Manatiaki Kōawa
rivers GROUP
A joint technical interest group of IPENZ & Water NZ

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INSIDE THIS ISSUE

FROM THE CHAIR

Mark Pennington, Chairman of the Rivers Group

With our annual Symposium looming, this issue of our newsletter, FLOW, is aimed at complementing the symposium programme and furthering our objective of keeping members engaged and interested in river-related matters. I hope you enjoy the read and, as usual, your committee is very receptive to any suggestions, ideas or contributions for future editions.

I hope that many of our members have registered for our annual Symposium, "Friend and Foe – Our rivers as the source of resources and hazards". This is the group's highlight of the year, and will feature a stimulating field trip with the opportunity for "contact recreation" with the Kaituna River. This will be the group's 4th symposium after formation in 2009, with previous events having been held in Hamilton, Wellington and Christchurch in 2010, 2011 and 2012 respectively. Please see the links towards the end of this newsletter for more details of this year's symposium.

Symposium time is also Annual General Meeting time for the Rivers Group. At our AGM we will elect the 2013/14 committee, and nomination forms should have been received by all members. Serving on the committee is your opportunity to become involved and make a contribution, and election of committee members is the way you can influence the representation that you will have. The current committee welcomes any involvement from members, especially those keen to volunteer as new committee members. We will also present the annual Arch Campbell Award at this year's symposium – for those of you who are not familiar with it, this 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.

Finally I would like to extend a very big thank-you to our symposium sponsors: TUFLOW, PDP, Tonkin & Taylor, NIWA, Boffa Miskell and Mike by DHI. Without the generous assistance of these organisations the viability of our symposium would be under greater scrutiny. Please give your support to them all wherever you can.

I hope to see you all in Rotorua next month! ≈

LANDSLIDES AND DEBRIS FLOWS IN THE TASMAN DISTRICT CAUSED BY THE DECEMBER 2011 AND JUNE 2013 RAIN STORMS

M.J. Page G.J. Stevens
R.M. Langridge K.E. Jones

Between the 13 and 15 December 2011 the Tasman District experienced an extreme rain storm which caused severe flooding, landsliding and a number of debris flows which affected homes and properties, and resulted in the declaration of a civil defence emergency. In the Pohara-Ligar Bay area in eastern Golden Bay, properties in Nyhane Drive and Pohara Valley were severely affected by debris flows and debris floods. The houses in both these areas are built on fans which have formed over thousands of years, and will continue to do so through the deposition of sediment eroded from their upstream catchments. Debris flows and debris floods are two of the processes that deliver this sediment, and their recurrence intervals are important for natural hazard risk management. An earlier debris flow event may have occurred in the historic record, but this has not been verified. Rainfall records since 1932 show that the rainfall that fell in the December 2011 storm was much greater than in any previously recorded event. The estimated return period for the 24-hour rainfall that generated the debris flows is ~200 years, which is similar to the interval between two dated debris flow deposits in the Nyhane Drive catchment. However, this recurrence interval may reduce, based on NIWA-modelled changes in precipitation for this century (using an IPCC scenario of a 2°C increase in temperature), which suggest that present 100-year average recurrence interval 24-hour rainfall totals are projected to increase by around 60-80 mm, and to occur about twice as often (i.e. become 50-yr events).

Large Slip in Ellis Creek Catchment (2011 - Courtesy of Paul Woperies)

A debris flow is a very rapid to extremely rapid flow of water-saturated sediment and debris that travels down a steep channel. Material is contributed from landslides on the surrounding hillslopes and from sediment and vegetation scoured from the channel as the debris flow travels downstream. It is capable of carrying large boulders and logs and can be destructive when it reaches a fan or other depositional surface. A debris flood is a very rapid surging flow of water, heavily charged with debris, in a steep channel. A debris flood almost always occurs as a continuation downstream of a debris flow, but can occur in the absence of a debris flow. Debris flows were responsible for the worst damage to houses and other infrastructure in Nyhane Drive and Pohara Valley. This mainly occurred where the stream flowed onto the upper parts of the fans. Further down the fans, as the larger debris was deposited and velocities reduced, debris floods continued often to the coast and many houses and properties were affected by the deposition of finer sediment.

Debris Flow on upper part of Nyhane Drive Fan (2011 - Courtesy of Tim Cuff)

The number of debris flows that occurred during the December 2011 storm in Golden Bay, and also during a storm in the Tapawera area in 2010 has highlighted a hazard that until now was either not recognised, or regarded as occurring very rarely in the Tasman District. These areas are largely underlain by deeply weathered and highly erodible Separation Point Granite, a lithology which is reasonably common in the Tasman District. The majority of these debris flows deposited their sediment onto fan surfaces which are favoured locations for housing and other development, and it can be expected that there will be increased pressure for such development in the future.

