

Central Government Co-investment in River Management for Flood Protection

Critical Adaptation to Climate Change for a
More Resilient New Zealand

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Front cover photo: Anzac Parade, Whanganui, Whanganui River in flood, 2015

Contents

Executive summary.....	4
Purpose	6
Scope	6
The challenge shared by regional authorities and central government.....	7
A brief history of river management for flood protection	10
Current central government role	11
Assets protected.....	11
Asset value and budgeted expenditure	13
Flood risk management – shared investments and shared outcomes.....	13
Methods for moving forward	18
Request to central government.....	20
Conclusion.....	22
Appendix 1: Case Studies	23
Appendix 2: from Tonkin + Taylor report ‘Hiding in Plain Sight’ (April 2018).....	38
Appendix 3: Additional information to support comments made elsewhere in this paper	52
References	58

This report was first released as a draft in November 2018.

Executive summary

The purpose of this paper is to provide a case to support central government co-investing, alongside regional communities and directly benefiting property owners, in river management and flood protection schemes.

Improving flood protection is a critical, practical and achievable **first action** in adapting to climate change to achieve a more resilient New Zealand, for the benefit of every New Zealander.

Flooding is the most common natural hazard we all face in New Zealand. In most cases New Zealanders have been protected from the full force of flood events by river management and flood protection schemes. These provide safety and security to around 1.5 million hectares of our most productive and intensely used land and to over 100 towns and cities. They also protect the families and communities living alongside our rivers. In total, these schemes currently provide an estimated annual benefit of over \$11 billion each year. This is over five times their capital replacement value.

The total estimated capital replacement value of the 364-river management and flood protection schemes throughout New Zealand is \$2.3 billion. Communities annually spend close to \$200m maintaining these schemes.

Regional authority research indicates the current structures have generally been well maintained in their current configuration, and they have provided good value for money. However, the intensity and frequency of climate change-induced weather events are increasingly placing stress on the integrity and risk reduction capability of these schemes. This in turn significantly increases the risks faced by our communities and our economy. This is of major concern to regional authorities and is likely an equal concern for central government.

Present regional authority long-term provision for capital and operating expenditure primarily addresses risks in a traditional way, albeit with some variation across New Zealand. Change is required. There is a critical need to make more provision for climate change impacts and to plant more trees. There is also a need to better protect land and assets, now valued more highly than when schemes were initially constructed. In addition, ecological / environmental / whole catchment and iwi considerations need to be incorporated into flood scheme solutions, in a more sympathetic and systematic manner than in the past.

The outcome sought is 'fit-for-the-future', risk-aligned and environmentally sensitive scheme infrastructure providing appropriate levels of resilience and safety to the communities and assets they protect.

Regional authorities estimate the annual capital cost of meeting these refreshed multiple objectives, particularly the need to provide the necessary level of future resilience, would be at least \$150m beyond current \$200m levels of capital and operating expenditure. In total, the estimated need for future investment in flood risk mitigation therefore totals more than \$350m per annum for at least the next ten years.

In the past, (prior to the early 1990s), the capital cost of substantial river management and flood protection schemes was commonly supported at levels of 50% to 75% by central government with maintenance and operating costs at rates of around 33%. A review of documents from the time suggests this national support typically amounted to over \$114m per annum in today's dollars.

In the three decades since the central government stopped funding flood protection works, the Crown's assets have received flood protection at a cost to regional and targeted local ratepayers, with **no contribution** from the Crown¹. These protected assets include rail and road infrastructure, some airports, education facilities, Crown land and health facilities and more broadly, the efficient functioning of the economy and communities.

¹ The Crown does not pay rates on its assets.

Present funding arrangements are neither equitable nor sustainable for addressing present and emerging needs. The essential request to central government is for it to 'return to the table' and financially share in the task of providing necessary fit-for-the-future protection against New Zealand's primary natural hazard risk - flooding.

The national interest in doing this is clear. It is to protect public safety, provide community resilience, mitigate risks to the national economy, and protect nationally significant and publicly owned infrastructure in a manner that addresses the increased risk from climate change.

The challenges are real, substantial and present now. These challenges are also becoming more complex and difficult as time passes. A committed central government / regional authority co-investment response is required so that necessary changes can be implemented in an orderly, timely, community-focused and adaptive manner.

An added advantage of such a change in approach is it will reflect a necessary shift in central government focus from disaster relief and rehabilitation towards a focus at the 'top-of-the-cliff' mitigation of the risks faced by communities, regions and the nation.

The need is for river management and flood protection schemes to be re-purposed and upgraded, or renewed, to meet contemporary challenges, including adaptation to 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.

In the absence of central government co-investment in mitigating risks, scheme re-design and reconstruction will not be able to deliver expected nationally defined resilience-focused outcomes. This will inevitably mean more central government funds having to be directed towards 'ambulance at the bottom of the cliff' recovery and rehabilitation.

National annual funding, in the order of at least \$150 million, with a three-year ramp-up, is recommended. To achieve this level of co-investment, a long-term funding formula is proposed with:

- Co-investment of up to 75% assistance contributed by central government toward the cost of **new** works involving fully integrated catchment schemes, to recognise the importance of adopting a climate change adaptation approach, alongside achieving a wide range of other objectives – including planting more trees to better manage sediment run-off and improve water quality and possibly assistance with 'managed retreat'.
- Co-investment of up to 50% assistance contributed by central government toward the cost of the capital works required to **upgrade existing** river management and flood protection works to enable them to be better adapted to cope with climate change-induced storm events and to begin to achieve a wider range of other current and future objectives.
- Co-investment of 33% of assistance from central government toward the **maintenance** of existing scheme works in recognition of the role they play in protecting Crown assets / related infrastructure and to enhance the role they play in sustaining the operation of national and regional economies and communities.

The actual co-investment share at any single location will vary and should reflect a range of considerations, perhaps in a similar manner to the financial assistance rate (FAR) applied to central / local co-investment in transport solutions.

Details about the preferred design of a co-investment model should be prepared by a central and local government officials group, supported as needed by external advice and led by Treasury. This group should be invited to provide recommendations to 'Resilience Group' ministers and regional authority chairs within three months of the receipt of this paper, including making decisions about immediate investment priorities. Provision for central government co-investment in river management for future flood protection should be included in Budget 2020.

Central Government Co-investment in River Management for Flood Protection

Purpose

The purpose of this paper is to provide a case to support future central government co-investment, alongside regional authorities² and directly benefiting property owners, in river management and flood protection schemes.

The paper is supported by three appendices with case study examples, additional evidence, and further descriptive material, to support the logic for river management for flood protection co-investment by central government³.

Scope

This paper focuses on natural water flowing in rivers and streams, from the catchment watersheds to the sea. The paper does not include consideration of storm water systems and the networks of water related infrastructure - often referred to as 'the three waters'.⁴

Rivers generally flow in a natural pattern across our landscape, although sometimes their flows are boosted by drainage works and sometimes their flows are constrained and channelled via river management and flood protection schemes (Figure one). It is these drainage works and river management and flood protection schemes that are the core subject of this paper.



Figure one: Schematic of river management, flood protection, land drainage services (Source: Tonkin and Taylor, March 2018)

The paper does not include consideration of works to mitigate against coastal erosion or the effect of land inundation from waves breaking over a foredune and flooding the immediate coastal lowlands behind the sand-dunes. However, the paper does include consideration of the measures sometimes required in estuary areas, where river water is held up by a storm surge until it can naturally drain to the sea.

The central government co-investment proposal, at the heart of this paper, could possibly be influenced by consideration of future local government funding options or other Government policy reviews, but

² Regional authorities include the regional councils and the unitary district councils (the latter carrying out the functions of both a district council and a regional council). There are 16 regional authorities throughout New Zealand.

³ These appendices include critical parts of a paper prepared for regional authorities by Tonkin & Taylor Ltd titled 'Hiding in Plain Sight' (April 2018).

⁴ The 'three waters' project addresses water/wastewater and storm-water transported in reticulation systems such as sewers, pipes and street gutters. Management of flood waters is not and never will be part of the three waters project. River control and flood management provide significantly different contributions to national outcomes than the other services local government provides. It requires a whole catchment approach. It is also reliant on a mandate established in specific and discrete legislation, rather than the generic Local Government Act 2002, and it is delivered as a function, duty and responsibility of regional authorities rather than territorial local authorities.

there is a need for flood-risk mitigation matters to be progressed with priority and not be held up by the likely complexity of generic local government funding and related issues associated with territorial local authority functions. This includes issues such as managed retreat and insurance which, while related, are being dealt with in other forums.

The challenge shared by regional authorities and central government

As a group of small islands in the 'roaring forties' weather system, New Zealand regularly experiences high-intensity rainfall. On average, a major damage and loss causing flood occurs every eight months. Floods are New Zealand's most frequent and, cumulatively, most significant and most avoidable hazard.⁵

Flood hazards are most often avoided because of the efficacy of river management, drainage and flood protection schemes. Regional authority research indicates the current structures have generally been well maintained in their current configuration and have provided good value for money (Figure two). They have been managed in a prudent, professional and efficient manner. However, significant adjustments are now required to meet the challenges of today and the future.

Climate change adaptation

The intensity and frequency of climate change-induced weather events is substantially increasing the severity and frequency of the risk of flooding.⁶ This is causing higher levels of damage to the assets located behind existing structures and to adjacent communities, cities and towns, with associated social and environmental costs. We have seen regular recent reminders of this⁷. Climate change will also shift the geographical risk areas for floods and make new areas more susceptible to floods.

The severity of the consequences of not securing and enhancing the integrity and service levels of existing structures, and the community resilience role they play, increases every day.⁸ The increased frequency and severity of flood occurrence is influenced by several climate change-induced 'additive factors' including:

- More intense rainstorms generating higher river flows.
- Those flows causing more soil erosion.
- Higher sea levels and more significant storm surges, over-time, affecting the control conditions and significantly increasing flood heights for several kilometres up many river systems.⁹

⁵ Over the past 100 years, New Zealand has experienced over 1,000 serious floods making flooding, due to intense or prolonged rain, the most frequent natural hazard New Zealand faces (Ministry for the Environment, 2008).

⁶ Generally scheme designs, looking to allow for climate change out to 2100, would use an increase in peak flood flows of approximately 20%. This is based on the latest NIWA report prepared for MfE (HIRDs V4). That report states for every degree of temperature increase there is a corresponding 10.1% increase in rainfall (this is called the augmentation factor). Using the RCP6 climate change scenario out to 2100 (the mid-range CO2 emission scenario) this gives a 2.0-degree temperature increase or an equivalent increase in rainfall intensity of 20%. A 20% increase in rainfall will generally translate into a 20% increase in peak flood flows. These higher flows will also give rise to increased flood heights because of higher sea levels and greater sediment flows.

⁷ The first appendix to this paper provides relevant case studies.

⁸ Lawrence et al (2013) suggest that what is considered a 40-year return period event now, will be reduced to the equivalent of an 8-year return period event by 2090. The findings recorded by Lawrence are reinforced within publications from GNS Science.

⁹ This includes large areas of drained land on the Hauraki Plains of the Waikato region and land adjacent to Edgecumbe, which in some places is now below sea level. It also includes the protection of cities like Lower Hutt and Christchurch i.e. schemes protect far more than the intensive farming and horticultural activity often established on lowland areas. In fact, schemes provide protection to all types of economic and human endeavour at almost all New Zealand locations.

- In combination, the above elements leading to more deposition of rocks, stone, gravel and silt in mid to lower river reaches with resultant significantly increased flood heights.

