manatiaki kōawa
rivers
GROUP

A joint technical interest group of IPENZ & Water NZ

INSIDE THIS ISSUE

NEWSLETTER

Issue 27 | October 2019

FROM THE CHAIR

Heide Friedrich

With our annual conference rcem2019.co.nz around the corner, I'd like to use the opportunity to highlight our keynote speakers that join us in Auckland. We have Murray Hicks and Catherine Knight representing the local scene. Murray will share with us latest knowledge on morphodynamic challenges for braided rivers, whilst Catherine will guide us through how the perceptions of rivers in Aotearoa have evolved over the last two centuries. We are pleased to have been able to attract Laura Moore, Doug Jerolmack and Dan Parsons from the US and UK respectively, to share with us insights on the global challenges in riverine and estuarine systems, as well as landscape couplings and natural-human dynamics in those systems.

A big thank you to our main conference sponsors: NIWA, TUFLOW, Water New Zealand and Nortek. We have exhibitions by envco, Scottech, TUFLOW and Aerialsmiths, so come and check their products out during the conference days. It is the generous assistance of these organisations and the relentless effort by the local organising committee that enables us to bring international conferences of this calibre to New Zealand. We are looking forward for you to join us in Auckland during 18-21 November, with still some spots left in our pre-conference workshops.

During the conference, we also will hold our Annual General Meeting. At our AGM we will elect the 2020 management committee, and nomination forms are distributed to all members. We welcome new committee members who can help running local events. We have a good supporting structure working with other groups when running events, yet need you to help make more events happen. You would have seen our call for nominations for the annual Arch Campbell Award. The call is closed now, and we will announce this year's awardee at the conference in November. The Arch Campbell Award is our group's premier award for contributions made by members in the fields related to our rivers. It is a celebration of technical expertise and dedication to our rivers.

We discussed the Government's discussion document on Essential Freshwater: Action for Healthy Waterways in our committee meetings. As a group we feel we are not in a position this time around to prepare our own submission, yet many of our members as well as Water New Zealand and Engineering New Zealand are engaged in that space and have reviewed and provided input into this large suite of proposals, expected to affect substantially how we manage our rivers and waterways in future.

Please remember to check out our facebook facebook.com/EngNZRiversGroup and twitter twitter.com/RiversGroupNZ channels. We believe it is important to share with you interesting articles and updates when it comes to the management of river systems not only in New Zealand, but around the world, helping you to have easy access to topical information. Similarly, if you have interesting projects to share with us, please also send us articles for our newsletter rivers.group@engineeringnz.org.

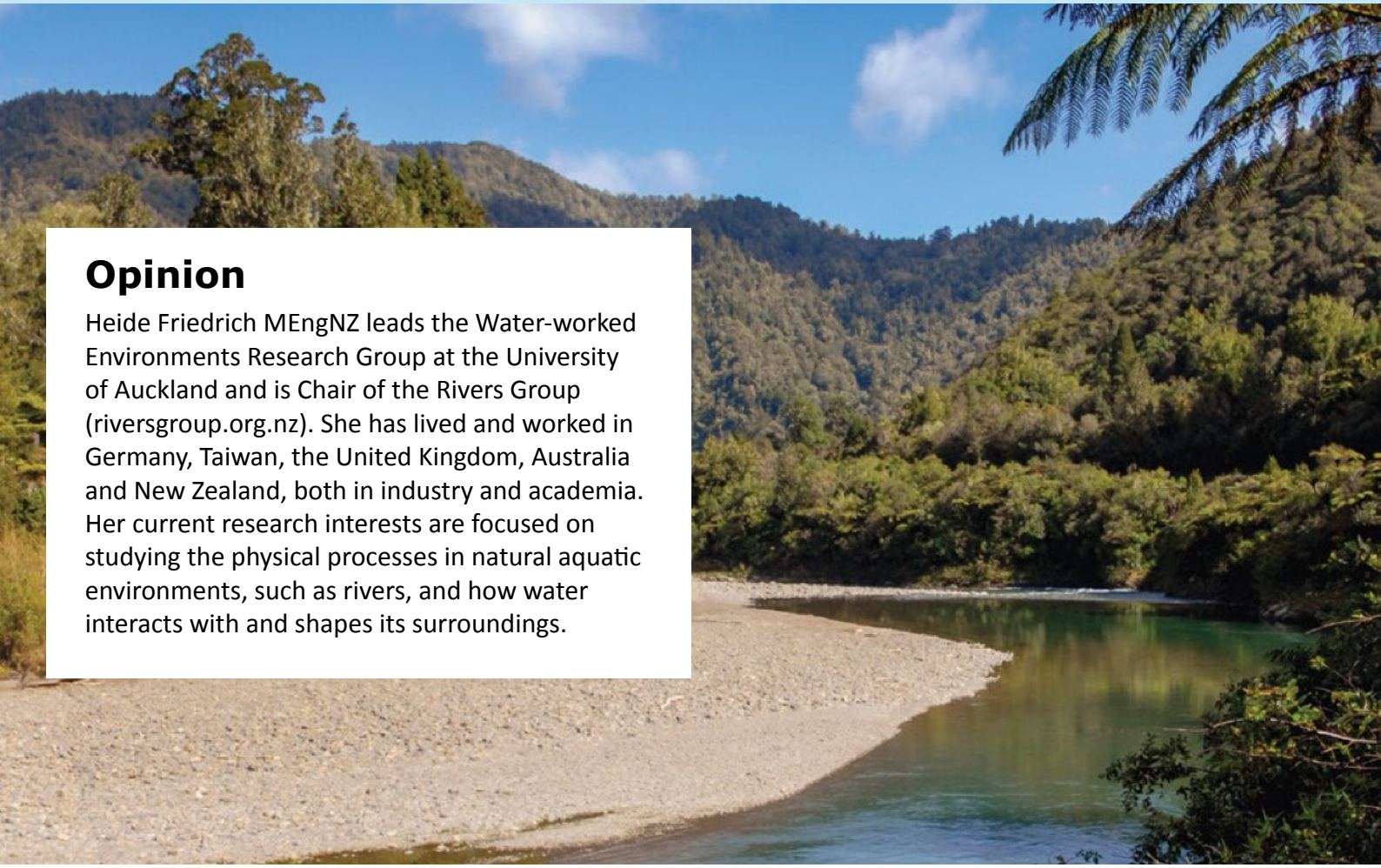
I hope to see you all in Auckland in November.