Of the twenty-nine catchments identified in the Pohara-Ligar Bay area, only some generated debris flows and debris floods. There are threshold values for catchment length and catchment ruggedness (measured using catchment relief and catchment area) which, when combined identify those catchments capable of generating debris flows and those capable of debris floods. These thresholds are likely specific to catchments dominated by Separation Point Granite, and require refinement with analysis of further catchments. Such analysis may provide a high level or district-wide assessment; however, site investigations are always necessary where development is proposed.

Debris Flow Deposit surrounding property at 64 Pohara Valley Road (2011 – TDC photo)

For the Nyhane Drive and Pohara Valley communities, mitigation options largely involve engineering works, land use and land management. At Nhyane Drive there are still areas of the fan that are not built on, and which could be modified to contain debris flow and debris flood sediment. The existing channel which delivers sediment to the fan could also be enlarged and possibly lined, and moved slightly eastward away from existing houses to flow onto areas of the adjacent fan which is confined between rows of hills, severely limiting mitigation options on the fan. The stream channels could be enlarged and lined, and culverts significantly enlarged. Consideration could be given to building debris-retention structures in the upper reaches of the two largest catchments that drain onto the fan.

A significant amount of large woody debris was deposited on the fans, some of which added significantly to the structural damage of houses. Logging of the exotic forests in the steep catchment areas requires careful management to reduce the amount of slash. The optimal mix of vegetation cover to minimise the volume of sediment and woody debris carried by debris flows and debris floods requires further research.

More recently, a rain storm in the Tasman District on the 15-17 June 2013 caused numerous landslides and debris flows in the Motueka area. One of these landslides struck a house at Otuwhero Inlet, killing the woman occupant. Another landslide in the Marahau Valley destroyed part of a dwelling, fortunately just missing a father and daughter who were sleeping in another room. Landsliding was particularly severe in a logged area of Shaggery Forest west of Motueka. Many roads were blocked by landslides and debris flows between Marahau and Kaiteriteri, in the Riwaka and Brooklyn Valleys, and along the west bank of the Motueka River as far south as Rocky River. A salmon farm at Anatoki west of Takaka was badly damaged by debris flow.

Fatal Landslide at 597 Kaiteriteri-Sandy Bay Road (2013 – Nelson Mail photo)

A site inspection was made of the fatal landslide site at Otuwhero Inlet. The landslide occurred at ~1 pm on Sunday 16 June after ~180 mm of rain fell in the preceding 24 hours and ~80 mm fell in the preceding 4 hours. The house was pushed several meters off its piles and collapsed, and the woman's body was subsequently recovered from the landslide debris outside the house. The landslide occurred in an area of convergent drainage on the slope directly above the house. The head scarp of the landslide is level with an access track that cuts across the slope. The house had been built on material deposited by an earlier (paleo-) landslide.

Factors contributing to the landslide were: the high intensity rainfall, the deeply-weathered Separation Point Granite lithology, steep convergent slopes, and probably the side castings deposited along the outer edge of the track during construction and maintenance. The death of the occupant was the result of the house being located at the base of slopes susceptible to landsliding, and the light-weight materials with which the house was constructed.

The landslide that severely damaged the dwelling in the Marahau Valley occurred after ~290 mm rainfall in the preceding 24 hours, ~140 mm in the preceding 12 hours and ~30 mm in the preceding hour. Again the dwelling had been built at the base of steep convergent slopes underlain by Separation Point Granite, and on material deposited by an older landslide. In this case the natural toe of the slope had been excavated to increase the area for building. This steepening of the lower part of the slope reduced support for the area above and facilitated the landslide.

Elsewhere landslides occurred on both natural and modified slopes, and a number of other properties had "near misses". This latest storm is the fourth in the last three years that has caused landslides and debris flows in the Golden Bay-Nelson district. Given the number of rural life style properties in the Tasman District, more consideration should be given to identifying at-risk existing houses and at-risk sites prior to planning consent and house construction.