Other requirements and opportunities

As a nation, we need to define an 'acceptable level' of 'climate change-induced' risk and then establish schemes to manage floods to achieve that level of risk. On top of this, flood management activities must now also be multi-purposed and consequently, implemented in a way that:

- Better achieves integrated land use.
- Enhances ecological values.
- Improves water quality outcomes.
- Better reflects iwi and community aspirations about the management of natural systems.

We need to invest to be more 'fit for the future.' This approach necessarily makes flood protection assets core 'economic enabling' infrastructure for a resilient New Zealand.



Extensive inundation of Edgecumbe following the failure of Rangitāiki River stop-banks in April 2017.

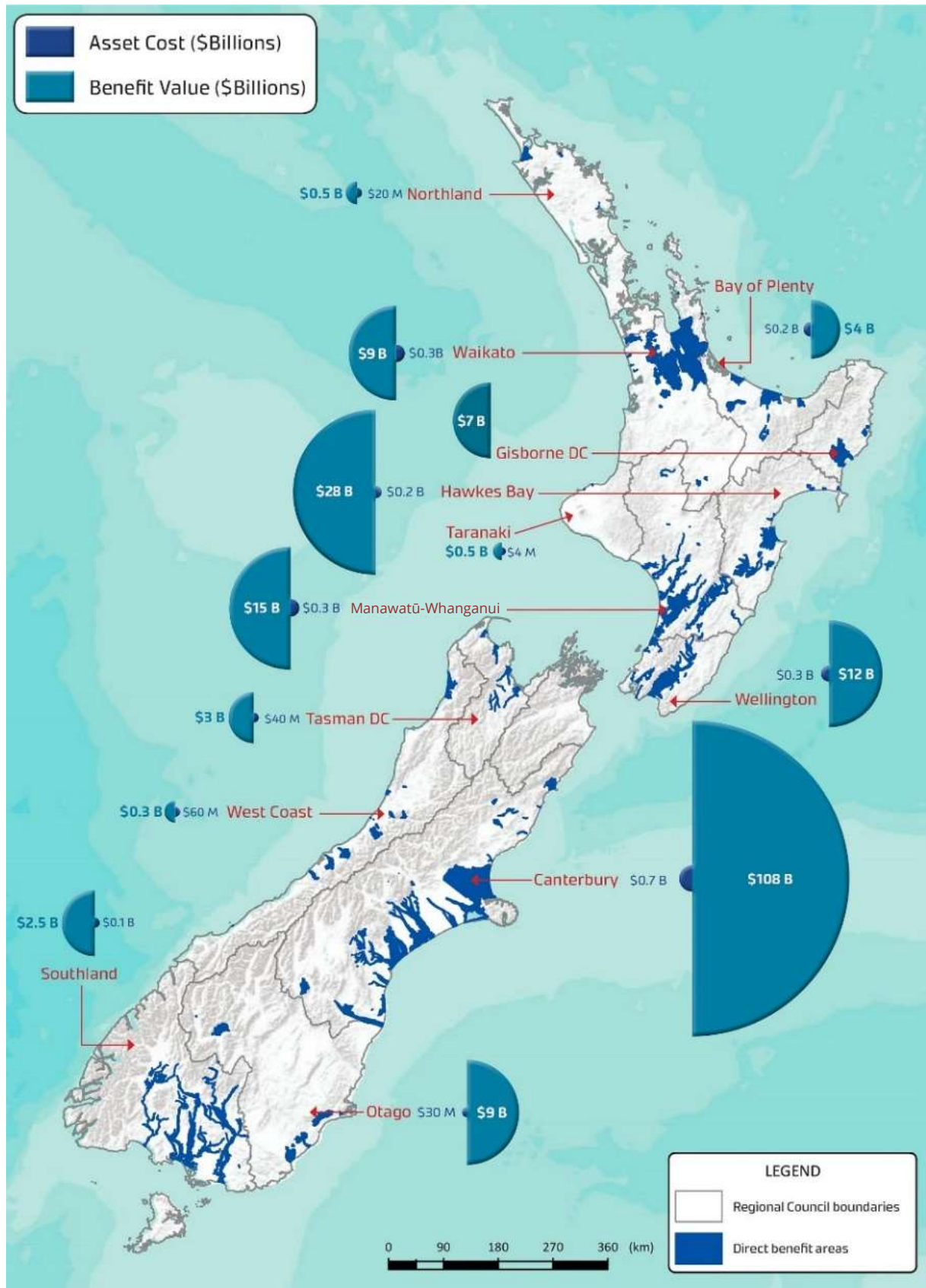


Figure two: Net Present Value of scheme benefits¹⁰ and operational costs by region (Source: Tonkin & Taylor, April 2018)

¹⁰ The net present benefit / value of all schemes is \$198b in 2016 dollars. (NB 'net present benefit' is the sum of benefits in all future years expressed in 2016 dollars).

Regional Authorities' River Managers Special Interest Group

Regional authorities have the capacity to get the job done if the money is available to meet necessary 'agreed risk profile' programmes. A planned, carefully prioritised and inter-regional response approach is proposed – noting that in some locations the solution may be more complex than in other locations.

As part of this planned approach, the regional authorities' River Managers' Special Interest Group has developed a comprehensive 'Five Year Sector Resilience, Sustainability and Improvement Plan' for flood protection, river management and drainage. As part of this Plan, a work programme has started that covers four key areas requiring renewed focus on:

- Working together across the sector, including seeking co-investment with central government.
- Applying consistent practices, methodologies and standards.
- Recruiting quality people.
- Communicating and creating an enabling environment.

The challenge

The essential challenge is this: the cost of construction and maintenance of schemes to meet future 'acceptable levels of risk' is beyond the reasonable capacity of ratepayers and directly affected property owners alone, to provide. Exacerbating this situation is a concern these parties are increasingly bearing a disproportionate share of scheme costs when compared to those, such as the Crown, who benefit from such schemes. In addition, regional communities face significant constraints on their ability-to-pay to achieve the multi-objective demands now required to be served by their 'river management for flood protection' schemes. Central government needs to come to the party.

A brief history of river management for flood protection

New Zealand previously led the world with its recognition in 1941 that land and water management for flood protection needed to be catchment based. The purpose of the Soil Conservation and Rivers Control Act 1941 is ... *'to make provision for the conservation of soil resources and the prevention of damage by erosion, and to make better provision with respect to the protection of property from damage by floods'*. This statute led to joint investment by central government, regional communities and directly benefiting property owners, in river management, drainage and flood protection schemes.

Most river management, drainage and flood management schemes were constructed up to half a century ago. The value of the assets protected by these schemes has incrementally increased and is now very large. The type of land use activity carried out on this protected land is more intense than that initially envisaged at scheme design and construction and the scale of adjacent urban development has also intensified. A fresh perspective on the important role played by schemes is now required.

Prior to the early-1990s, the capital cost of river management and flood protection schemes was commonly supported by central government at rates of 50 to 75%¹¹. Maintenance, to ensure the integrity of the performance of these schemes typically received 33% support from central government. Collectively, this level of support amounted to around \$40m per annum from central government. That is equivalent to over \$114m per annum in today's dollars.

Since the early to mid-1990s, river management and flood protection schemes' funding has relied almost entirely on regional and directly benefiting property owners via targeted rates. By comparison, internationally, including in Europe and the UK¹², most developed countries currently have significant

¹¹ We note the Waihou Catchment control scheme – a very large whole catchment scheme (and the largest addressed in a holistic manner in the country), received a 87.5% government grant.

¹² In the United Kingdom the current Environment Agency programme, which runs from 2015-16 to 2020-21, includes 1,136 flood and coastal erosion projects at a projected total cost of just over £6bn.

levels of central funding for flood protection activities, in recognition of the national benefits they provide¹³.

We acknowledge that managed retreat must be given more active consideration now than in the past. Regional authorities will need to work closely with central government and district / city councils on this challenge but, no matter what is achieved through retreat, improvements to existing river management schemes are urgently required now to better manage existing risks.

In comparison to the challenge of managing the effects of gradual sea level changes (but please recognise we are not wanting to diminish the need for sea-level-rise response action in any way), extreme flood events are happening now, there are well developed response capabilities already in place and there is a very clear understanding of the practical actions that can be taken, with real adaptation effect. The need for this capability was clearly demonstrated by the April 2017 storm event that was off the charts in terms of its return period frequency, causing catastrophic failure of stop bank protection on the Rangitāiki River at Edgecumbe.

Current central government role

Central government's current role is more as the ambulance at the bottom of the cliff than as a health / wealth assister and advisor at the top of the cliff. Government's role is currently focused on disaster response, relief and rehabilitation. Funding arrangements are generally applied after the event. Anticipatory central government funding to reduce risk and prevent future losses is minimal.¹⁴

More particularly, central government currently has two roles. Firstly, it has an enabling role - to ensure regional authorities have the power to manage hazards, including flooding. Key legislation includes the Local Government Act 2002, Resource Management Act 1991, Soil Conservation and Rivers Control Act 1941, Land Drainage Act 1908 and the Civil Defence and Emergency Management Act 2002.

Secondly, when an event occurs of a size beyond local government's ability to cope, central government assists with response measures and provides financial assistance to speed up recovery. This assistance is per the National Civil Defence Emergency Management Plan 2006. If a major flood damages critical flood defence infrastructure, then central government will also meet up to 60 percent of the asset's repair cost, once damages reach a certain threshold, although we understand this level of assistance is now under review.¹⁵

Assets protected

River management and flood protection schemes provide outstanding value to the New Zealand economy¹⁶. Over 100 towns and cities across the country have families and communities living alongside rivers or on flood plains that are protected. In total, river and flood protection structures protect around 1.5 million hectares of land or 5% of New Zealand's land area.

This land is where a very high proportion of our economic enterprise takes place. It includes areas of highly productive primary sector enterprise of significant value to the New Zealand economy.

¹³ We acknowledge that the central / provincial government responsibilities in Europe are different from those applied in New Zealand. The principle emphasised here is that European countries tend to give higher recognition to the national benefits of river management for flood protection than in New Zealand.

¹⁴ For example, central government may provide funding for research through the science system to provide some limited guidance to the role played by regional authorities, but little else. In rare circumstances such as for the Waiho River at Franz Josef, NZTA has entered into arrangements with regional authorities to contribute towards the cost of river management works to protect state highways.

¹⁵ Government may also provide aid to parties affected by flood events, within the terms and conditions defined in the 'On-Farm Adverse Event Recovery Policy' administered by the Ministry for Primary Industries.

¹⁶ See the information included as part of the extract from Tonkin & Taylor in the appendix. See also Figure one included earlier in the current paper.

Schemes are designed and constructed to achieve defined performance levels, based on expected land use. Where a flood event exceeds the design capacity, there will be resultant flooding and damage. The 2004 Manawatū floods provide an illustration of the extent of the types of costs incurred because of this damage. Insured losses from that event were \$112 million. However, the cost to the agricultural sector alone in uninsured losses (lost production and uninsurable rehabilitation costs) were calculated at \$185 million.¹⁷

The Tonkin & Taylor report '*Hiding in Plain Sight*' (March 2018)¹⁸ suggested the schemes provide an estimated Net Present Benefit of over \$11 billion each year. This benefit value has increased markedly since the schemes were constructed, because of the advent of a full range of more intensive land uses and associated property values.

It is somewhat ironic that while flood protection schemes have been extremely good investments, the analysis also implies that under-investment has probably occurred since their construction. With the value of protected property ramping up in recent decades, there should generally have been a commensurate ramping up of protection service levels, to achieve significantly higher levels than original design. This has only occurred variably.

Adding complexity are the effect of climate change impacts on protection levels. These climate change impacts are effectively reducing protection service levels at many locations, particularly where scheme improvements have not been progressed.¹⁹ More people are now being exposed to risks to their safety than ever before.