Heide Friedrich
Chair

NEW PATHWAY FOR RIVERS

Heide Friedrich MEngNZ

Article 1



Opinion

Heide Friedrich MEngNZ leads the Water-worked Environments Research Group at the University of Auckland and is Chair of the Rivers Group (riversgroup.org.nz). She has lived and worked in Germany, Taiwan, the United Kingdom, Australia and New Zealand, both in industry and academia. Her current research interests are focused on studying the physical processes in natural aquatic environments, such as rivers, and how water interacts with and shapes its surroundings.

There's a return to more holistic approaches to river engineering and management as people from a range of disciplines work together to achieve better river flow and improved flood prevention.

Earlier this year, the Environment Aotearoa 2019 report highlighted nine issues that need tackling. The Ministry for the Environment and Stats NZ report states the way we live and how we make a living are having a serious impact on our environment. When it comes to rivers, our waterways are not only polluted in farming areas, but also in urban areas. It's becoming increasingly common that changes to water flow, partly caused by the presence and operation of hydraulic structures, are affecting our freshwater ecosystems and connectivity.

Worldwide, there is a trend to go back to holistic approaches to river engineering and management. As engineers we are traditionally reductionists: we reduce systems to identify what is force, and what is action and reaction. Legally, a river is defined as the bed, the banks and margins, and the water. In current discussions we often come back to the question: how much space does the river require? This means taking into account not only the riverbed and the water, but also the banks and margins.

NEW PATHWAY FOR RIVERS

Heide Friedrich MEngNZ

Article 1

Communities have an inherent faith in the engineering works and systems that have been constructed to protect them. We're becoming increasingly aware of, and understand, complexities associated with flooding, and in turn feel more powerless each time it affects communities. As river engineers and managers, do we need to more proactively communicate to our communities how the river will behave and respond, and explain clearly the residual risk, which is always there? This also leads us towards current discussions on the need for licensing of professional practising for river design.

In Aotearoa we do not have to look far for examples of holistic river management. It's part of the traditional Māori world view to see rivers as sentient beings, illustrated by the Māori saying "Rivers are the veins of Papatūānuku, Earth Mother, and the water in them is her lifeblood". There are increasing pressures on riverine environments, not only when it comes to freshwater quality, but also regarding the space provided for river networks. In addition to protecting our freshwater quality, we have to understand and manage the space needed for healthy river systems.

In 2009, the Rivers Group Manatiaki Kōawa was formed to provide a forum for those involved with, and with an interest in, rivers, flood risk management and the operational and environmental issues of catchments and river systems. A joint technical group of Engineering New Zealand and Water New Zealand, the group also incorporates a wide range of related fields and professionals, promoting a multi-disciplinary, culturally sensitive approach to river management in an integrated and holistic manner. Instead of controlling the river with traditional engineering approaches, the Rivers Group Manatiaki Kōawa provides a platform for people working with rivers to jointly explore new, interdisciplinary pathways that aim to inform river management practices that encourage dynamic river systems. We need to give room to the river, a concept that passed legislation in The Netherlands, aiming to give unpopulated space to the river to spread out as needed, and thus reduce the effect of flooding on society and infrastructure.

We're excited to bring the River, Coastal and Estuarine Morphodynamics Symposium to Auckland in November, with the theme: Ka mua, ka muri: Looking back, moving forward. Delegates' backgrounds include engineering, physical geography, mathematics, biology and social sciences, connected by a strong interest in the

latest understanding, technologies and applications of environmental morphodynamics monitoring. This aligns well with the Rivers Group's objective to facilitate cross-disciplinary interaction between individuals, communities and professionals involved in catchment management, flood risk management and river management throughout New Zealand and to promote best practice, leadership and the sharing of technical knowledge.

This article was first published in Engineering New Zealand's EG magazine, Issue 8/2019.

RIVER MANAGEMENT FOR FLOOD PROTECTION IN NZ

Article 2

A task force from Regional Councils Rivers managers Group is preparing a proposal to put to Central Government for a better way of funding river management for flood protection across New Zealand including the possibility of a co-investment strategy with central government.

The article below is an overview of the investment in current flood protection programmes in NZ along with a summary of the findings of the task force so far including the associated issues around adaptation needed for climate change impacts.

For the coming climate change challenges, New Zealand needs to move more to investing in providing enhanced flood protection to prevent and mitigate flood damage, rather than increasingly relying on expensive disaster management after flood hit.

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1. Protection from floods is essential to New Zealand's resilience

Flooding is New Zealand's most common natural hazard.

Floods happen frequently

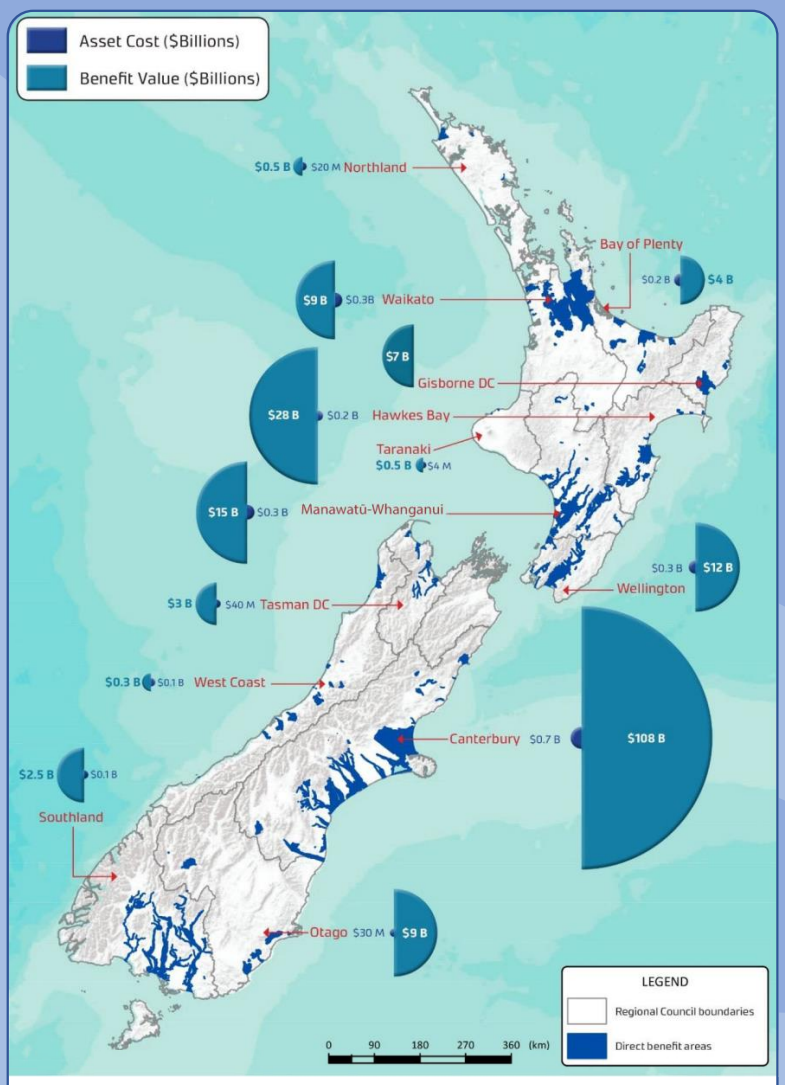
There have been over 1,000 serious floods in New Zealand in the last 100 years. On average, despite 364 river management and flood protection schemes, major damage-causing and loss-incurring floods occur once every 8 months.