Detailed GNS landslide and debris flow reports for both the 2011 and 2013 events can be found respectively at:

http://www.tasman.govt.nz/services/emergency-management/recovery/december-2011-rain-and-flood-event/ ,and

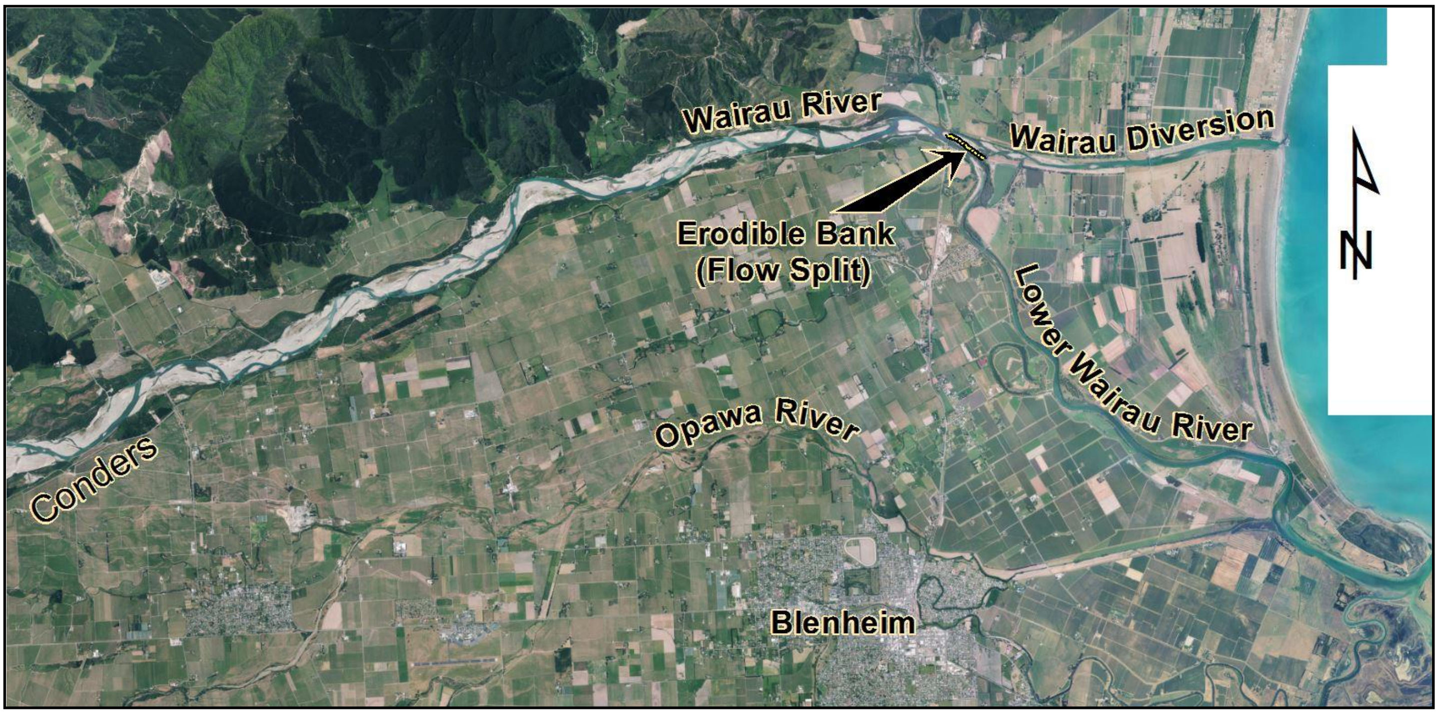
http://info.geonet.org.nz/download/attachments/2196288/SR+2013-044_Final.pdf. ≈

CHALLENGES WITH SEDIMENT DYNAMICS IN MARLBOROUGH'S LOWER WAIRAU RIVER

K. Christensen
B. Williman
PATTLE DELAMORE PARTNERS
MARLBOROUGH DISTRICT COUNCIL

The district of Marlborough had more than its share of river management projects over the past 150 *years*, each one uniquely affecting the geomorphology and flood hazard of the Wairau Plains. A major early project was to block the Opawa distributary channel at Conders. The Opawa distributary channel took a third of Wairau floodwaters and was a major threat to Blenheim. To this day effects from this project present difficult challenges for river managers.

Originating within the northern most extent of the Southern Alps, the Wairau River makes its way east, following the Alpine (Wairau) Fault between the Richmond Ranges to the north and the Bounds and Raglan Ranges to the south



Location of Wairau River's Flow Split & Erodible Bank

before emerging onto its alluvial fan at the head of the Wairau Plain. Over geological time the Wairau avulsed across its fan building the Wairau Plains depositing approximately 28 x 10^9 *tonnes* of sand and silt and 1.4 x 10^9 *tonnes* of gravel. In more recent times (2000 BP) the northwest tilting of the geologic block that the Wairau Plain sits on has resulted in a tendency for the main channel to occupy the northern most extent of its fan. However, when the river arrives at Tuamarina it is met by high erosion resistant beach ridges deposited as sea level receded from its maximum level some 6000 *years* ago. Unable to naturally break through to the sea the river turns through 90 *degrees* and meanders behind these beach ridges for 12 *km* before breaking through at the mouth of the Vernon Lagoons.