Protection of Crown assets

One of the effects of central government being narrowed to the roles described earlier is that, for three decades, Crown owners and other infrastructure asset owners, have received asset protection at a cost to regional and targeted local ratepayers. These protected assets include rail and road infrastructure, lifeline infrastructure such as power lines and water supply and sewage networks, some airports,²⁰ communication services, schools, hospitals, universities and public conservation land.

Estimates by Ericksen (1986) cited by the NZIER (2004) show that for floods in Nelson and New Plymouth in 1970 and 1971, losses associated with central government works and services (roading, railways, bulk power supply, flood control and drainage works) amounted to 49 per cent of the total value of all direct losses. An example is provided by the Leith Flood Protection Scheme in Dunedin. This Scheme plays a significant role in protecting the CBD from flooding. This includes the protection of education facilities (University of Otago and Otago Polytech) and the sites for the new Dunedin hospital, public reserves, residential and commercial areas. The capital value of Crown properties and non-relatable University land and assets, in the area protected by the Scheme, is 35 per cent of the total assets in the area. The

¹⁷ The cost of emergency services and infrastructure repairs during the 2004 Manawatū floods was put at a further \$90 million. The flood was modelled as having a 150-year return period.

¹⁸ The reason underpinning the use of this '*Hiding in Plain Sight*' title is relevant to the issue being addressed in this paper. The protection provided by engineered infrastructure, located at the heart of river management and flood protection schemes, is not usually visually intrusive and is not often apparent as they 'do their job,' perhaps only once or less a year. Consequently, the protection provided by such schemes is very much taken for granted by New Zealanders, despite the increasing risks currently faced.

¹⁹ Schemes are facing a 'pincer' challenge, where simply maintaining current assets is seeing the benefit of these maintenance gains eroded by the effect of climate change-induced flood events. Ideally, service levels should be substantially increasing to protect the more valuable public and private assets located behind this protection infrastructure and to better cope with climate change induced higher magnitude / frequency events.

²⁰ Airports such as those at Christchurch are located on flood plains. Many New Zealand airports are 50% owned by the Crown.

benefit received from flood protection is equivalent to the level of economic impact avoided. Six months after the 2006 Leith flooding event, the total economic impact on Dunedin was \$154m.²¹

Asset value and budgeted expenditure

The total replacement value of the 364 river management and flood protection schemes throughout New Zealand is estimated at \$2.3 billion.²²

Regional authority Long Term Plans for 2018 to 2028 show budgets for operating expenditure of at least \$1 billion and, in addition, capital expenditure of a further \$1 billion for this ten-year period is allowed for. This excludes depreciation.

These budgets are, to varying degrees, based on a continuance of the same design paradigms as were applied when the schemes were initially constructed. They do not reflect the quantum and systemic change needed to recognise emergent contemporary challenges, particularly the incremental impacts of climate change.

Regional authorities are concerned they are on the cusp of a significant 'infrastructure deficit' problem that will just get worse unless acted upon. There is a massive renewal programme ahead of them, not simply a maintenance programme, nor simply a matter of replacing existing infrastructure with 'like for like'.

The schemes operate in a living environment. They are subject to wear-and-tear and now must endure increased loading from the changing nature of weather events and the increasing value of the assets they protect and the public safety benefits they provide.

The upshot is that additional investment is urgently needed to enable the schemes to be fit-for-purpose for the next generation. There is not enough 'ability-to-pay' in the regions to meet the cost of the changes now needed to provide appropriate flood risk mitigation, in a manner that is equitable and achieves broader national outcomes.

Flood risk management – shared investments and shared outcomes

Regional authorities have hard choices to make. Existing schemes and new areas of land need significant investment to sustain even their current levels of river management for flood protection service, let alone to meet future challenges. Any capital investment should be equitably shared. Funding to do this should come from all of those who directly or indirectly benefit.

To avoid a worst-case flood disruption scenario, scaled-up central government and regional authority investment in risk reduction measures will be required.

The priority objective is to create resilient communities and places where future generations can safely live and undertake economic enterprise. Companion objectives include:

- Support for well-functioning ecosystems.
- Improved water quality.

²¹ Source: 'Benefits of the Leith Lindsay Flood Protection Scheme to Crown Properties', prepared for Otago Regional Council by Market Economics, April 2011

²² Source: Tonkin & Taylor report 'Hiding in Plain Sight' (April 2018).

- Satisfaction of the expectation of our communities and iwi partners that our rivers will be managed as national treasures.

Higher levels of resilience against the risks of extreme floods will also contribute to the full suite of government objectives, including investment certainty and social cohesion. These benefits will be expressed in all regions, not just the 'richer' regions.

The cost of flood hazard events may be counted not just in terms of the cost of replacing buildings, other property losses and the real risk to life and social disruption. There are also other tangible costs such as the number of hours or days businesses cannot operate at full production. In addition, flood costs have both an immediate and sometimes an on-going effect on people's lives. This includes the effect on their willingness to want to continue to live and invest in areas subject to hazards.

Unfunded liability

The government's 2015 'Thirty Year Infrastructure Plan' noted average annual costs of responding to flood events now exceed \$50 million. While necessary, this may be viewed as sub-optimal expenditure in that it occurs after the storm event. As such, it does not minimise future risk to the community or central government. This 'after event' focus also means government bears an excessive unfunded future liability in its fiscal accounts.

The severity of the consequences of not securing and enhancing the integrity and service levels of existing structures, and the community resilience role they play, increases every day. The fiscal consequences for government of not proactively investing at the top of the cliff are growing at a similar rate. It is only a matter of time before lives are lost.

Consistency with election priorities

The current emphasis on remedy after the flood event, and therefore an implicit acceptance of often irreversible asset destruction, is contrary to clearly stated coalition government election promises. These include those related to:

- Lifting the productivity potential of the regions.
- Job creation.
- Social inclusion.
- Healthy and cohesive societies.
- Improvements to the well-being of all New Zealanders.
- Improvements to the environment we live in.

There is also an alignment between investment in river management for flood protection responsibilities and government's water quality, carbon sequestration and the 'whole-of-catchment' climate change adaptation programmes and policies, including the commitment to plant one billion trees.

Provincial Growth Fund

Establishment of the Tuawhenua Provincial Growth Fund (PGF) was an early commitment by the government to assist with regional development. The Cabinet Paper on this Fund notes:

- Nearly half of New Zealand's population lives outside the main urban centres.
- Areas outside the main urban centres generate around 40 per cent of the country's economic output.
- If the provinces are not doing well, New Zealand's overall economic performance will be affected.

- Diversification of the economy will make it more environmentally sustainable.

With the above points in mind, the government committed to invest \$1 billion dollars per year, for three years, to support regional economic development. This was viewed as an essential component of its economic strategy for the benefit of all New Zealanders.

The value of new investment in other regional infrastructure, including that such as rail, made with the assistance of the PGF²³, will be at risk if there isn't commensurate investment in infrastructure protection. Managing flood hazards is a critical element of this protection.

Treasury's Living Standards Framework

Treasury's Living Standards Framework and Budget 2019 has moved towards a 'four capitals' approach inclusive of:

- Natural capital, with reference to all parts of the environment needed to support life and human activity.
- Financial / physical capital, with a direct role in supporting incomes and material living conditions.
- Human capital, with reference to the things which enable people to participate fully in work, study, recreation and society.
- Social capital, with reference to the norms and values that underpin society.

All elements of the new Living Standards Framework imply the need for active central government investment in the management of flood risks.

Resource Management Act 1991 and Treaty Settlements

The Resource Management Act (RMA) was amended in 2017 to provide for the inclusion of natural hazards, as a matter of national importance. The Cabinet Paper to support this change indicates the provisions will help *'ensure that development does not occur in areas where the community deems risks from natural hazards to be too high, unless the management of those risks has been adequately addressed'*. This implies recognition of a need for central government to more actively consider the role it plays in the management of flood risks.

The RMA also places costly obligations on scheme owners and managers to meet environmental and cultural obligations. In addition, numerous Treaty settlements impose obligations that have the effect of adding new complexity and costs to the task of designing and managing river management and flood protection schemes.

Australian Productivity Commission

The Australian Productivity Commission suggests, by implication, that the principles underpinning the current New Zealand approach deserve re-examination. Its recommendation to the Australian government is that the government adopt a formula for allocating mitigation funding to achieve *'greatest net benefits, after considering the future risks of natural disasters'*. With this point in mind, the Commission called for the Australian government to increase annual mitigation funding contributions to state and territory governments by \$100 million in the first year, then to \$150 million in the second year and \$200 million in the third year.²⁴ New Zealand should take a lead from this precedent setting Australian recommendation.

²³ This includes the significant investment made into KiwiRail assets as part of Budget 2019.

²⁴ This recommended 'federal' commitment is on top of commitments already made at the state and local levels.

The Sendai Protocol

The Sendai Risk Management Protocols of the United Nations (2015), to which New Zealand is a signatory, recognise the importance of investing in risk mitigation activities. The National Resilience Strategy being developed by the Ministry of Civil Defence and Emergency Management aligns with the Sendai Protocols.

The Sendai Protocols reflect four priorities:

- Priority 1: Understanding disaster risk.
- Priority 2: Strengthening disaster risk governance to manage disaster risk.
- Priority 3: Investing in disaster risk reduction for resilience.
- Priority 4: Enhancing disaster preparedness for effective response and a commitment to “Build Back Better” as part of recovery, rehabilitation and reconstruction.

These priorities clearly imply a need for central government to play an active role in risk mitigation.

Climate Change Bill

The Climate Change Response (Zero Carbon) Amendment Bill (2019), was introduced on 8 May 2019. This amends the Climate Change Response Act (2002). The amended purpose of the proposed Act is to provide a framework through which New Zealand can develop and implement clear and stable climate change policies. The Bill is expected to come into effect in November or December 2019.

One of the purposes of the Bill is to require the government to have a plan for how it adapts to the effects of climate change. A Climate Change Commission will be established to assist with this task. Among other things, this Commission will conduct a national climate change risk assessment every six years and, in response to each assessment, the responsible Minister will produce a national adaptation plan²⁵. River management for flood protection will inevitably be an important part of that plan.

Productivity Commission – draft report on local government funding and financing

The Productivity Commission released its draft report from an enquiry into local government funding and financing, in July 2019. River management was selected by the Productivity Commission as an example of a function deserving of attention as a model for a stepped-up co-investment-focused arrangement between central and local government.

The terms of reference for the enquiry, as issued by the Ministers of Finance and Local government, noted that:

- Local authority debt has grown steadily since 2006 to the point where some councils are now coming close to their covenanted debt limits.
- One of the major factors influencing local authority debt is the cost of adapting communities and infrastructure to mitigate risks and hazards associated with climate change.

²⁵ The well-respected editors from the weekly newsletter Trans-Tasman described (9 May 2019) the Bill as creating 'a legal obligation on the government to plan for how it will support New Zealand towns and cities, business, farmers and iwi to adapt to increasingly severe storms, floods, fires and droughts we are experiencing as a result of climate change.' Such planning could rightly be expected to include co-investing in river management schemes to help protect against the effects of flooding.

The Commission favours the “benefit principle” as the primary basis for deciding who should pay for local government services. In this regard, the Commission further notes that *‘some local assets and their associated services could benefit... national interests. In these cases, the benefit principle points to shared funding with a contribution from central government’*²⁶.

In addition, the Commission identified four key areas where the existing funding model is insufficient to address cost pressures, and new tools are required:

- Supplying enough infrastructure to support rapid urban growth.
- Adapting to climate change.
- Coping with the growth of tourism.
- The accumulation of responsibilities placed on local government by central government.