Schemes protect people and property

Most flood hazards are avoided because of existing regional authority river management and flood protection schemes. Current structures have been generally well-maintained and effectively function as originally designed.

RIVER MANAGEMENT FOR FLOOD PROTECTION IN NZ

Article 2



Area and net current value of schemes. Tonkin & Taylor, 2018

The value of our current schemes is the protection that they provide to:

100 New Zealand towns and cities

1.5m ha highly productive land

5% of New Zealand's land area

The net present benefit for New Zealanders from the protection provided by the schemes is **$11b per annum** (current asset value $2.3b).

RIVER MANAGEMENT FOR FLOOD PROTECTION IN NZ

Article 2

2. Who currently pays

Regional authorities currently spend $200m each year on scheme operational and capital improvements. This is funded from regional rates and by directly affected private property owners. This is required to:

- Sustain the schemes at their 'design' level of functionality.
- Protect State Highways, the rail network, communication and electricity networks, hospitals, education facilities, conservation land and the efficient functioning of communities and the economy.

Local contribution $200m

Crown contribution $0

3. Responding to contemporary challenges

Flood risks and protection scheme requirements are increasing:

- Climate change is causing higher flood levels and more frequent floods.
- More communities and expanded assets, with much more value than when the schemes were constructed, are now at risk from floods.
- These people and assets require higher levels of protection than in the past.
- Schemes must also now achieve integrated land uses, enhanced ecological and water quality outcomes and meet contemporary iwi and wider community aspirations.

To meet these compounding challenges:

- Major changes are needed to improve the performance of flood schemes, including planting more trees and applying a whole-of-catchment approach.
- These scheme upgrades need to be implemented in a timely way in collaboration with communities and as a key part of a comprehensive suite of measures to improve resilience.
- A major step-up in investment is needed with effective partnerships to achieve results.
- Needs to be funded by co-investment that more fairly recognise national, regional and local public and private interests.

The need is for river management and flood protection schemes to be re-purposed and upgraded to meet contemporary challenges, including adaption to better cope with climate change-induced flood events. The schemes must also satisfy a wider spectrum of community, environmental, cultural and economic objectives than in the past.

RIVER MANAGEMENT FOR FLOOD PROTECTION IN NZ

Article 2

4. National interest in co-investing

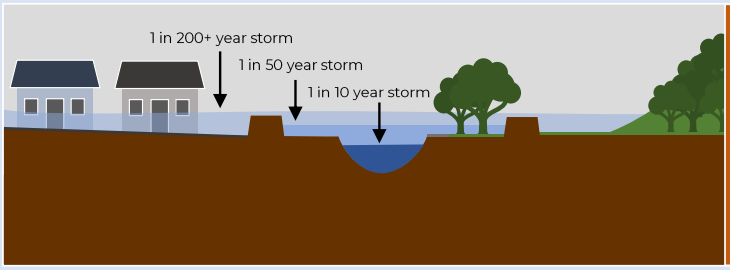
- ✓ Fiscally responsible and fair.
- ✓ Reflects Treasury's new performance measurement and Living Standards Frameworks.
- ✓ Is supportive of wellbeing and social inclusion and reflects equity / ability to pay considerations.
- ✓ Is supportive of job creation and lifting the productive potential of the regions.
- ✓ Contributes to the security of access routes (rail and road) for commerce.
- ✓ Directly protects Crown assets.
- ✓ Contributes to investment 'opportunity costs.'
- ✓ Works against the risk of escalating insurance premiums or the risk of insurance companies refusing to provide insurance cover in flood risk areas.
- ✓ Contributes to the environmental and water quality expectations of our communities and iwi partners.
- ✓ Provides for resilience and adaptation against the effects of climate change-induced 'above-design' storm events.
- ✓ Above all else, provides resilience and increased levels of safety to existing and future individuals and communities.

RIVER MANAGEMENT FOR FLOOD PROTECTION IN NZ

Article 2

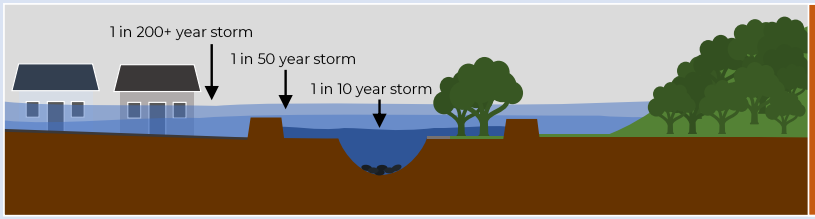
5. Solution

5a) Scheme design at inception



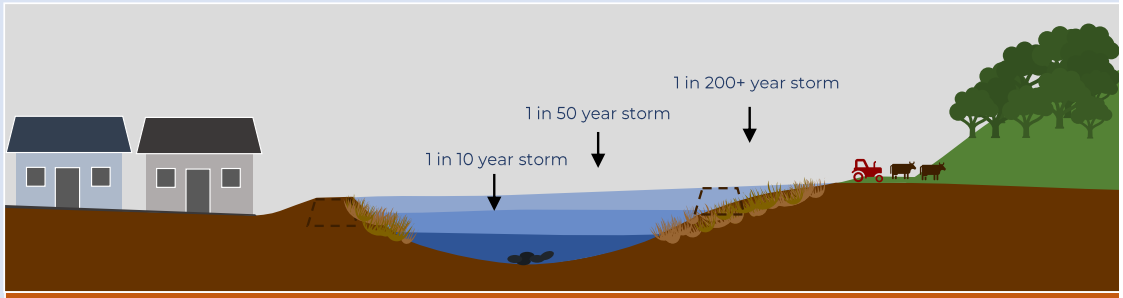
- Schemes were fit-for-purpose when constructed up to half a century ago
- These schemes are now inadequate because of the higher value of the production land and the expanded urban development now located behind protection structures.