The blocking of the Opawa required the Wairau and Lower Wairau rivers to carry greater flood flows more often. Consequently the tidal Lower Wairau River was breaking out of its stopbanks approximately every ~7 *years*.

The idea of diverting flood waters at Tuamarina by providing a direct diversion to the sea through the beach ridges was conceptualised back around the 1920s; however, limits on resources and machinery meant the mission of excavating this diversion didn't become feasible until the 1960s.

In 1963/64 a 10 *m* wide pilot channel was cut from the sea to Tuamarina with an initial capacity of 700m^3/sec. It was expected that floods would eventually scour this '*Wairau Diversion*' to its design channel width of 150 *m*. As it turned out, less than the anticipated scour occurred due to the underlying erosion resistant geology. Occasional mechanical assistance between the late 1990's and 2012 helped achieve the current and intended design capacity of 3,000 m^3/sec.

The introduction of the Wairau Diversion realized the goal of significantly relieving floodwaters for a design event on the lower end of the plains; however, its enlargement through erosion and excavation resulted in the very opposite in the Lower Wairau River – sedimentation and an aggrading bed.

The flow-split in the Wairau River since the excavation of the Wairau Diversion has reached a ratio as high as 55/45 in favour of the Diversion. This division not only occurred at times of significant flood but also during smaller freshes and normal flows, gradually converting the Diversion into the dominant channel of the lower river system.

The Wairau Diversion's Erodible Bank looking downstream to the head of the Wairau Diversion

Unfortunately reducing the flood flow regime of the Lower Wairau also reduced its ability to transport the sediment laden flood flows, resulting in aggradation of the Lower Wairau channel.

Investigations throughout the 2000s (B.Williman and K.Christensen) confirmed that the higher sediment concentrations entering the Lower Wairau at flows with insufficient energy to keep the sediment entrained was resulting in significant deposition. The higher sediment concentration at any given flow in the Lower Wairau is a result of the total river flow now having to be more than double to achieve the same Lower Wairau flow. Further to this the suspended sediment concentration at Tuamarina has been estimated by the equation $C=0.028Q^{1.6}$ meaning that if the flow increases by a factor of two the sediment concentration will increase by a factor of three. Compounding this even further is the geometry of the flow split at Tuamarina with the Lower Wairau being on the inside of the bend where sediment concentrations will be higher. This was confirmed during a sediment and flow gauging in November 2006 which measured sediment concentrations on the inside of the bend double those on the outside.

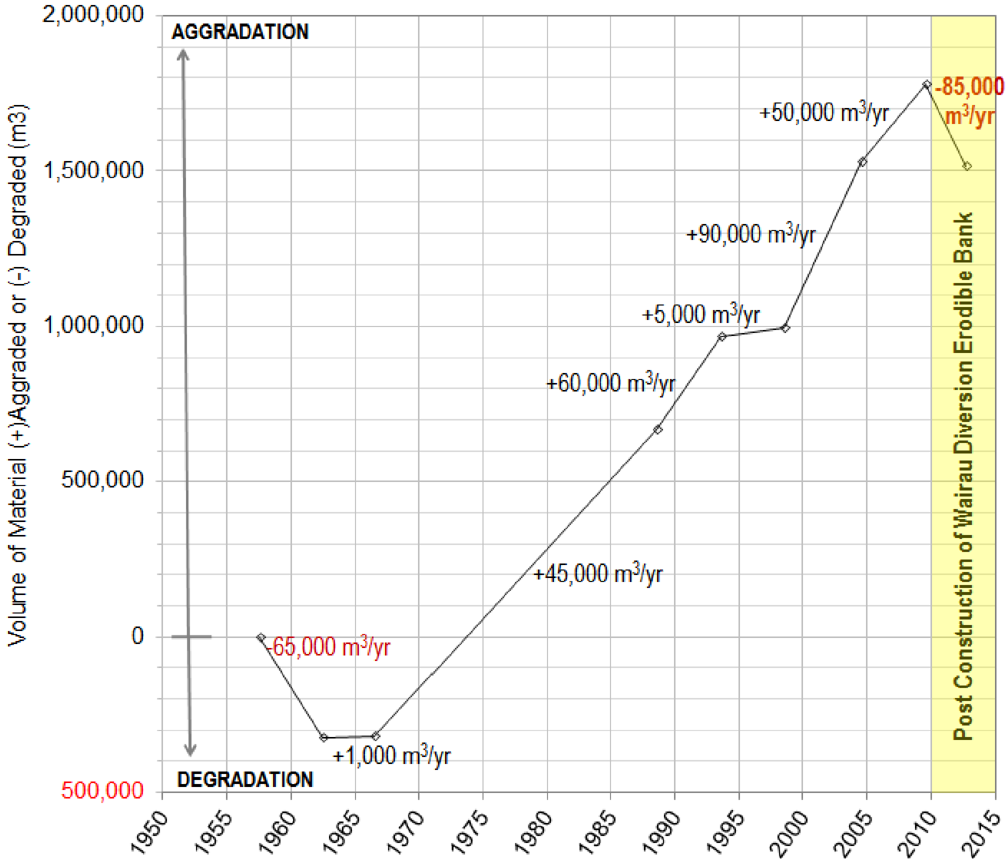
This combination of reduced flows and increased sediment concentrations has resulted in an extended period of aggradation in the Lower Wairau. It is estimated that approximately ~2,000,000 m^3 of sediment was deposited along the bed of the Lower Wairau River in the time between the Diversion's introduction and 2010; raising the Lower Wairau's bed upwards of ~1.5 *m* in some locations.