All four of these identified areas support the need for co-investment by central government in river management schemes. In addition, the Commission suggest the Government should extend the role of the New Zealand Transport Agency (NZTA) in co-funding local roads, to include assistance to councils facing significant threats to the viability of local roads and bridges from climate change.

Summary – reasons for central government co-investment

In summary, the reasons for a return to active central government co-investment in flood risk mitigation are that it:

1. Is more fiscally responsible and fairer than focussing on post-event response and recovery.
2. Reflects Treasury’s new performance measurement and Living Standards Frameworks.
3. Is supportive of wellbeing and social inclusion and reflects equity / ability to pay considerations.
4. Is supportive of job creation and lifting the productive potential of the regions.
5. Contributes to the security of access routes (rail and road) for commerce.
6. Directly protects Crown assets.
7. Contributes to investment ‘opportunity costs.’
8. Contributes toward satisfying its moral and legal responsibility to support New Zealanders as they attempt to adapt to climate change-induced extreme weather events.
9. Works against the risk of escalating insurance premiums or the risk of insurance companies refusing to provide insurance cover in flood risk areas.
10. Contributes to the environmental and water quality expectations of our communities and iwi partners.
11. Provides for resilience and adaptation against the effects of climate change-induced ‘above-design’ storm events.
12. Above all else, provides resilience and increased levels of safety to existing and future individuals and communities.

²⁶ Page 4: Productivity Commission, Draft report, Local Government Funding and Financing, July 2019.



Waimarama Bridge North, Hawkes Bay Floods 2011

Methods for moving forward

The options for the future range from a 'business as usual' approach, to managing the retreat of some land uses and communities from certain areas, to those solutions involving the construction of enhanced infrastructure in association with whole-of-catchment solutions.

For all situations, options need consideration within the context of present-day flood risk realities. We are facing circumstances of 'real and present danger.' And as is the case with many complex issues, it is important that a full range of risk reduction methods are applied in tandem.

Business as usual (not recommended)

Maintaining existing scheme service levels²⁷ is not tenable, nor practical, because the influence of climate change is such that current levels of resilience will continue to be eroded. This, in turn, will result in:

- Increased risk to public and private local, regional and national assets.
- Increased demands on emergency and recovery funding.
- Increased insurance premiums.
- Increased risks to public safety and a risk to life.
- Increased numbers of communities unable to get insurance.
- Increased community and personal hardship and distress.
- Increasingly negative impacts on local, regional and national economies and the environment / ecological and iwi values.

²⁷ A 'Service Level' is calculated using one of three methods: a scope of physical works agreed with the affected community; or a scope of physical works with a target capacity e.g. a maximum channel flow and; or a scope of physical works with a level of performance defined in terms of a target return period e.g. a one in one-hundred-year event.

Community / planned withdrawal (may be possible at some locations)

This option proposes to reduce risk by reducing activity in flood risk prone areas. But asking residents and businesses to withdraw from locations at risk of being flooded, particularly when this relocation involves urban communities, is extremely difficult. The sunk costs of existing investments are very large and the impact on landowners of allowing rivers to flow more freely will extend both upstream and downstream of the 'run free' location.

The social and political disruption associated with this option is likely to make it unpalatable in many cases. Nevertheless, there will be some locations within catchment schemes where this solution must be considered an acceptable part of a more holistic approach.

Whole of catchment (favoured)

The desires of iwi and broader regional and national communities are that regional authorities apply river management in a more environmentally benign / ecologically sensitive manner than in the past.

Integrated and sustainable land management or 'whole-of-catchment' approaches have always been a core part of regional authority business. More substantial investment in whole-of-catchment solutions will be required in the future. This option can reduce the level of sedimentation and erosion occurring within our catchments. It will also improve the water quality in our rivers, estuaries and coastal waters and contribute to biodiversity values.

To successfully adopt and achieve a 'whole-of-catchment' approach requires extensive 'outreach work' beyond that needed for a regional authority to design, gain agreement and construct improved flood control schemes. For example, among other things, it requires one-on-one work with landowners to alter land use practices and internal property infrastructure and change enterprises to achieve more benign long-term water and soil and environmental outcomes.

Part of this work will involve planting trees. The one billion trees programme will be an important contributor to these 'whole-of-catchment' solutions approach because, alongside other current initiatives, it will:

- Accelerate application of sustainable land use practices.
- Promote the conversion of some areas from pastoral uses into indigenous forest.
- Promote more extensive riparian planting.
- Accelerate careful consideration of the use of some areas for Mānuka planting and honey production.
- Promote expanded plantation forestry in suitable locations.
- Help to forestall the risk of transferring this generation's 'challenges' into compounded problems for the next generation.

Enhanced infrastructure in association with whole-of-catchment solutions (preferred)

Sustainable land use is an essential ingredient of flood risk management. Investment in sustainable land use also needs to be increased but, no matter how successful, it cannot and will not on its own, provide the necessary level of protection to productive land and communities at levels desired by communities.

This is because 'more sustainable land uses' will have only a minor effect on the increasing amount of rainfall from the inevitable and more intense, climate change-induced storms that will then need to be transported by our rivers and streams. Enhanced river management for flood protection infrastructure must be built into the solution, together with the occasional use of 'planned withdrawal'.

Request to central government

Regional authorities seek a central government commitment to co-invest, with regional authorities and other directly benefiting property owners, in improving the integrity and resilience of flood risk mitigation infrastructure. This should be alongside the wide-spread and comprehensive adoption of whole-of-catchment solutions.²⁸

Collectively, such an approach will better achieve integrated land use, enhanced ecological values, improved water quantity and quality outcomes and generally a better reflection of iwi and wider community aspirations about how natural systems should be managed.

Regional communities and directly benefiting private property owners cannot fund the necessary step-change needed to manage increased flood risks, in the more sophisticated manner set out above, on their own. Central government and regional authorities must therefore share the task of addressing this challenge. This is not about attributing blame for the failure of the efficacy of current systems. All New Zealanders are facing the challenges of climate change. A new co-investment and funding partnership approach with central government is sought²⁹ as the preferred path forward.

Regional authority river engineers have engaged in an active 'foresight' process to estimate spending of \$374m / year is required to ensure river management and flood protection schemes are 'fit for the future'. Regional authority Long-Term Plans (2018-2028) currently indicate operational and capital expenditure of approximately \$200m / year. The shortfall required to make the necessary step-change to add resilience to the schemes, and to enable them to meet other contemporary objectives, is estimated at \$174m / year.

Central government co-investment of \$150m per annum, with an incremental ramp-up to this level over the first three years, and expenditure at this level for ten years, is viewed as a pragmatic contribution to this necessary expenditure.³⁰ The balance of the shortfall in funding, currently estimated at \$24m per annum to meet the desired 'future-proof' status of these schemes, may be contributed through increased regional rates and increased rates on directly affected private properties.

The actual co-investment share at any single location would reflect a range of considerations, perhaps in a similar manner to the financial assistance rate (FAR) applied by NZTA to central / local co-investment in transport solutions.

It was initially proposed that the Provincial Growth Fund (PGF) provide a short-term central government funding solution to support four critically necessary scheme upgrade proposals³¹. Since preparing the draft of this report (November 2018), government informed regional authorities they did not see co-investment in river management schemes from the PGF being an appropriate use of those funds. Within an overall national policy context, their preference was for it to be addressed as part of the 'resilience' work currently being progressed for consideration later this year by a group of 'Resilience Ministers.'

²⁸ The co-investment propositions outlined in this paper do not include provision for soil conservation planting and or steep land retirement. These provisions are currently being separately considered by MPI. Budgets for these complimentary activities could be sensibly combined with the proposed programme outlined in this paper under the later described 'new works involving fully-integrated catchment schemes category.

²⁹ Regional authorities acknowledge that, alongside a government decision to co-invest in river management and flood protection schemes, there is a need to establish related funding-accountability measures.

³⁰ These estimates were derived by asking the river managers from the seven major river managing regional authorities to make their own estimates, based on their knowledge of council policy and their various schemes, of the likely future cost to make them 'fit for the future'. These estimates were then moderated and applied across all 16 regional authorities. Based on this moderation work, an average increase of 85% of the current spend of \$200m is required, bringing the total future expenditure need to \$374m per annum for the next ten years.

³¹ These applications were for the: Lower Whanganui River in the Horizons / Manawatū-Whanganui Region; Awanui River, Kaitiāia in the Northland Region; Rangitāiki River, Edgecumbe in the Bay of Plenty Region and the; Waipaoa River, Poverty Bay in the Gisborne region.

This being the case, a long-term embedded and budget-based solution is the essential means for providing for a planned and systematic programme for the provision of 'fit for purpose' flood protection infrastructure. This may include consideration of the redirection of existing 'response' funding toward mitigation investments.

Possible funding formula / levels of co-investment

A long-term funding formula is proposed with:

- Co-investment of up to 75% assistance contributed by central government toward the cost of **new works involving fully-integrated-catchment schemes**, to recognise the importance of adopting a climate change adaptation approach, alongside achieving a wide range of other objectives.
- Co-investment of up to 50% assistance contributed by central government toward the cost of the **capital works required to upgrade existing** river management and flood protection schemes to enable them to cope with climate change-induced storm events and to begin to achieve a wider range of other current and future objectives.
- Co-investment of up to 33% of assistance from central government toward the **maintenance of existing scheme works**³² in recognition of the role they play in protecting Crown assets / related infrastructure and their role in sustaining the operation of national and regional economies and communities.

Although variable, indications are that for any year, approximately half of the total annual spend would comprise works in the maintenance category, with the balance being split approximately evenly between the first two categories of expenditure.

Details about the preferred design of a co-investment model could be provided with the assistance of a central and local government officials group, supported as needed by external advice and led by Treasury. This group could be requested to provide its recommendations to the recently established Resilience Group of Ministers and regional authority Chairs and Mayors within three months.

The matters for consideration by the proposed joint officials group could include the:

- Total quantum of capital and operational or maintenance investment required over the next ten years to meet desired levels of flood 'risk protection'.
- Quantum of a co-investment contribution from Central government over the next ten years.
- Design parameters for a graduated grant regime.
- Need for new regulatory tools and allied mechanisms to assist achievement of 'planned withdrawal / adjusted land uses' for some locations.
- Projects requiring immediate and priority investment.³³

³² Consideration should also be given to co-investment in the restoration of damage to flood schemes caused by a significant flood event, alongside and distinct from co-investment in normal maintenance.

³³ Applications have already been lodged for assistance from the Provincial Growth Fund for river management and flood protection projects in Gisborne, the West Coast and Northland. These deserve priority, but they also require consideration within a coherent framework.

Conclusion

There is a strong case for central government reconsideration of the role it needs to play in flood risk mitigation, alongside regional authorities. The essential request to central government is for it to 'return to the table' to share financially in the task of providing fit-for-purpose protection against New Zealand's primary natural hazard – 'flooding'.

The Crown owns assets protected by schemes and enjoys the benefits these schemes provide. The Crown currently makes no funding contribution to the maintenance and improvement of these schemes.

This is at a time when schemes also need to be re-purposed, modified and upgraded, or renewed to meet contemporary challenges including adapting to climate change pressures and meeting a wider spectrum of community environmental, cultural and economic needs. The schemes must be to a standard allowing New Zealanders to go about their business and make investment decisions without the fear and disruption caused by floods.

The proposed central government co-investment of \$150m per annum appropriately reflects the national interest in protecting public safety, providing community resilience, mitigating risks to the national economy and protecting nationally significant, publicly owned infrastructure.