5b) Today's climate change-induced flooding effects



Flood risks have compounded since design because of riverbed aggradation; increased soil erosion; more frequent high-intensity storms.

5c) Future scheme design and integrated catchment management



- Ecological planting and fish passes
- Resilient infrastructure
- Room for the river to move when in flood
- More sustainable land uses

A whole of catchment approach is recommended.

A business as usual approach will not cut the mustard.

Land use change / community withdrawal may be possible and appropriate at some locations.

Preferred: a comprehensive, whole-of-catchment approach, together with river management and flood protection infrastructure.

TREADING WATER

Contrafed Publishing

Article 3

Regional councils, property owners and insurers remain stuck over how best to document and respond to data on high-risk flood areas. Patrick Walsh from Landcare discusses issues around gathering and sharing comparable flood risk data.

When it comes to flood management there are no easy answers, says Patrick Walsh, senior economist and capability leader at Landcare.

The authority and responsibility to manage flood risk is currently delegated to regional councils. However, they are not obliged to publish flood risk data for property owners, or insurers.

Currently, some, but not all, regional councils provide data online detailing flood plains or other hazards, he says and citing Auckland as one of the better councils for sharing such data.

Yet, even when councils release flood data online, there is a high degree of variation in how they report this information.

“If you go to Auckland’s website and see a flood hazard layer, it might be a one-in-500-year flood risk layer. In other places, there could be a one-in-100-year risk of flood layer. So, it’s hard to compare across regional councils.”

Patrick spoke at the Urban Futures New Zealand Conference in Auckland earlier this year, where he presented a snapshot of his work to date in a paper titled, Deep South Challenge: Flood management in rural areas - the location and effectiveness of flood schemes.

He says he hopes to release the full paper around October this year.

Full and consistent data will be helpful for environmental Crown Research Institutes in and regional councils compare policies on flood mitigation.

Importantly, it will also help to make informed decisions about flood risks to a property that improves upon relying on LIM reports for evaluating flood risk.

In the US, the Army Corps of Engineers releases nationwide flood plain data so anyone can clearly see if a property is at flood risk. This information dovetails with subsidised flood insurance programmes and means property owners on a flood plain pay a higher insurance premium.

“There is a general trend in New Zealand to be moving in that direction whereby you will be paying more for insurance in the future if you live in a flood plain,” notes Patrick.

Patrick says cost considerations discouraged, or even prevent, some regional authorities from collating and publishing flood risk data online.

Relevant data may need to be collated from a wide range of sources, from satellite imagery to oral histories of floods. This data then has to be mapped into searchable files that can be shared online.

And some regional councils are less well equipped than others to analyse whether a specific area may be a one-in-100 or a one-in-500-year flood risk or otherwise, he says.

“There are also potential legal reasons why they might not want to do that,” says Patrick.

“If someone moves into a house where the regional council has said there’s no flood risk and they are getting flooded every few years, the council could be liable.”

Many think the issue should be a central government responsibility, he says.

“The Ministry for the Environment has been saying they’re going to release more structured policy on this. And some regional councils are waiting for more working groups to get together to try to motivate this.

“That want to know what an agreed definition might be.

“So, there are potentially things in the works but nothing concrete so far.”

Meanwhile, our country remains out of step with insurance practices in many other parts of the world where people living in an area characterised by higher flood risk pay correspondingly more for their insurance.

“There is this equity concern,” he says between insurances for properties in hi and low risk areas. At one end of the scale hi-value costal properties that could be at risk are subsided by non-risk property owners. At the other end of the scale a large number of lower-income people live in our country’s less desirable, lowlying, damp, and flood-prone inland areas, who can least afford higher premiums.

“If we were to move to a new regime where people were paying for flood insurance there would have to be some sort of graduated way to accommodate that.”

Patrick says one of the main, but “very preliminary”, results of his paper is that in mesh blocks with flood schemes where a targeted rate is used to help finance flood infrastructure, Earthquake Commission (EQC) claims are tens of thousands of dollars below claims in other areas.

“The exact figure is still a little bit up in the air - we are working on our models - but we find a negative and significant effect of flood schemes on EQC claims.

“And since EQC claims are only a small proportion of total private insurance claims, we find these flood schemes do have a significant effect.”

Originally published by Contrafed Publishing in Water New Zealand and Local Government magazine.

RIVER POEM

River's Muscle – A beautiful poem from Nora Bateson's Book "Small Arcs of Larger Circles"

Article 4

River's Muscle

Rivers coursing over landscapes meet and fold their molecules in muscles of current,

Without yield, without stacking one sandbag against the surge.

I ask you to be strong, strong enough to release your hold against turbulence.

A forest of trees, each leaf a receptor for the caress of the wind, is wealthy in sensations.

I ask you to be rich, banking each whisper of affection against the poverty of numbness.

I am a pool of water, cupped in your palms, your reflection flickers on my surface, wobbly in the movement of light.

I ask you to have courage to see yourself there, transparent, clean, as I see you.

For one second, for a million years.

A city skyline of jagged grace is held against the same clouds the dinosaurs pondered,

I ask you to be loyal to your own transformations, while I shift and twist in mine.

River's Muscle
A beautiful poem from Nora Bateson's Book
"Small Arcs of Larger Circles"
Publisher: www.triarchypress.net/small-arcs

Contestable Funds Project Update

Waiapu River Water Resource Study

Water Extraction from the Waiapu River for the Establishment of a Native Nursery

Prepared for Hikurangi Enterprise Trust
June 2018
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Waiapu River Water Resource Study

1.1 Background

The research project is funded by IPENZ Rivers Groups Public Project grant, which is available to support public sector groups in works related to river management and restoration. The research grants are aimed at supporting projects that are focused on improving New Zealand's rivers, catchments and management of flood risks. This includes projects that seek to improve the management of rivers, improve public education and river management that furthers all New Zealanders knowledge of rivers, their values or processes. The IPENZ Rivers Group Project supports works related to flood risk, sedimentation and erosion, water quality and quantity, and enhancing ecosystem function. As a recipient of the grant Hikurangi Enterprises is interested in extraction of water from the Waiapu River for the purposes of establishing a 15 hectare native nursery.