K.Christensen's predictive sediment transport analysis led to the decision and resource consent to construct an Erodible Bank at the head of the Wairau Diversion to divert more frequent scouring-flows (+400 m^3/sec) down the Lower Wairau River. The initial construction of the bank followed in late 2009 with the combination of a non-erodible rock groyne extending approximately ~35 *m* downstream of a rail bridge pier followed by a ~450 *m* long and ~15 *m* wide erodible bank, which divides the upper end of the Lower Wairau and Wairau Diversion. The bank's level at a fuse location is set to overtop and begin washing out at a combined Wairau flow of 1,400 m^3/sec.

The construction of the Erodible Bank along with silt and gravel extraction efforts near the flow-split area have shifted the Wairau River's flow-split ratio to approximately ~70/30 prior to the bank washing out and ~55/45 after a wash out occurs; both in favour of the Lower Wairau.

In the +3years since the Erodible Bank was first constructed the Wairau River has sustained 14 events with recorded flows at Tuamarina above 1,000 m^3/sec and three of these event measured in excess of 2,500 m^3/sec.

Looking upstream at the Erodible Bank just as flood waters are beginning to breach the Fuse Location



Estimated Sediment Volumetrics in the Lower Wairau River post-excavation of the Wairau Diversion and post-construction of the Erodible Bank

These freshes and floods resulted in washout and rebuild of the Erodible Bank 8 times with a combined rebuild expenditure of ~$80*K*. The cost to reinstate the bank varied for each washout between ~$8*K* and +$20*K* depending on the degree of washout and amount of rebuild material required.

Marlborough District Council's Rivers Department maintains a regular monitoring program for the bed of the Lower Wairau River, which consists of recurrently surveying a series of standard cross sections and estimating the mean bed level (*MBL*) at each section as well as an overall *MBL* change over time. A survey was carried out just prior to the installation of the Erodible Bank and another survey was carried out earlier this year.

The results from this latest survey show for the first time since excavating the Wairau Diversion the bed of the Lower Wairau River as a whole is losing material; thus the anticipated scour from the Erodible Bank's influence is occurring. It is estimated that the entire bed of the Lower Wairau has gone down by an overall average of ~60 *mm* since the introduction of the Erodible Bank. It is also estimated that the river has lost ~260,000 m^3 of sediment since the Erodible Bank was first constructed. At a cost of \$0.30/m^3 this represents excellent value compared to mechanical dredging which would likely be in excess of \$10/m^3.

It is difficult to say if this ~85,000 m^3/yr is a trend since this is only the first bed survey since the initial construction of the Erodible Bank but it is certainly moving in the right direction and is fundamentally working with the natural processes and making the most of the energy that the river is providing.