Flood risks are real, and they are trending upwards, as are the effects on the communities who live and work on New Zealand's flood plains. A committed central government / regional authority response is required now so that necessary, practical and system-ready changes can be implemented in an orderly, timely, community-focused and adaptive manner.

To achieve the necessary shared and sought-after objectives, regional authorities urge central government to work with them to reach agreement about location-specific and short and long-term combined investments to address increasing flood risks.

A joint central government / regional authority officials group should be established to work through the design details for implementing the proposed co-investment programme, and to make decisions about immediate investment priorities. They should be given three months to report back.



West Coast flooding March 2016 – image credit stuff.co.nz

Appendix 1: Case Studies

Introduction

Ten case studies have been selected from throughout New Zealand to describe the relevance, value and future challenges faced by managers of current river management and flood protection schemes. These case studies are:

1. **Lower Waikato and Waihou-Piako** schemes (Waikato Regional Council).
2. **Franz Josef** (West Coast Regional Council).
3. **Kaitiāia** Flood Resilience Scheme (Northland Regional Council).
4. **Hutt River** Scheme (Greater Wellington Regional Council).
5. **Ruamahanga River** (Greater Wellington Regional Council).
6. **Matarawa, Porewa and Tutaenui** Flood Control Schemes (Horizons Regional Council).
7. **Rangitāiki** River Scheme (Bay of Plenty Regional Council).
8. **Waipaoa** Flood Control Scheme Upgrade (Gisborne District Council).
9. **Leith** Flood Protection Scheme (Otago Regional Council).
10. **Canterbury** Scheme reviews (Environmental Canterbury).

Each of the case study river management and flood protection schemes described below contribute, in varying degrees, to all eleven of the national objectives listed in the primary part of this paper. Comment is made, in each of the case studies, about the most important 'national contribution' aspects of each of the schemes.

Lower Waikato and Waihou-Piako schemes (Waikato Regional Council)

Waikato Regional Council's flood protection schemes have been developed over the last 80 years. They primarily consist of stop-banks, pump-stations and floodgates, across eight management zones. They have a replacement value of \$580m. The schemes are supplemented by a range of privately owned land drainage assets.

Additional to the Lower Waikato and Waihou-Piako schemes, Waikato Regional Council also maintains several flood protection assets in the Coromandel and Taupo Districts.

The following challenges have been identified as affecting the schemes managed by Waikato Regional Council:

- Ageing of assets and impact on levels of service.
- Increasing environmental and regulatory performance expectations.
- Ability to cope with extreme climate change-induced flood events.
- Risk of natural disasters.
- Economic conditions and affordability.
- Protection of opportunities for growth and development.
- Business continuity.



Overtopping of the stop-banks and inundation of Hauraki Plains by the Piako River flood in April 2017 (NB This 100-year flood event far exceeded the 50-year flood-event design capacity of the existing scheme).

The current 'generally applied' analytical model applied to funding schemes does not accurately reflect the full incidence of costs and benefits. By contrast, a benefit-cost analysis (BCA) case study of the Lower Waikato and Waihou-Piako schemes includes ecosystem services, to reflect the importance of valuing natural capital alongside human capital, social capital and financial/physical capital. The Treasury 2018 Investment Statement – 'Investing for Well Being *He Puna Hao Patiki*' has therefore selected the Waihou-Piako approach as one of its case studies to demonstrate the merit of this approach.



State Highways are increasingly under pressure during flood events, as occurred on State Highway 25 near Thames on 8 March 2018

The drainage of wetlands and the subsidence of peat soils are examples of the environmental costs arising from these schemes. Plantings and the stability-control measures applied within scheme design represent the environmental benefits. These include reductions in sedimentation and thereby, improvements in water quality outcomes.

Council's preferred approach to scheme management is generally based around continuance of present asset management practice and policy, while looking for opportunities for targeted improvements.

Waikato Regional Council's forecast expenditure in relation to the management of flood protection and land drainage assets over the next 50 years is \$1,983.7m as follows:

- Capital expenditure: \$637.2m
 - \$629 million on renewals
 - \$8.2 million on new capital
- Operational expenditure: \$1,346.5m



A major issue is that the deep marine mud soils have limited load carrying capacity, leading to stop-bank stability issues as shown above near Ngatea. More expensive sheet piles provide a solution

The primary reasons for active central government co-investment in the Waikato schemes are:

- Supportive of job creation and lifting the productive potential of the regions (the area is prime quality dairying land).
- Contributes to the environmental and water quality expectations of our communities and iwi partners (fish passes etc. are required).
- Equitable contribution to recognise the scheme's protection of Crown assets.

Franz Josef (West Coast Regional and Westland District Council)

Franz Josef is vitally important for tourism. It faces increasing major flood risks³⁴.

There are only 510 residents in the wider Franz Josef area but over 500,000 visitors stay at Franz Josef each year and use the town's hotels, restaurants, council infrastructure, and visitor activities. Estimated expenditure in 2016 was \$122m. The night-to-resident ratio is 2.9 visitor nights, per day, per resident.

Tonkin + Taylor and EY were commissioned to undertake a Natural Hazards Option Assessment and Cost-Benefit Analysis of the Franz Joseph scheme to obtain evidence for future river management for flood protection decisions. Key options being considered are:

- Moving the township to Lake Mapourika.
- Decreasing stop-bank management, thus allowing the river to fan out in its natural pattern. (NB This option includes relocating the state highway. This will reduce long-term flooding risks and management costs but has significant up-front costs).

³⁴ The 25 March 2019 Waiho River flood which destroyed the Waiho Bridge is the most recent example of the increasing frequency of Franz Josef flood events.

Annual current maintenance costs of around \$50,000 per year are paid from the Rating District plus another estimated \$50,000 from NZTA bringing the total maintenance cost to around \$100,000. When a large flood hits, it is estimated \$800,000 to \$1,000,000 of work will be needed to simply maintain the scheme at its existing design level.



State Highway 6 was closed, and 70 staff and guests were evacuated from the Scenic Circle Hotel when the Waiho River breached its banks in March 2016.

The primary reasons for active central government co-investment in the Franz Josef scheme are it:

- Is supportive of wellbeing and social inclusion and reflects equity / ability to play considerations.
- Is supportive of job creation and lifting the productive potential of the regions (the area is a sought-after visitor destination).
- Directly protects government assets (The state highway is protected and, therefore, the effective functioning and connectivity of the economy throughout the West Coast is sustained. NB the 2016 floods prevented traffic from flowing between areas located North and South of Franz Josef).

Kaitāia Flood Resilience Scheme (Northland Regional Council)

Kaitāia township is surrounded by stop-banks and flood-ways constructed from the 1900's through to the 1960's.

The current flood scheme provides protection for only up to a 1 in 30-year flood event. The stop-banks are unstable. A 2003 flood came close to overtopping the existing flood-banks.



Loss of road access to local communities during 2003 Kaitāia flood event.

A planned scheme upgrade will provide resilience to 1 in 100-year standard. The estimated damage to Kaitāia of a future 100-year flood without additional scheme works is \$156m. Total project investment is \$15.2m.

Funding contribution requests include: Northland Regional Council: \$7.6m (50%) and Provincial Growth Fund (PGF): \$7.6m (50%).

Northland Regional Council has recently approved a change to its Long-Term Plan to enable it to contribute a greater share from a general rate, with now a 70 per cent general rate funding basis established (compared with zero% previously).

The initial PGF funding request is to assist with an immediate start on the detailed design, progressing property purchase negotiations and commencing physical works.

PGF assistance is viewed as an opportunity to significantly bring forward completion from an earlier estimate of 2026.

Māori population account for 50 per cent of the population of Kaitāia (2013 Census).

The community struggles with affordability for the project due to high unemployment and significant social challenges. The project will protect major industries (including the Juken Triboard Mill) that provide employment opportunities to the wider Far North community.

The planned scheme includes providing improved flood resilience for State Highway 1 which is an essential lifeline.

Northland Regional Council has been working on this project for several years as part of a larger "Priority Rivers Flood Risk Reduction Project". The project will also reduce floodwater stored in Lake Tangonge (a drained lake bed) during flooding events by diverting floodwater to the Awanui River and Rangaunu Harbour.

The primary reasons for active central government co-investment in the Kaitiāia scheme are it:

- 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 (the area is a critical provider of employment opportunities).

Hutt River Scheme (Greater Wellington Regional Council - GWRC)

The Hutt River Scheme has been improving the level of security for flood protection in the Hutt Valley and to Lower Hutt City since 1995.

The current 'RiverLink' project is the most recent part of these works. This was estimated to cost \$80M in 2001. The objective was to increase the current level of flood protection from a 65-year return period level of protection to the design standard of 1:500 years once completed, and thereby provide an allowance for climate change to 2100.

The project reflects high levels of co-operation between its partners: Greater Wellington Regional Council; Hutt City Council and; the NZ Transport Agency. Each partner has a focus area: flood protection for Greater Wellington; urban rejuvenation for Hutt City; and better regional transport links for the NZ Transport Agency.

Addressing this does not however address an issue faced at the seaward end of the system in the Waiwhetu / Seaview and Petone area. The combination of increased rainfall and rising sea-level makes finding a solution to this problem challenging. The figures from the Parliamentary Commissioner for the Environment report on the impacts of climate change in New Zealand³⁵ suggest that structural measures are unlikely to be sustainable in this area and some form of managed retreat or land use change may be required.

Managed retreat is something that will need a joint approach with central government/local government/landowners/business.

The primary reasons for active central government co-investment in the Hutt scheme are it:

- Contributes to the security of access routes (rail and road) for commerce.
- Contributes to the environmental and water quality expectations of our communities and iwi partners.
- Provides for resilience, adaptation and increased levels of safety against the effects of climate change-induced 'above-design' storm events.

³⁵ 'Preparing New Zealand for Rising Seas: Certainty and Uncertainty', Parliamentary Commissioner for the Environment, November 2015.



Hutt City centre with a 25-year flood event in January 2005



Hutt River erosion adjacent to State Highway two during a small annual flood event in June 2018



An impression of what the Hutt River riverbank could look like once flood protection works are completed.

Ruamahanga River (Greater Wellington Regional Council)

The Ruamahanga River Scheme (Lower Wairarapa Valley Development Scheme) was developed by central government from the mid-1950s through to the mid-1980s with the primary purpose, at the time, of increasing land use productivity. It has been extremely successful in achieving this outcome, but the future challenges of climate change, coupled with a desire now for a better environmental outcome and the need to address Iwi aspirations imply a need for inputs beyond the resources and affordability of the local community.

Currently there are several initiatives in front of the community including the Ruamāhanga Whaitua Committee's desire to further develop kaitiaki roles. Restoring the mauri of the wetland area is a part of what kaitiaki expect as one of their responsibilities. Restoration projects to restore the balance of nature on the public land are supported by farmers and the wider community, with the Department of Conservation, iwi, regional and local councils working together to protect the wetlands for future recreational enjoyment.

Six wetland waterbodies located in Wairarapa Moana have been selected to be restored and monitored as part of the 'Fresh Start for Freshwater' Program. Fish are one of the variables to be monitored as indicators of restoration success.

Local and regional ratepayers are currently contributing considerable sums of money and are looking for a contribution from central government to recognise the national benefits of this work.

The primary reason for active central government co-investment in the Wairarapa Moana area is therefore that it:

- Contributes to the environmental and water quality expectations of communities and iwi partners.
- Is supportive of job creation and lifting the productive potential of the regions (the area is a critical provider of employment opportunities and is a prominent agricultural region).
- Is beyond the ability of the adjacent land owners to fund.



Extensive 'environmental enhancement' planting as part of the Lower Wairarapa Valley Development Scheme.