The principle objective within this report is to assess the sustainable water extraction rates from the Waiapu River, which also maintain a healthy ecosystem function within the Waiapu River, while providing irrigation for the establishment and development of a native nursery. The project will investigate a few sites adjacent the river where ecosystem function will be most and least affected at different times of the year and also the factors influencing those differences. The report will also identify constraints on water extraction in relation to river sedimentation and high rates of suspended solids, which is recognised globally by Earth scientist and any other mitigating factors.

1.2 Purpose of the report

The Waiapu River is currently the subject of a number of significant regulatory, cultural, ecological, economic and scientific initiatives and investigations. It has one of the highest sedimentation loads in the world with extreme erosion features along much of it tributaries. The Waiapu River has the highest cultural significance for nga hapu o Ngati Porou, especially the hapu living adjacent the Waiapu River within the traditional boundaries of Ngati Uepohatu and Ruawaipu.

Hapu members and landowners in the Waiapu catchment area have been progressing plans to replant highly eroding land with support from the Gisborne District Council and central government. To enable the development and growth of enough 'locally sourced' plants, it is proposed that a fifteen acre nursery will be built and developed.

The nursery will need a consistent water supply and ground water sourced from bores is unlikely to provide sufficient volumes for the nursery during summer months and at times of drought. An investigation of possible nursery sites adjacent the Waiapu River requires an understanding of the life supporting capacity of the river and the potential adverse impacts of various water extraction scenarios at different locations along the river.

This report researches an estimation of the minimum flow levels, for maintaining a healthy habitat and ecosystem function in the Waiapu River, and ensures that any extraction for a nursery or other purposes is within the ecological limits.

2 Cultural and physical characteristics of Waiapu river and catchment area

Ko Hikurangi te maunga
Ko Waiapu te awa
Ko Hourouta te waka
Ko Ngati Porou te iwi

2.1 Ko Waiapu te awa, Ko Ngati Porou te iwi

A key point to note for this report is that the Waiapu River and catchment area are of great spiritual, cultural and physical significance to Ngati Porou. Especially to the hapu of Ngati Uepohatu and Ruawaipu (the local traditional tribes and hapu adjacent the river). Therefore the health and well being of the Waiapu River and catchment area, including the mountains, extend much further than the physical elements of the landscape. Many Ngati Porou and especially Ngati Uepohatu and Ruawaipu, seek Mana Motuhake over the river and catchment, and its restoration should embrace the aspirations and values of the community and tangata whenua.

Any developments involving the river will require a holistic view of interconnectedness and wellbeing of the community and environment – the health of the river and the people are one, and there is much development and restoration to be done.

2.2 The Waiapu River and Catchment Area

The Waiapu catchment covers an area of 1734 square kilometres in the north of the Gisborne-East Coast region. The highest point in the catchment is Mount Hikurangi, which stands at 1752 metres above sea level. Mount Aorangi (1272 metres) stands to the east and north-east of Mount Hikurangi, Wharekia (965 metres), and Taitai (677 metres), and on the north-west by Whanakao (1618 metres). From the middle to upper part of the catchment, hill country rises steeply from many incised valleys to heights between 100 and 600 metres bounded in the west by the Raukumara ranges, between 500 and 1500 metres.

The Waiapu River is located near East Cape within the Gisborne region of the North Island and drains the northern part of the eastern side of the Raukumara Range. At approximately 22 km from the sea the Mata River joins with the Tapuaeroa River to form the Waiapu River, which originates in the headwaters of the steep Raukumara range. The Waiapu River flows past the Ruatoria township and then further down past the Tikitiki township, finally ending at the 'ngutu awa' or river mouth in Rangitukia.

The Waiapu River is predominantly a single channel cobble and gravel bed stream and is characterised by runs and with occasional pool habitats present. A common observation is that the course sediment of slow flowing stream margins is often covered in thick drape of fine sediment. Approximately one sixth of the annual sediment flow in all New Zealand river systems is in the Waiapu River, which continues to be one of the most sediment laden rivers in the world. The annual suspended sediment load is 36 million tonnes, and 90.46 cubic metres of sediment flows into the sea every second (Wikipedia 2018). Anecdotal evidence suggests that this sediment is adversely affecting nearby coastal and marine environments.The water quality of the river's tributaries is often much higher, as they are closer to the native vegetation of the Raukumara Ranges (GDC, 2012).

2.2 History and past land use

Historic records indicate that pre 1840, eighty percent of the Waiapu catchment was mainly native forest consisting of mature podocarp broadleaf and beech forests. From about 1890 until the 1920's deforestation and the establishment of pastoral farming by European settlers began a progression of increased erosion and sediment transfer. Today the present state of the catchment exhibits an extensive and serious erosion problem largely as a result of post European settlement forest clearance and land development, accompanied by many subsequent storm events and floods in 1916, 1918, 1938 and Cyclone Bola in 1988 (Harmsworth 2002). Flooding within the catchment has been extensive and occurs throughout the entire area, and has always has severe effect on the productive flood plains and low terraces in the lower parts of the catchment, from the Ruatoria township to the 'ngutu awa' or Waiapu River mouth. Exotic forest planting for the purpose of erosion control began in the late 1960's. In 1969, the conversion of eroded pasture to exotic forest began in the Tapuaeroa subcatchment.

The East Coast of the North island has always experienced periodic destructive storm and flood events and other natural phenomena such as earthquakes and erosion. However with the advent of pastoral farming between 1880 and 1920, following clearance of large areas of erosion-prone land from indigenous forest, scrub and fernland to pasture, heightened the risk of erosion and flooding. Over time whanau, hapu and community have had to adjust to the drastic transformation of the landscape, including the loss of rongoa resources the loss of traditional foods and natural ecosystems.

2.3 Current use within community

High levels of sedimentation, deem the Waiapu River water unsuitable for drinking. Local farmers cross livestock over the river which is also used as the source of drinking water for the livestock, especially during the dry months.

Locals from Ruatoria, Tikitiki and Rangitukia communities use the water for domestic purposes, such as bathing in the summer months and also transporting water in portable tanks to water gardens during low rainfall periods, typically during the dryer months of September to April. All households within the Waiapu Catchment Area rely on water tanks, bore or spring water for household usage. None of the adjacent communities have reticulated water systems and during the dry summer months or prolonged dry periods, the river becomes a vital back up water supply for adjacent communities and landowners for all purposes except drinking water. Currently there are no consents to take, use or dam water.

The Waiapu Landfill managed by Gisborne District Council is adjacent the beginning of the Waiapu River, near the Rotokautuku Bridge. This further compromises the 'mana' and well being of the river from a tangata whenua perspective and also regarding the water quality and the adverse effects of leachate and other pollution associated with landfills, especially in ground water and run off.