In conclusion, the Wairau has been subjected to three significant events – Dec2010, May2011, and Jul2012 – all within a 1.5*year* time frame, which make it difficult to say how much of this estimated reduction in bed level is the result of the Erodible Bank as opposed to scour during the peak of these high flow events; however, these early results confirm the concept of the Erodible Bank and that further monitoring and surveying will be required to confirm it's long term effectiveness. ≈

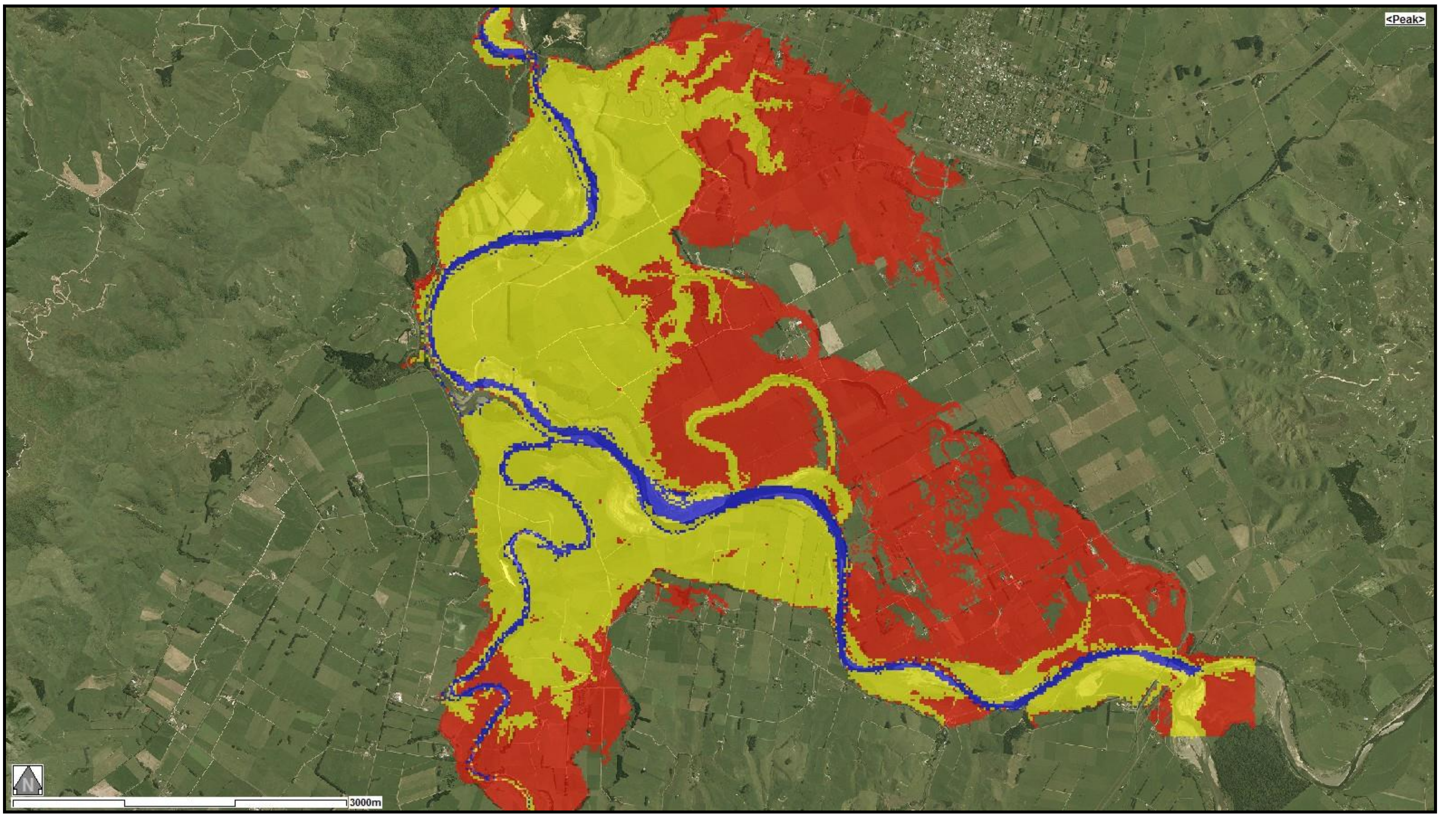
HORIZONS REGIONAL COUNCIL'S FLOOD FORCASTING SYSTEM

C. Druery
WORLEYPARSONS (SYDNEY, AUS)

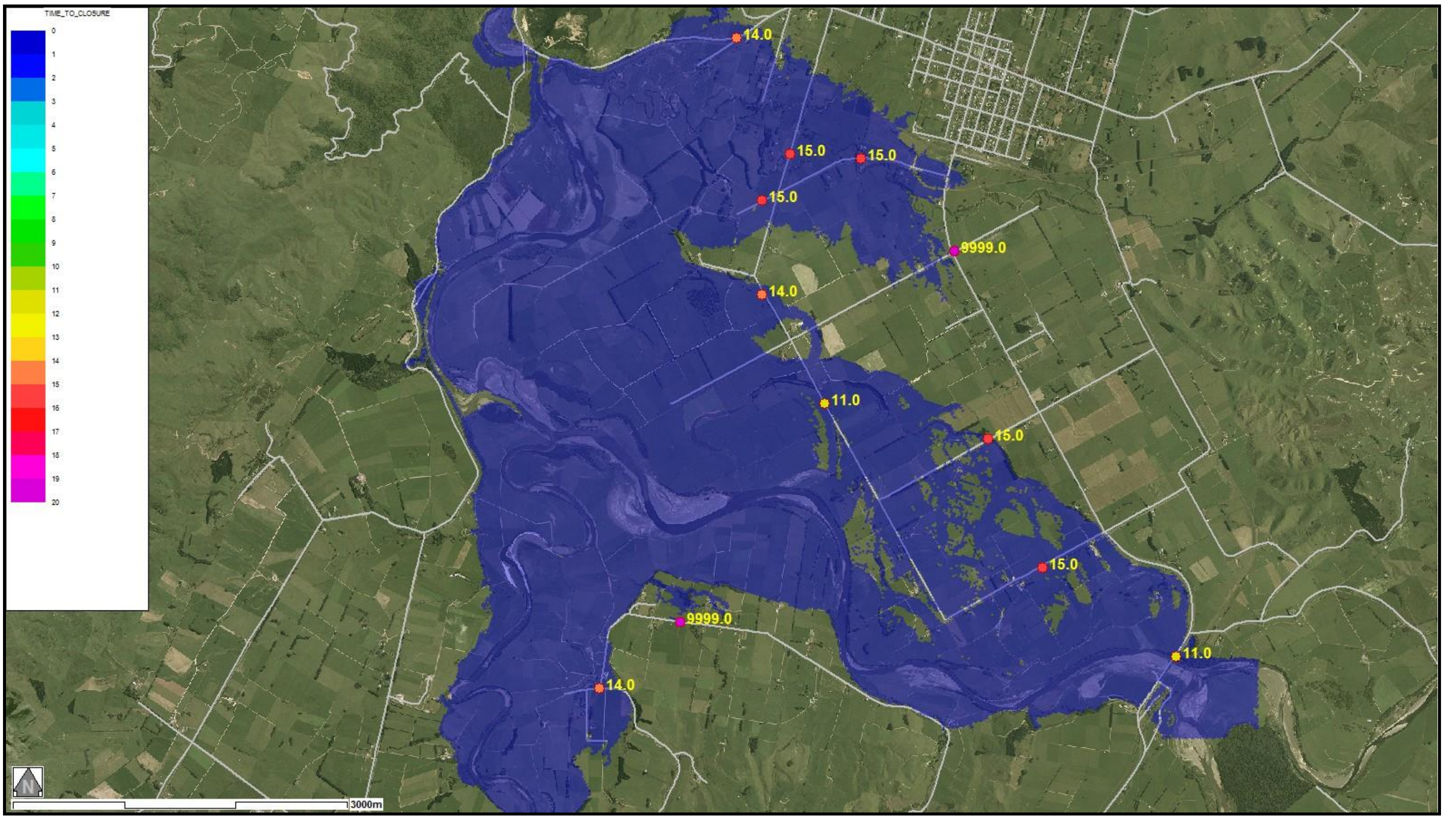
Following the major flooding that occurred in February 2004, Horizons Regional Council has made a significant investment in flood forecasting, flood mapping and land use planning in its major river catchments.

A key outcome of the February 2004 flooding was the need to not only quantify the flooding risk throughout the region, but provide a means of delivering critical information on likely flood behaviour during a significant flood event.

To this end, Council is in the process of finalising the expansion of its leading edge flood forecasting system to leverage "readily available" datasets (such as actual and forecast rainfall data, hydraulic modelling results, digital elevation models, and various property and infrastructure GIS datasets).



Forward Looking Surface: Blue = now; Yellow = 2hrs from now; Red = peak of flood



Time of closure of evacuation routes

For any given catchment, the existing system combines actual rainfall data collected from Council's internally managed telemetered rainfall and river gauge network, with hourly at point rainfall forecasts from the MetService to create the base inputs for real-time hydrologic modelling. The real-time hydrologic modelling provides flow and stage hydrographs at key gauges in the catchment, giving an indication of likely flooding. Static "pictures" of flooding at various gauge levels were then used to provide an indication of the extent of flooding.