Matarawa, Porewa and Tutaenui Flood Control Schemes (Horizons Regional Council)

This scheme comprises a series of flood detention dams built with substantial central government funding, in the 1950's and 1960's to provide protection to the state highway network in the Hunterville area.



Photo: State Highway and North Island main trunk railway line near Hunterville protected by Porewa Dam during 2004 flood event.

The flood storage dams were designed for a 25-year return period, and the spillways were designed for a 100-year flood, based on the design models of the 1950's and 1960's. The Porewa Scheme consists of 27 dams.

Subsidy funding from central government for maintenance (1:1) ceased in the late 1980's. The replacement cost of the Scheme is estimated at \$9.7m. Review work is underway, including recognition that the funding model needs revisiting.

The primary reasons for active central government co-investment in the scheme are it:

- Directly protects government assets (State highway one and the main trunk rail line) and therefore, provides effective transport functioning and connectivity throughout the southern part of the North Island).

Rangitāiki River Scheme (Bay of Plenty Regional Council)

The April 2017 flood event caused major damage and personal trauma and it was fortunate, some would say sheer luck, there was no loss of life. Increasing community resilience and managing flood risk in the Rangitāiki catchment, in conjunction with implementing the recommendations from the 'Rangitāiki River Scheme Review', is a priority for the Bay of Plenty Regional Council (BOPRC).



Extensive inundation of Edgumbe following the failure of Rangitāiki River stop-banks in April 2017.

BOPRC have already invested in the replacement of the College Rd stop-bank and wider catchment urgent flood repairs as a result of the April 2017 Flood Event. Attention has now turned to the long-term and catchment wide approaches that respond to climate change and provide wider cultural and ecological benefits.

The BOPRC River Scheme Sustainability project is investigating and implementing this whole of catchment response. The priority now is the lower Rangitāiki: increasing the capacity of the Floodway, securing the river Spillway, geotechnical strengthening, and improving the wider catchment flood defences in the face of climate change and a vulnerable community. Funding is sought to assist with a package of projects, which will provide '1 in 100 year' protection for the community and local economy. Increasing the flood capacity to 804 cumecs is needed, in conjunction with system innovations that make room for the river, use flood plain attenuation, and use multi-functional infrastructure.

The seven major industries in the catchment have an estimated output of \$1.9b per annum and the project would also provide a high level of protection to Fonterra's Edgumbe processing facility. Failure to act will put these significant sources of regional employment and revenue generation at risk. The River Scheme also has a high debt levels, accentuated by the 2017 event and scheme rates have risen 26% as a result.

The primary reasons for active central government co-investment in the Rangitāiki River Scheme is that it:

- Is supportive of wellbeing and social inclusion and reflects equity and ability to pay considerations.
- Provides for resilience and adaptation against the effects of climate change-induced 'above design' storm events.
- Provides for resilience and increased levels of safety to existing and future communities.
- It will speed up 'whole of catchment' innovations and alignment with the Rangitāiki River Scheme Review. These recommendations may be summarised as follows:

Waipaoa Flood Control Scheme Upgrade - WFCS (Gisborne District Council)

Upgrade designs for the Waipaoa Scheme will provide protection to Gisborne City and the Poverty Bay flats against a 1:100-year design flood event. This accounts for climate change factors out to the year 2090.

Current budget costs are estimated at \$30-\$35m, excluding the cost of the proposed Cycle Trial (\$2-\$3m). Most of the Scheme cost is planned for expenditure over a twelve-year period.

The proposed upgrade will widen the stop-bank top width from 2-2.5m to 4m and raise its height 1-2m with \$2m allocated to purchase land under the existing stop-bank and for the proposed widening, predominantly on the true left bank (Gisborne City side). This will leave approximately 15 per cent of the stop-bank under private ownership.

Based on a 15-year project duration, annual Capex will be \$2.5-3.4m and Opex is \$0.5-0.675m. If the project was shortened to a 10-year project duration, annual Capex would be \$3.5-5.5m.

The original WFCS was completed in 1969 following the devastating floods in 1948. The WFCS protects \$7 billion worth of production and horticulture land on both urban and rural areas, effecting the economic heart of Tairāwhiti.

Increasing resilience of the scheme will allow greater certainty for businesses to invest in and on the land. The scheme allows for socio-economic-environmental growth on Iwi land on Poverty Bay flats.

The scheme has around 75-100 culverts with flood gates. The clear majority of these will need fish passage provisions retro-fitted if Gisborne District Council's (GDC) Freshwater Plan and Conservation legislation is followed to the letter. An Integrated Catchment Management Plan is a requirement of GDC's new Freshwater Plan.

GDC's Land management team are supporting land owners in implementing MPI's erosion control funding project in the upper catchments of the Waipaoa River. The scheme protects State Highway 2 and KiwiRail's rail line. Both assets cross the river. The scheme also protects significant areas of Iwi/Hapu land.



Waipaora River stop-banks containing 11 June 2018 flood event at State Highway bridge to Gisborne. NB Te Karaka township was cut off due to flood waters crossing the State Highway where there are no stop-banks.

The primary reasons for active central government co-investment in the WFCS are therefore that it:

- Is supportive of wellbeing and social inclusion and reflects equity / ability to pay considerations.
- Provides for resilience and adaptation against the effects of climate change-induced 'above design' storm events.
- Provides for resilience and increased levels of safety to existing and future communities.
- Directly protects government assets.
- Is supportive of job creation and lifting the productive potential of the region.
- Contributes to the environmental and water quality expectations of communities and iwi partners.

Leith Flood Protection Scheme (Otago Regional Council)

Properties in the Dunedin CBD are vulnerable to flooding events. The Leith Flood Protection scheme plays a large role in protecting the CBD inclusive of education facilities (University of Otago and Otago Polytech) and the sites for the new Dunedin hospital, public reserves, residential and commercial areas.

The capital value of Crown properties and non-relatable University land and assets, in the area protected by the scheme, is 35 per cent of the total assets in the area. The dominance of the Education sector in the Direct Benefit Zone and in the wider Dunedin economy, is a key consideration when evaluating the costs of flooding.

The benefit received by the University from flood protection is equivalent to the level of economic impact avoided. This is very significant, not only in direct terms but also in terms of the flow-on effects of disruption to the wider economy. Six months after this 100 year Annual Return Interval flooding event, the total economic impact on Dunedin would be \$154m. A full year after this flooding event, this estimated cost was \$186m.³⁶

It is estimated that a flooding event will occur in Dunedin CBD area every 15 years.

The Otago Regional Council (ORC) is implementing the Leith Flood Protection Scheme at an estimated construction cost of \$35m. The scheme is funded by ratepayers. The non-rateable University is a major

³⁶ 'Benefits of the Leith Lindsay Flood Protection Scheme to Crown Properties', prepared for Otago Regional Council by Market Economics, April 2011

beneficiary of the existing and proposed flood protection works and yet the University is making no contribution to flood-scheme costs.



Water of Leith at University of Otago clock tower showing the amenity value achieved through sensitive design of river control and flood management works.

The primary reasons for active central government co-investment in the Leith Flood Protection Scheme are therefore that it:

- Provides for resilience and adaptation against the effects of climate change-induced 'above design' storm events.
- Provides for resilience and increased levels of safety to existing and future communities.
- Directly protects government assets.
- Is supportive of job creation and lifting the productive potential of the region.



Water of Leith in April 2006 during a 10 to 20-year Annual Return Interval flood.

Environment Canterbury Scheme Reviews (ECan)

ECan is in the process of reviewing its Schemes to address climate change and other challenges.

ECan have \$150k/year general rate funding to spend on scheme reviews. These reviews are assessing the "fit for purpose" status of existing schemes and the need for / nature of necessary changes. Currently ECan is in year 2 of this 10+ year programme.

The conclusions so far drawn by ECan from its review highlight two issues:

- Big Issue 1 – There is demand, because of intensification of development on floodplains, to develop new and extend existing schemes but that is beyond the ability of existing communities to fund.
- Big Issue 2 – Climate change impacts will need to be addressed.

Initial estimates, as defined in the ECan 30-year Infrastructure Strategy, suggest the future financial costs arising from the need to address climate change-induced flood events are as follows (expressed in 2017 terms):

- Kaikoura Rivers: \$3.0m.
- Ashley River: \$6.9m.
- Waimakariri-Eyre-Cust: \$9.7m.
- Selwyn River: \$5.9m.
- Ashburton Rivers: \$15.0m.
- Hinds River: \$3.7m.
- Orari-Waihi-Temuka: \$13.2m.
- Opihi: \$10.5m.
- Seadown Drainage: \$1.3m.
- Pareora River: \$2.5m.
- Waihao-Wainono: \$10.6m.
- Other: \$2.7m.
- Total: \$85.7m.



Photo: Selwyn River stop-bank overtopping in July 2017.

Appendix 2: from Tonkin + Taylor report 'Hiding in Plain Sight' (April 2018)

An overview of New Zealand schemes

So, what do New Zealand flood protection and land drainage schemes look like? This section provides a snapshot of river control, flood protection, and land drainage schemes. It covers what's included and excluded from a scheme, the extent and quantity of the schemes nationally, and the state of the infrastructure assets within schemes.



Figure 1.1: Stop-banks protected Palmerston North from inundation during the 2004 Manawatu River flood event. Source: teara.govt.nz

Schemes – what's in and what's out?

The river management activities undertaken by regional councils generally deal with the management of rainfall runoff on a catchment scale, and are broadly classed into four scheme types based on the nature of their benefit as follows:

- Land drainage – getting water off the land into a stream or river
- Flood protection – keeping water in the river and off land
- River management – keeping the river where it is
- Tidal inundation – keeping sea water off land.



Figure 1.2: Surface flooding on productive land served by land drainage scheme, Waikato 2008. Source: Waikato Regional Council.

Each regional council classifies schemes and their infrastructure assets into these four broad types. This publicly available information has been used in this assessment.

What is not covered under these schemes and is excluded from this assessment is the management of storm-water runoff in urban or semi-urban settings by city and district councils. The management of some flood control and coastal protection schemes by city and district councils such as the Avon-Heathcote River in Christchurch or the Maitai River in Nelson is also excluded³⁷.

Additionally, regional councils undertake soil conservation activities to reduce soil erosion and, in some instances, these are key elements of flood protection schemes. Although these soil conservation activities are important to water quality and overall catchment health, assessing the state and value of them is beyond the scope of this assessment.

Scheme extent

The geographic coverage of river control, flood protection and land drainage schemes can be described as follows: **Infrastructure assets** – physical structures which protect land from being inundated by water, for example, stop-banks, flood gates, pump stations, and river training works.

Capital and operational expenditure associated with these assets are generally funded by rates from the following areas:

- **Direct benefit areas** – areas of land which are immediately protected from flooding by infrastructure assets and would otherwise be subject to flooding during storm events up to and including the size of a design event

³⁷ The scope of this survey included regional councils and the regional council functions of unitary authorities.

- **Indirect benefit areas** – areas of land which sit outside the direct benefit area and receive a ‘community good’ from protection afforded by the infrastructure assets
- **Exacerbator areas** – upper areas of land in a catchment that contribute runoff to low-lying portions of a catchment and contribute to drainage or flooding issues experienced in these lower lying areas.

The direct benefit areas for all scheme types across New Zealand is shown in Figure 1.3, below.



Figure 1.3: Extent of direct benefit areas

Number of schemes

There are around 364 river control, flood protection, and land drainage schemes administered by regional councils across New Zealand that have been included in this assessment.

A breakdown of the number of scheme types by region is given in Table 1.1 below. We found that how the nature of scheme benefit is described varies depending on the scheme. Specifically, some schemes provide a single benefit type only, while other schemes provide multiple benefits. For those schemes that provide multiple benefit types, the available data was insufficient to understand the proportion of benefit type.