Due to there never being any resource consents for the extraction of water from the Waiapu River or its tributaries, the Gisborne District Council decided that it was not necessary to implement the usual water plan regulating water usage in the district. (Gisborne District Council (Land & Water NZ)(2012). However due to the recent nationwide focus on freshwater policy, has meant that a fresh water plan needed to be developed by 2016, with the guidance of the Gisborne Freshwater Advisory Group. In 2015, the Gisborne District Council, contracted NIWA to carry out an instream habitat survey and analysis to provide advice on a minimum flow and flow allocations for the Waiapu River. The report was also to have regard of the potential effects of different minimum flows on instream ecology.

Ngati Porou – Treaty Settlement Crown Accord

Recently as part of the Ngati Porou Treaty Settlement Agreement the Waiapu Catchment Accord was negotiated between Ngati Porou and the Crown to address the high erosion rates within the Waiapu catchment area and also the extremely high sediment load in the Waiapu River. The "Waiapu Restoration Agreement" is part of the Accord and was signed at the same time between Ngati Porou and the Ministry for Primary Industries (MPI) who are the lead Crown Agency working with Ngati Porou on the restoration of the river. It has resulted in the most comprehensive research ever for the Waiapu River and catchment to be undertaken.

A Memorandum of Understanding was signed in April 2014 between Ngati Porou, MPI and the Gisborne District Council (GDC) which sets out the collaborative approach all stakeholders and businesses to collaborate and work better together within the Joint Management Agreement (JMA) between Te Ruananganui o Ngati Porou, Ministry for Primary Industries and the Gisborne District Council.

The vision for the 100 year programme is: "Healthy land, healthy rivers, healthy people – Ko te Hauora o te whenua, Ko te Hauora o nga awa; Ko te Hauora o te iwi".

2.4 Rainfall and storms

The climate in the Waiapu catchment is warm temperate maritime, with warm moist summers and cool wet winters. Within the Waiapu Catchment the average annual rainfall is 2400 mm/year, but varies from 1600 mm/yr at the coast to >4000 mm/yr in the head waters. The region's climate is strongly influenced by the El Nino/Southern Oscillation (ENSO), with increase in major rainfall events during La Nina conditions and severe and prolonged droughts during El Nino (SCION, 2012). However erosion-generating storms in the Waiapu Catchment have a recurrence interval between 2.6 years in the headwaters and 3.6 years in the lower catchment near the coast (Harmsworth, 2002).

2.5 Tectonic setting

Tectonically active and structurally a complex zone known as the "East Coast Deformed Belt," the Waiapu Catchment and the river are situated in one of the most geologically complex areas in New Zealand. It is a zone that is adjacent the boundary between the Pacific tectonic plate to the east and the Australian plate to the west. Main features of this zone are the Raukumara Range to the west, and the Hikurangi Trough to the east. The Raukumara Range (~500 – 1500 m a.s.l) is the northeast extension of the axial ranges of the North Island, and the deep Hikurangi Trough (~3500 – 4500m) is the seafloor expression of the two obliquely colliding tectonic plates. Subduction of the Pacific plate under the Australia plate has led to deformation and uplift, especially in the last 2 million years. Much of the folding, faulting and numerous crash zones characteristic of the Gisborne-East Coast region are attributable to this crustal mobility, and the Waiapu catchment has experienced a number of large earthquakes. The landform pattern, high uplift rates (1-4mm/yr) during this period, and widespread and severe erosion is largely lithologically and structurally controlled and related to the diastrophism of the region (Harmsworth, 2002).

Diastrophism refers to deformation of the Earth's crust, especially to folding and faulting (Wikipedia, 2017).

3 Allowable rates of Extraction and Allocation for the Waiapu River

3.1 Report findings by NIWA (Commissioned by Gisborne Districct Council) to determine the Minimum Flow and Allocation requirements

In 2015, a report was completed by National Institute of Water & Atmospheric Research Ltd (NIWA) for the Gisborne District Council (GDC) to recommend a minimum flow and to suggest a total allocation (the sum of all maximum allowable rates of extraction) for the Waiapu River. NIWA followed procedures recommended by the Ministry for the Environment (MfE 1998, 2008). The report provides information regarding minimum flow and flow allocations for the Waiapu River, while also having regard to the potential effects of different minimum flows on instream ecology. While there is currently nil or little demand for water from the river, GDC needed to put in place a minimum flow and total allocation so that if demand increases they are positioned to grant allocations knowing the instream values will be protected. The study was undertaken in the vicinity of Ruatoria and a similar report was also produced and released at the same time for the Mata River (Duncan, 2015).

Ecological studies are not the only values that are important for consideration, as landscape values, aesthetic values, our Maori cultural and traditional values can also be influenced by flow changes (MfE 1998).

However the focus of the report was on physical habitat as defined by the combination of depths, velocities and substrates found in the Waiapu River. The instream modelling that was undertaken was a time intensive method for providing information for the environmental management of flow regimes and the results that were produced were site specific for 14 different locations. Additional factors influencing habitat, such as geomorphological changes, water quality and temperature were not investigated in the report (Duncan, 2015).

3.2 Sedimentation

The Waiapu River has the highest suspended sediment yield of any river in New Zealand and is known worldwide where by much research has been undertaken by international scientist and researchers. Each year 35 million tonnes of soil flow out from the river to the sea. The Waiapu River's high sediment yield is attributed the regions natural geology and the impact of decades of unsustainable land use practices.

The high sediment load is likely to reduce the value of habitat for most species. Therefore, the amount of physical habitat found is likely to more than the amount of habitat that is useful for various species. This is because, although the combination of depth and velocities might be suitable for fish, the drape of sediment makes the habitat unsuitable for periphyton and microinvertebrates that the fish feed on. This supports the need to improve the water quality of the Waiapu River by managing better the sediment sources and especially current farming and forestry practices near all riparian strips so that the Waiapu River may have a chance to restore to its former habitat potential.

3.3 Health of river ecosystems and determining instream flow requirements

Many factors influence the health of river ecosystems including temperature, oxygen, light, geomorphology and flow. All elements of a flow regime are important, including floods, average and low flows. A holistic approach must therefore be taken for the long-term management of river systems. Such an approach considers how human activities impact upon interactions between factors such as geology, sediment transport, channel structure, riparian conditions, water quality and biological habitat. (Duncan 2015)

The direct relationship between physical habitat and flow provides a means for assessing the ecological impact of changing the flow regime of a river. However, assessment of river flow management options often involves assessing scenarios that fall outside the range of observed conditions, and thus predictive models are required. Essentially these models quantify the relationship between physical habitat, defined in terms of the combination of depth, velocity and substrate/cover, and various flows. Criticisms of this approach include lack of biological realism and mechanisms. Nevertheless, the models have been applied throughout the world, primarily to assess impacts of abstraction or river impoundment. The report examined the effect of flow on instream physical habitat only. The approach used did not investigate potential changes in water temperature, water quality or sediment transport arising from changes in flow management.