The recent expansion to the system sought to enhance the delivery of targeted intelligence to both the community, and Councils emergency management personnel, in a readily usable format. Essentially, the "man on the ground" managing flood response efforts needed to know more than what the peak levels were going to be, but what was the likely *affectation* of the impending flooding:

- ≈ What is the likely flood extent?
- ≈ How deep will it be?
- ≈ Who is likely to be affected?
- ≈ What roads will be cut?
- ≈ What critical infrastructure will be affected?
- ≈ When will the above occur?

The recent expansion to the system has focussed on converting the forecast levels at these discrete gauges into a continuous water surface representing the likely flooding across the entire floodplain. This has been achieved in the waterRIDE™ environment using the hydraulic surface interpolation algorithms based on a library of "pre-cooked" hydraulic model water surfaces.

The forecast levels at each gauge are used to identify the library surface above and below that forecast level. The hydraulic interpolation is then applied using the relative ratio between the upper and lower surface at all points on the floodplain, allowing a smooth transition between subsequent gauges on a river or between tributaries. Using the hydraulic surfaces as the basis for interpolation ensures that the appropriate hydraulic gradient between the gauges is maintained, resulting in high quality forecasts.

Since the system is based on water level surfaces, the affectation of the flooding can be readily addressed by integrating the forecast flood surface with relevant GIS datasets, for example:

- ≈ Overlaying against a DEM to provide both flood extent and likely depths
- ≈ Integrating floor level property datasets to determine who is affected by above floor flooding
- ≈ Integrating evacuation routes to determine if they are accessible or not
- ≈ Integrating critical levels at various items of infrastructure to determine if they are operable

"This system provides Council with a wealth of usable information to assist in managing flood emergencies," says Councils manager of hydrology, Jeff Watson, "the recent enhancements to the system should give Council the ability to provide some sophisticated mapping and information in real-time, for future floods".

One of the key advantages of the overall system has been that in utilising readily available data, it provides a rapid and stable means of delivering key flood information to emergency managers during a flood event, whilst hiding the more "technically complex" aspects of flood forecasting.

For further information, contact:
Jeff Watson at Horizons Regional Council
(jeff.watson@horizons.govt.nz), or

Cameron Druery from WorleyParsons
(cameron.druery@worleyparsons.com). ≈

KAYAKING ON CANTERBURY RIVERS – VALUES, FLOW REQUIREMENTS, AND HAZARDS

D.A. Rankin[1]
N. Earnshaw[2]
I.G. Fox[3]
T. Botterill[4]

1. WHITEWATER New Zealand
2. AORAKI POLYTECHNIC
3. ENVIRONMENT CANTERBURY
4. UNIVERSITY OF CANTERBURY

A study and report have been funded by Environment Canterbury to identify the key valued river reaches in Canterbury used by kayakers and determine flow data for kayakers of different abilities (beginner, intermediate, advanced and expert) that provide for these values. The report aims to produce data in a form that is able to be understood and used by hydrologists, planners and the Canterbury Water Management Strategy zone and regional committees in drawing up the Zone Implementation Programmes, Regional Implementation Programme, and Land and Water Regional Plan.

The most valued reaches of white water kayaking rivers in the Canterbury region have been identified by an expert panel (the authors). They have drawn on their own personal experience and knowledge of the runs, or from that of respected and experienced kayakers that they know who have completed the runs. The expert panel has also determined or estimated flow requirements for kayakers on the valued reaches.

The expert panel technique has primarily been chosen so that data can be generated quickly and because a formal survey of a sample of the kayaking population would be unfeasible, and only generate limited data in some cases, because of the limited numbers of paddlers that have completed some of the runs.

To address concerns of possible bias or missing important issues, extensive consultation on the report during its preparation has been carried out using key Environment Canterbury personnel and experienced kayakers from the paddling community.

The results of the study are presented in the report along with some brief comments on man-made and natural hazards associated with kayaking on rivers. For more information on the report contact Doug Rankin at:

http://rivers.org.nz/contact. ≈

WHAT'S ON

≈ **2013 IPENZ Rivers Group Symposium** – If you haven't registered already it's not too late! Registration for your upcoming IPENZ Rivers Group Symposium in Rotorua is still open. Check out the details to the left and online here.

≈ Taking communication even further the Rivers Group is running a group on LinkedIn, which can be found here.

LinkedIn

≈ **Fish Passage Restoration Symposium** – A two day Fish Passage Restoration Symposium aimed at theory and practice is scheduled for late November in Wellington. Check out the detail below. For more information and registration details contact Anna Burrows at:

Anna.Burrows@gw.govt.nz

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GROUP
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