For example, there are a large number of schemes in the Waikato that are identified as only providing drainage benefit. This is contrasted with the Kaituna scheme in the Bay of Plenty that provides flood protection for an event having a 1% Annual Exceedance Probability (AEP) and drainage protection for events up to 20% AEP.

Schemes with multiple benefit types were most common for regional councils in the Bay of Plenty, Hawkes Bay, Manawatu, and West Coast. Future data analysis would be made easier if the schemes or their constituent parts were able to be classed under a single benefit, though we recognise this may be difficult.

Council	Benefit Type			Tidal	Mixed Benefit	Total Schemes
	Flood	Drainage	River Management			
Northland	2	0	0	0	1	3
Auckland ¹	-	-	-	-	-	-
Waikato ²	3	86	0	0	5	94
Bay of Plenty	0	1	0	0	4	5
Gisborne DC	2	17	0	0	0	19
Hawkes Bay	2	0	2	0	21	25
Taranaki	0	0	0	0	2	2
Manawatu	7	6	6	0	15	34
Wellington	51	15	0	0	0	66
Marlborough DC	-	-	-	-	-	-
Nelson CC	-	-	-	-	-	-
Tasman DC	0	0	16	0	6	22
West Coast	3	1	2	1	13	20
Canterbury	15	13	28	0	4	60
Otago	3	3	1	0	1	8
Southland	6	0	0	0	0	6
Grand Total	94	142	55	1	72	364

Table 1.1: Number of scheme types by region

Notes:

1. Council reported it does not have any relevant schemes under management.
2. No data was provided for schemes protecting urban settlements in Taupo and Thames – Coromandel Districts.

What schemes protect

The 364 schemes for which data is available provide direct benefit to some 1.5 million hectares of land (about 5.6% of New Zealand’s land area). As noted previously, schemes provide benefit beyond the areas of direct benefit. Regional councils recognise this through the identification of indirect benefit areas and exacerbator areas for the purposes of striking a rate to fund the schemes.

In addition to the rateable areas of benefit that schemes protect — or otherwise provide a ‘community good’ — schemes also protect non-rateable land and regionally and nationally significant infrastructure, including transportation, energy and telecommunication links. For example, State Highway 1, the North Island Main Trunk Line, and a trunk fibre optic cable are protected by the Lower Waikato scheme. Social and cultural infrastructure, for example, the Hutt Hospital and numerous schools, marae, libraries and churches, are protected by the Hutt Valley scheme.

The available scheme rating databases from each region were combined to prepare Figure 1.3, below. This figure shows the four benefit types relative to each other for rateable land area, rateable land value, and rateable capital improvements (capital value less land value).

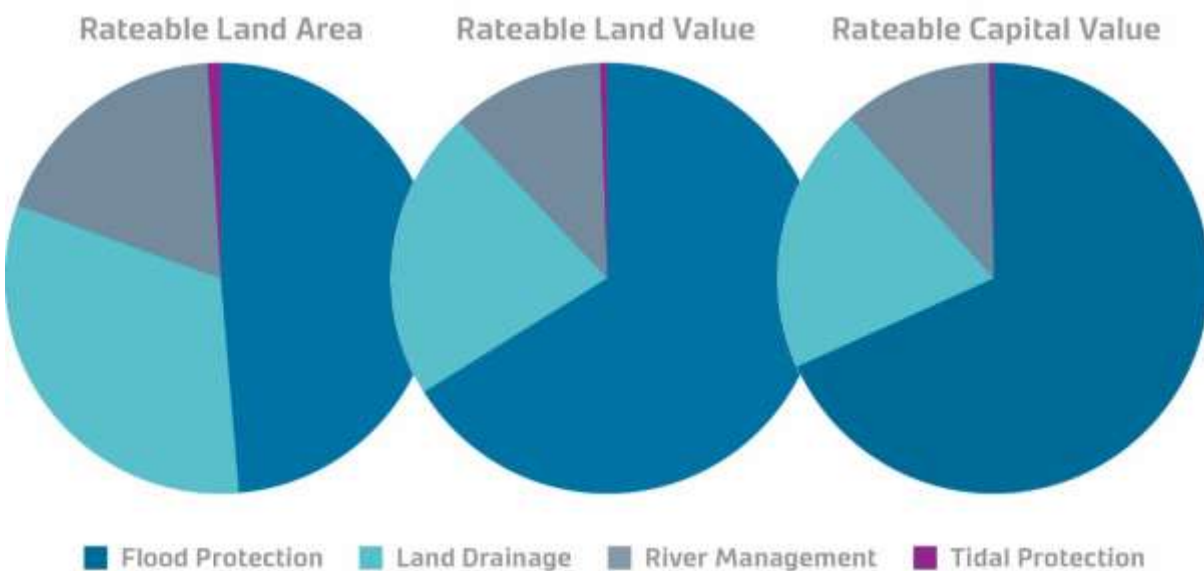


Figure 1.3: Comparison of benefit proportions for rateable area, land value, and improvements value by scheme type based on available data

Discussion

As illustrated in the pie charts, flood protection schemes protect an increasingly greater proportion of rateable land area, land value and capital value compared to other scheme types. This indicates that flood schemes may protect a greater portion of urban land — with capital improvements — than other scheme types.

Land drainage schemes comprise approximately half of the total number of schemes in this assessment. However, they protect a disproportionately small amount of rateable land area, and a diminishing proportion of rateable land value and capital improvements. This is indicative of the more rural nature (primary industry production) of land protected by these schemes.

The same diminishing proportion of rateable land area, value, and capital improvements are observed for tidal protection schemes. Again, this is indicative of the rural nature (primary industry production) of land protected by these schemes. For example, the area protected from tidal inundation in lower

Piako River is the largest area of tidal protection benefit, as this scheme covers an extended area of low-lying farmland near or below sea level.

A diminishing proportion of rateable land area, value, and capital improvements is also observed for river management structures. However, these structures are often integral to flood protection schemes. The data does not clearly illustrate a linkage between these structures and the type of land they benefit. Further work would be required to demonstrate this link at a national or regional level.

Infrastructure assets

Asset value

The total replacement value³⁸ of river control, flood protection and land drainage infrastructure assets is approximately \$2.3 billion. This is about 4.5% of the estimated \$45 billion replacement value of assets for three waters infrastructure (drinking water, waste water, and storm-water) as stated in Treasury's Thirty-Year NZ Infrastructure Plan 2015-45.

The total replacement value of infrastructure assets (about \$2.3 billion) is broken out by asset type in Figure 1.4, below.

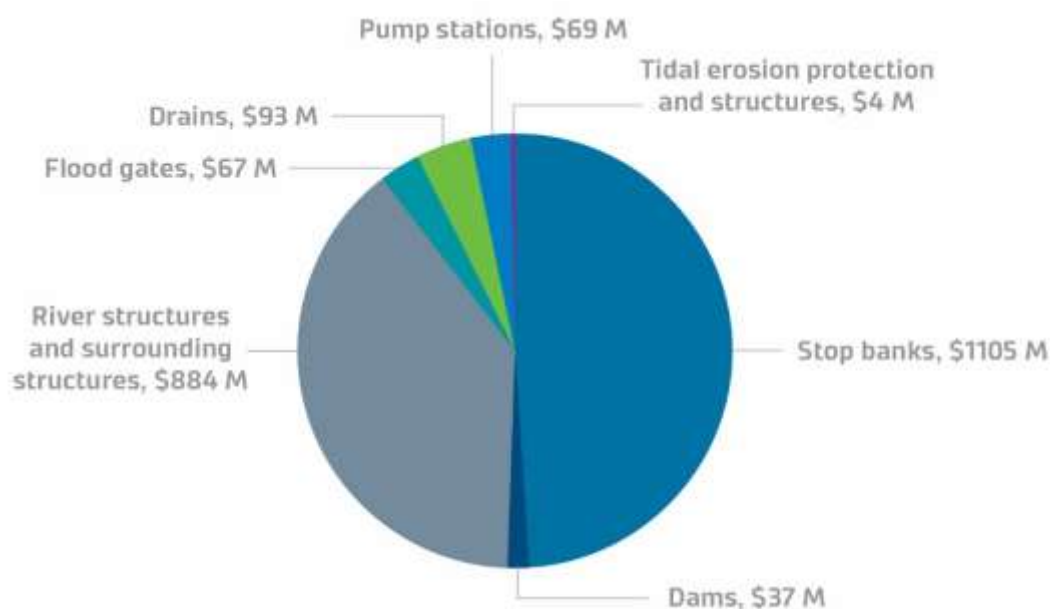


Figure 1.4: Summary of total replacement value by asset type for provided data

Flood protection is generally provided by stop-banks and dams. Across the assessed councils, these assets make up about half of the capital investment but provide almost three quarters of the capital value protected. In other words, the capital value of land protected by stop-banks and dams is disproportionately higher than the asset value.

The same pattern can be seen for assets including pump stations, floodgates and drains which provide land drainage. These assets make up about a tenth of the total capital investment and from this provide benefit to around a fifth of the capital value protected.

River structures, such as groynes, rockwork and other armouring, training banks, weirs, and trees/vegetation, are associated with both flood protection and river management as noted above.

³⁸ Total replacement value of the infrastructure assets is based on the valuations published in the asset management plans available for this assessment.

However, based on the data provided it is difficult to apportion value of these assets to those benefit types. We note that river structures are often capital intensive and integral to flood protection schemes, and the river structures themselves may not directly relate to a large area of benefit.

Further work is needed to better understand how river structures integrate with flood protection schemes, and how the river structure capital and economic values could be apportioned to discrete benefit types.

Asset condition

A fundamental aspect of asset management is the systematic inspection and recording of asset condition. The International Infrastructure Management Manual (IIMM) 2015³⁹ uses a five-point scale for asset management scoring. For the purposes of this assessment we have used the IIMM qualitative descriptors (Excellent/Good/Average/Poor/Failed) instead of a one to five scale.

Based on the data available for this assessment, it appears all regional councils use the NAMS scale. However, there is little, if any, asset condition assessment standardisation across the councils or even within a council. In our experience, the way asset condition is assessed can vary depending on who undertakes the assessment and when the assessment is carried out. For example, staff who are very familiar with an asset can become complacent with its condition and overlook some shortcomings. Additionally, in absence of condition scoring guidance staff departures can result in new staff using a different reference point to score asset condition.

The sector has recognised that standardisation in asset condition scoring is important and has recently developed a stop-bank condition assessment framework that all councils should adopt. Development of further assessment frameworks for assets such as for pump stations, floodgates and the like, is beneficial and should be considered by river managers.

The overall condition of river control, flood protection and land drainage infrastructure assets is summarised in Table 1.2, below. Data is based on conditions published in the asset management plans made available for this assessment.

Infrastructure asset type	Condition (qualitative descriptor)
Stopbanks	Average or better
Floodgates	Average or better
Drains	Good or better, some Average
Dams	Average or better
Pump stations	Average to Good, some Poor
River structures	Good, some Poor to Average

Table 1.2: Asset condition summary

At an overview level, the asset condition scores suggest regional councils have adopted an appropriate level of asset management, renewal and upgrade according to asset type. Scores also reflect councils’ general asset management approach of maintaining stop-banks in perpetuity while river and mechanical structures are worn and then replaced, hence the latter group having a wider range of condition.

³⁹ The IIMM 2015 is identified by the New Zealand Asset Management Support Organisation as best practice in asset management.