No investigation was undertaken for potential changes in water temperature, water quality or sediment transport from changes in flow management.

A variety of approaches and frameworks to instream flow methods exist. Whilst there are many methods available for setting flows, all of which have pros and cons, physical habitat modelling and IFIM is the technique most commonly used throughout New Zealand at present. Therefore, this technique has been used to determine a minimum flow range for the Waiapu River in the report. (Duncan, 2015)

3.5 Flow setting

The National Policy Statement for Freshwater Management (NPSFM) states that, for flowing water, water quantity limits (i.e., environment flows as defined in MfE 2013) must comprise at least a minimum flow and an allocation rate. In situations where a regional council has not set minimum flows for a catchment, proposed interim limits for ecological flows for rivers with mean flows greater than or equal to 5 m3 /s were proposed by the Ministry of the Environment (MfE 2008). These proposed limits are for a minimum flow of 80% of the mean annual low flow as calculated by the regional council (or the unitary council, Gisborne District Council) and a total allocation of 50% of MALF. (MfE 2013) suggests that this default minimum flow would be superseded following any more detailed study, such as a physical habitat modelling study.

Regardless of the method of data collection, simulated hydraulic conditions are then compared with the habitat suitability criteria in order to assess how the combined quality and quantity of physical habitat varies as flow changes.

The total area of suitable physical habitat is then plotted as a function of flow to show how the area of suitable physical habitat for a given species changes with flow. Variations in the amount of suitable habitat with flow are then used to assess the effect of different flows for target organisms. Where habitat modelling has been conducted, various approaches to setting levels of protection provided by a minimum flow can be used.

Habitat methods can also incorporate flow regime requirements, in terms of both seasonal variation and flow fluctuations. Flow fluctuations are an important component of the habitat of most naturally flowing streams. Such fluctuations remove excess accumulations of silt and accumulated organic matter (e.g., from algal slimes) and rejuvenate stream habitats. Extended periods without a flow disturbance can result in a shift in benthic community composition such as a reduction in diversity and an increase in density and biomass of snails and other species (Duncan, 2015).

3.6 Habitat suitability criteria

The habitat suitability criteria chosen for a study must be appropriate for the species known to occur, or likely occur, in the river to be studied. The habitat suitability criteria used for the Waiapu River in the report by NIWA, commissioned by Gisborne District Council, is below in Table 2. (Duncan, 2015).

Table 2: Aquatic species and habitat suitability indices

Taxa group/Species	HSC name	HSC source
Periphyton	Diatoms	Unpublished NIWA data
	Short filamentous	Unpublished NIWA data
	Long filamentous	Unpublished NIWA data
Stream invertabrates	Food producing	Waters (1976)
	Deleatidium mayfly nymps	Jowett et al., (1991)
Fish	Koaro	Jowett & Richardson (2008)
	Smelt	Jowett & Richardson (2008)
	Inanga	Jowett & Richardson (2008)
	Torrent Fish	Jowett & Richardson (2008)
	Common Bully	Jowett & Richardson (2008)
	Rainbow trout (<100mm)	Jowett & Richardson (2008)
	Rainbow trout feeding	Thomas & Bovee (1993)
	Longfin eel <300 mm	Jowett & Richardson (2008)
	Longfin eel >300 mm	Jowett & Richardson (2008)
	Short fin eel <300 mm	Jowett & Richardson (2008)
	Short fin eel >300 mm	Jowett & Richardson (2008)

3.7 Flow allocation

There is currently no flow allocation for the Waiapu River. It is assumed that the most likely demand for water will be for irrigation of the river flats adjacent to the Waiapu River from its confluence with the Mata River to the sea. An allocation was calculated from the area of the flats, assuming peak demand of 5 mm/day.

The area of flat land downstream of the Mata river confluence is ~49 km2 , of which ~ ⅓ is river bed. If approximately 80% of the remainder was to be irrigated with 5 mm per day then the peak water requirement would be 1.5 m3 /s. Similar logic was applied to the irrigation requirements of the Mata flood plain downstream of the Makarika Road Bridge to estimate a peak water requirement of 0.5 m3 /s. Given these allocations the total loss of flow from the river would be 2 m3 /s. During the irrigation season of 1 September to 30 April, and assuming a minimum flow of 5 m3 /s, an allocation of 2 m3 /s would have a 94% reliability of supply. (Duncan, 2015)

3.8 Hydrograph flat-lining

Table 3 shows the effect on flat–lining of a minimum flow of 5 m3 /s with and without an abstraction of 2 m3 /s compared to the 7d-MALF. Clearly, with the abstraction the minimum flow would occur much more often and for a longer total time. The duration of the longest low flow period is unchanged.

Table 3: The number and duration of periods with flows less than the 7d-MALF and a minimum flow of 5 m3/s with and without a constant abstraction of 2 m3/s.

Flow threshold (m3/s)	6.398	5.000	5.0 with 2.0 allocation
Lows/year <	1.8	1.1	5.0
Low days/year	12.0	7.0	11.4
Days/low	6.6	6.5	2.3
Maximum duration (days)	42	40	40

In summary, an allocation of 2m3/s for the whole river would increase the number and duration of periods with flow at or below the minimum flow, but some of the periods would be quite short. However, the number of flushing flows that are critical to river health and function is essentially unchanged (Duncan,2015).

3.9 Recreation

No formal analysis on recreational values was undertaken, instead observations were made at the time of the survey, of the suitability of depths and velocities for bathing, rafting, kayaking, and jet-boating.

The river would be suitable for bathing from a depth and velocity point of view at the flows during the survey. It would also be possible to raft, kayak or tube the river at the observed flows. However, given the low river slope, low velocities and bland landscape, the reach is unlikely to be attractive for these activities due to the lack of challenge offered by the river and its lack of scenic values compared to alternative venues. Jet boating at the observed flows would not be possible for recreational jet-boaters. It was difficult to find water deep enough to launch the large NIWA jet boat and they were only able to boat a few hundred meters before the river became too shallow (Duncan,2015).

