separately
- Provide credits and captions for your images

If you have articles which are longer, please email us and we will work out a way forward together with you.

Please email rivers.group@engineeringnz.org to submit your FLOW contributions or any news you want to share. We look forward to receiving your contribution.

Rivers Group Manatiaki Kōawa Mission Statement

The New Zealand Rivers Group Manatiaki Kōawa was formed in 2009 to provide a forum for 'Working together to promote good river management'. It is a place for people with an interest in rivers, flood risk management and the operational and environmental issues of catchments and river systems to come together.

We currently have over 300 members, and promote a multi-disciplinary approach to river management, reflecting cultural and societal diversity in an integrated and holistic manner. Our membership reflects this, with our members coming from a wide range of river management, science and engineering, and planning backgrounds - working as consultants, or in local, regional and central government, research institutes and universities.

New members can sign up here.

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