4 Conclusions

4.1 Flow regime requirements

The selection of minimum flows is a matter of judgement, where the habitat requirements and perceived values of the different species must be considered. Decisions need to be made about what an acceptable level of habitat protection is either on average across the species or for one or two key target species. For example, one option is to maintain 70% of habitat averaged across several species, or another option is to maintain 90% habitat for flow sensitive fish species. Minimum flow recommendations may be a compromise between species, and are usually made to prevent a sharp decline in habitat for most species or to retain a percentage of the maximum habitat, thus aiming to retain some habitat for all species that make up the aquatic community present in the study area. Higher levels of habitat protection may also be set for rarer species or for criteria viewed to be critical to the ecological functioning of the river such as production of food for fish or removal of nuisance algae. (Duncan, 2015)

4.2 Minimum flows

Low flows can limit the amount of available physical habitat and it is often assumed that frequently occurring low flows will limit fish populations. The mean annual low flow has been used as a measure of frequently occurring low flows for long-lived fish species. Alternatively, minimum flows are often selected so that they prevent a serious decline in habitat or the flow below which habitat declines sharply. However, effects on ecosystem health depends to some extent on the amount of time that the flow is likely to be at that minimum. The length of river of most relevance for minimum flow in this case is the 8 km of the Waiapu River between the Mata River and the Poroporo River. The Poroporo and Mangaoparo Rivers are substantial tributaries that contribute downstream of the water-level recorder at the SH3 bridge. The only species recorded as being in the Waiapu River are large Longfin eels, torrent fish and common bully. Given the cultural importance of the LOngfin eel , they should be considered of major importance for determining a minimum flow for the Waiapu River. A minimum flow of 4 m^3/s would mean that 88.9% of large Longfin eel habitat, and 75.5% of all fish habitat on average, would be retained.

Observed was the effect of flat–lining of a minimum flow of 5 m3 /s with and without an abstraction of 2 m3 /s. With the abstraction the minimum flow occurs much more often and for a longer total time. The duration of the longest low flow period is unchanged.

4.3 Considerations

The response of several species to changes in flow were modelled and whilst all species were given an equal weighting. When determining an appropriate minimum flow it was also important to consider the species that currently occur in the reach, their abundance and protection level. For fish communities, longfin eels, common bullies and torrent fish have been observed in the Waiapu River. Whatever minimum flow is proposed should be weighted in favour of these species.

Physical habitat modelling was used to assess the effects of changes in flows on instream physical habitat and aquatic species in the Waiapu River catchment.

The habitat modelling results show how different minimum flows alter instream ecological values.

The change in the instream ecological values with flow suggest that the minimum flow should be set somewhere between 3 and 6 m3 /s.

An allocation of 1.5 m3 /s for the Waiapu River reach would be sufficient to efficiently irrigate the alluvial flats adjacent to the river. This, together with the irrigation abstraction of 0.5 m3 /s for the Mata River flats would increase the number and total duration of flows at or below the minimum flow, but would leave flushing flow frequency effectively unchanged. The increased total duration of low flows is unlikely to be harmful to the species recorded living in the reach (Duncan, 2015).

The Waiapu River carries a very high coarse and fine sediment load and this limits the availability of habitat. The high sediment load possibly accounts for the fact that most fish species covered in the report were recorded in more stable tributary streams (Duncan,2015).

5.1 Contemporary Issues and future development

Some of the most important community and environmental concerns regarding the Waiapu River and catchment have been:

- The current site for the regional Waiapu Landfill being situated near the beginning of the Waiapu River, and above the Ruatoria township.
- Water quality and health effects (especially from from prevalent dust storms from the river in windy dry conditions)
- The lack of action to improve the state of the Waiapu catchment and river
- Clear felling and poor management of exotic forests in the catchment, especially adjacent riparian strips
- Flood protection, flood control and works to protect agricultural land in the lower part of the catchment, especially the Waiapu flood plains
- Gravel extraction, especially the point of extraction
- Restoration of native flora and fauna
- Education
- Rates on land
- Concerns about land use, land development, and future use and decision making
- Sustainable use of land, erosion and water quality

5.2 Reforestation and replanting of native species

The health of the Waiapu River depends on the health of the tributary catchments. It is a community aspiration to be able to restore the native vegetation to land that is most prone to erosion, especially the gullies and riparian areas.

Rangatahi are an essential for the success and sustainability of the native nursery project.

Having rangatahi involved in environmental projects, within the marae and school activities, were some of the aspirations of rangatahi living in the Ruatora area. Protecting and enhancing native flora and fauna are the priorities for some living within the community. However over the decades, traditional knowledge and the intimate connection whanau and hapu had with the natural heritage has been lost.

With significant growth in the Manuka industry in recent time, there is a desire by landowners to replant manuka and other native species as opposed to ‘pinus radiata’ and coppicing species such as willows and poplars.

5.3 Riparian management and restoration

Management and restoration of riparian areas is paramount when considering the initial priority areas for restoration. Not only is it the best solution for the erosion control, but is also the best option for improving the water quality of our rivers, streams, lakes, wetlands and other water bodies. It is also the best way to better enhance natural biodiversity and the populations of native aquatic and terrestrial flora and fauna, within the Waiapu River and catchment area.

5.4 A community model for decision making for the Waiapu River and improved environmental management within Ngati Porou.

Who makes the decisions in the community for environmental planning and management? Who should have a say? Any environmental strategy must involve whanau, hapu and community for a collective approach to achieving the best outcomes from the project. It is important for an ongoing discussion and engagement with whanau, hapu and community, but also utilising partnerships or relationships that a key for success of the project. A model inclusive of whanau, hapu and local community for the Waiapu River and catchment is essential, to the success and sustainability of any projects or developments going forward.

It requires hard work and commitment to work together as community to enhance our environment. Due to whanau and landowners dealing with an array of problems, especially regarding Te Ture Whenua and the barriers when dealing with Maori land title. Access to funding is one major issue when dealing with Maori freehold land.

River protection and restoration, native flora and fauna restoration, and any other forms of environmental enhancement will continue to be a low priority if there is little income or no socio-economic return. Therefore it is essential that any form of environmental enhancement should be developed alongside, economic development and human and social capacity building. Efforts need to occur simultaneously with sustainable management planning in the upper parts of the Waiapu catchment, where 'buy in' and commitment from landowners is essential.

The joint management agreement (JMA) between Gisborne District Council, Ministry for Primary Industries and Te Ruananganui o Ngati Porou, a result of the Treaty settlement for Ngati Porou for the restoration of the Waiapu catchment has been acheived. Finally the Waiapu River and the catchment areas are getting the priority to address the extreme erosion and land movement present.

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