The condition of an infrastructure asset does not tell the whole story of how well that asset is being managed. Asset condition needs to be assessed in conjunction with asset criticality and performance to understand if and when maintenance or renewal work needs to be carried out. Asset criticality and performance are generally not well documented by regional councils, and an assessment of these criteria is beyond the scope of this report. Further work to assess these factors against asset condition would require a more in-depth scheme by scheme review.

Regional breakdown

A regional breakdown of the number of schemes by type is given in Figure 1.5, below. There is significant variation between councils in terms of the size and make up of schemes. Figure 1.5 is ordered by total value of each councils' scheme assets with two cohorts emerging. One is a cohort of councils — Canterbury, Manawatu, Waikato, Greater Wellington, Bay of Plenty and Hawkes Bay — covering a significant overall proportion of asset value. The other, a cohort of councils collectively making up a smaller proportion of the asset value.

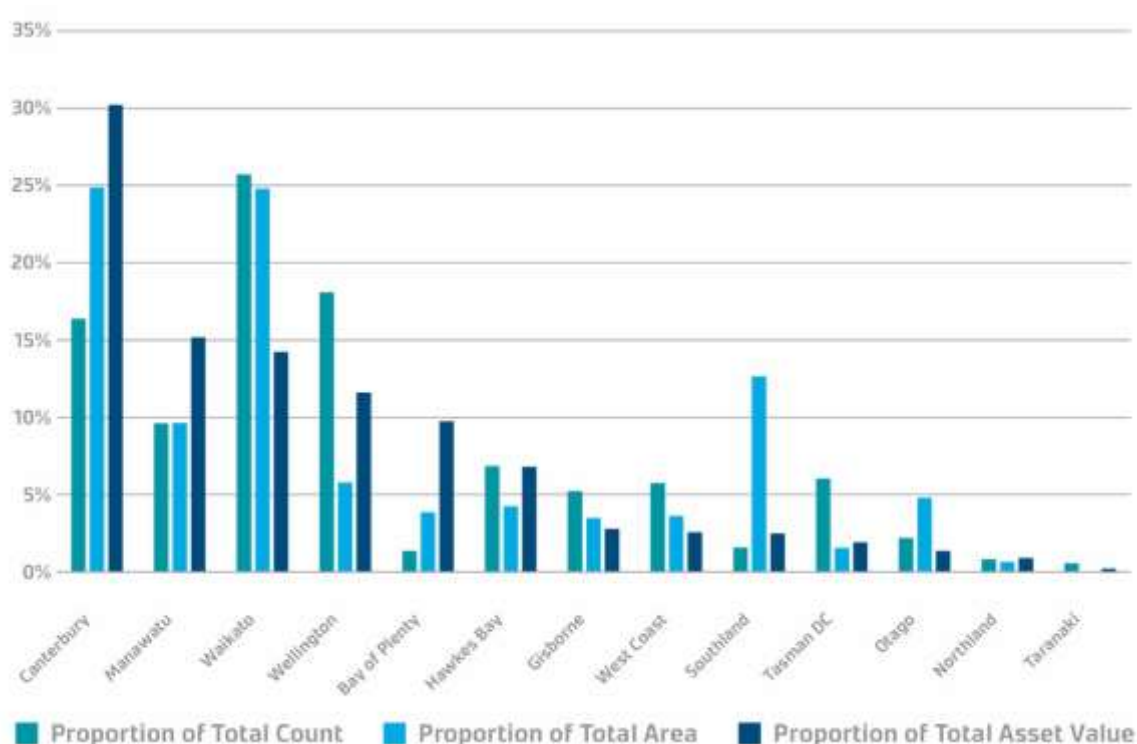


Figure 1.5: Scheme attributes as proportion of assessed total

Economic value of the schemes to New Zealand

A cost benefit analysis was undertaken by economic consultants, Covec, to help define the total economic value of the schemes included in this assessment.

Covec estimates that the river control, flood protection, and land drainage schemes included in this assessment provide a Net Present Benefit of \$198 billion (\$NZD at 2016). Using the sum of the regional councils' published infrastructure asset replacement values and operational expenditure of \$3.6 billion (\$NZD at 2016), the average Benefit Cost Ratio (BCR) of these schemes to New Zealand is approximately 55:1. For comparison, large infrastructure projects in New Zealand, such as those for the NZ Transport

Agency, are considered economically viable if the BCR is greater than 1:1⁴⁰. As such, with an average BCR of 55:1, these schemes provide outstanding value for money to New Zealand.

Methodology

A cost benefit analysis (CBA) of the schemes was undertaken by adding all of the estimated benefits of the schemes and subtracting estimated operational and maintenance costs. To undertake CBA, two scenarios were assessed:

- The factual case – that is the overall benefit to the community with the schemes in place, and
- A counterfactual case – that is the overall benefit to the community where there are no schemes in place.

Covec considered three different situations for the counterfactual case and evaluated situations in terms of the assumptions needed to define them, the analytical problems arising from these approaches, and whether and to what degree any approach adopted is consistent with best practice for CBA.

The counterfactual approach that was used for this analysis assumes that to continue to receive the current scheme benefits, the community is willing to pay an amount equal to value of assets and land currently protected by the schemes. This assumption, which is further described in Covec’s report, is made on the basis that the owner of the scheme could otherwise remove these assets.

The approach used to evaluate the benefits to the community was predominantly based on the value of damage to residential and other buildings, and the valuation of various land use types that are protected by the schemes. These are described in detail by Covec and summarised in Table 2.3.

Land use/ land type	Flood protection	Tidal protection	Drainage	River management
Built-up areas (residential and other buildings)	NPV of avoided damage	Value of improvements plus difference in value of land uses	Value of improvements plus difference in value of land uses	Value of improvements plus difference in value of land uses
Other land uses	Greater of NPV of avoided damage or Difference in value of land uses possible with/ without flood protection	Difference in value of land uses possible with/without tidal protection	Difference in value of land uses possible with/ without drainage	Difference in value of land uses possible with/ without river management

Table 2.3: Valuation approach by land use and scheme type (Covec 2017)

For flood protection, the Net Present Value of avoided damage was estimated through the development of flood risk density curves, whereby the annual average damage for an area of land can be determined with and without a scheme in place, as shown in Figure 2.6 below. For the purposes of estimating annual average damages, data from the NZ Insurance Council for floods between 1976 and 2016 was used.

⁴⁰ Economic evaluation manual, New Zealand Transport Agency, January 2016.

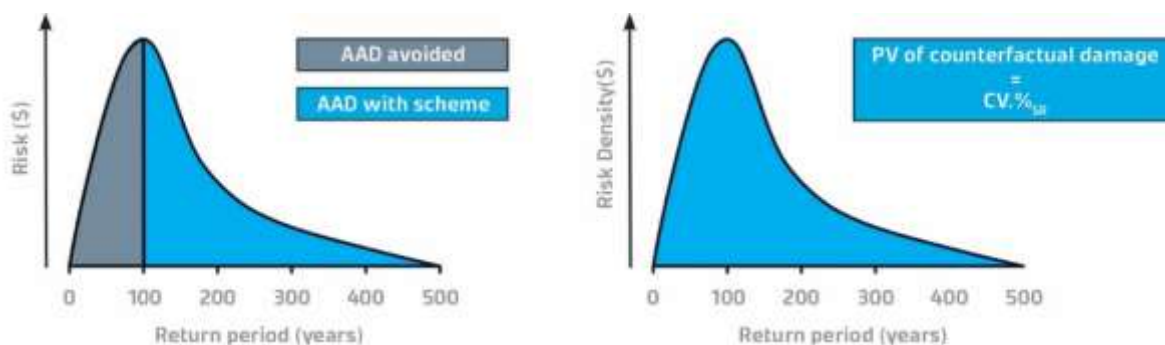


Figure 2.6: Annual Average Flood Damage (AAD), and Average Annual Damage avoided with a flood control scheme in place that has a 100-year return period level of service. The counterfactual is also shown.

Finally, the level of flood damage avoided was modified based on each scheme's benefit rating, as set out in their relevant asset management plans.

For differences in land use, Covec used the difference in value of land based on the current use, and counterfactual use assuming that no scheme was in place.

Covec reviewed potential non-market values such as insurance costs, emergency cost multipliers and health impacts on the community. Based on work carried out for the Greater Wellington Regional Council, Covec adopted a value of 100% of direct damage costs to take account of a range of non-market costs associated with flooding in urban areas. This cost was allocated on a pro rata basis for non-urban areas based on average population densities for rural areas in NZ.

The data used by Covec for this analysis is outlined in their report. It included:

- The flood level of service for the schemes used in this assessment
- The capital value of land within the scheme's benefit area
- The land value within the scheme's benefit area
- The level of benefit provided (low, medium, high)
- Land cover descriptions.

Results

The results are presented across all schemes assessed and separated into scheme types and are summarised in Table 2.4 below.

Overall the benefits of the schemes are significant with a Net Present Benefit of approximately \$198 billion (\$NZD at 2016) at an average Benefit Cost Ratio (BCR) of 55:1. The highest benefits come from flood control, drainage, and mixed benefit schemes followed by tidal and river control schemes. The annual benefit of over \$11 billion provided by the schemes is nearly five times their published infrastructure replacement value.

Due to the project steering group's concerns of the significantly large difference in benefit calculated for Canterbury region compared with other regions, we reviewed the input data for Canterbury and Wellington regions and performed a few sensitivity checks. In this review we found some differences in how these regions supplied their data and rate their schemes.

However, the differences between Canterbury and Wellington appear to be overshadowed by the relatively large areas of direct benefit, and population within these areas. Using the latest census mesh-block information Canterbury has about 350,000 normally resident population in direct benefit areas compared to 75,000 for Wellington's Hutt Valley.

It should be evident that built-up areas that are protected by these schemes represent the greatest benefit, which together represent over \$184 billion NPV or over \$10 billion of annual benefit, compared with over \$14 billion NPV or an annual benefit nearly \$1 billion for other land use types protected by these schemes.

While not all councils are represented in this analysis we consider that the information is sufficient for an evaluation of the benefits of the schemes to be made at a national level. It is expected that inclusion of schemes not included in our analysis would return a similar, outstanding BCR. Figure 2.8 depicts the cost and benefit of the schemes for each region in our assessment.

Figure 2.7 below shows the combined benefit and the benefit cost ratio for each region. This clearly shows the significant benefit derived from the protection provided in various locations throughout New Zealand, at various scales, and with different land use types being protected.

Protection type	Land type	Estimated benefit (PV) (\$m)	Annual benefit (at 6% Discount Rate) (\$m)
Flood control	Built-up area	\$134,601	\$7,619
	Other land use type	\$12,553	\$711
	Total	\$147,154	\$8,329
Drainage	Built-up area	\$12,796	\$724
	Other land use type	\$629	\$36
	Total	\$13,424	\$760
River Management	Built-up area	\$2,167	\$123
	Other land use type	\$83	\$5
	Total	\$2,250	\$127
Multiple types	Built-up area	\$34,631	\$1,960
	Other land use type	\$895	\$51
	Total	\$35,526	\$2,011
Total		\$198,354	\$11,228

Table 2.4: *Estimated benefit (2016 \$ million) of flood control, drainage, river management, tidal and multiple schemes*

Figure 2.7 shows that the Canterbury region has a very high BCR. This is because virtually all the Christchurch urban area receives flood protection benefit from the Waimakariri Flood Protection Scheme. We note that parts of Christchurch are protected by Christchurch City Council's flood protection schemes. The costs of these schemes have not been incorporated into our analysis and if incorporated would reduce the BCR for the Canterbury Region. However, given the small scale of the city's schemes relative to the direct benefit area for all the Canterbury schemes, we would expect little change to our overall findings, i.e. flood protection schemes in Canterbury provide outstanding value for money.

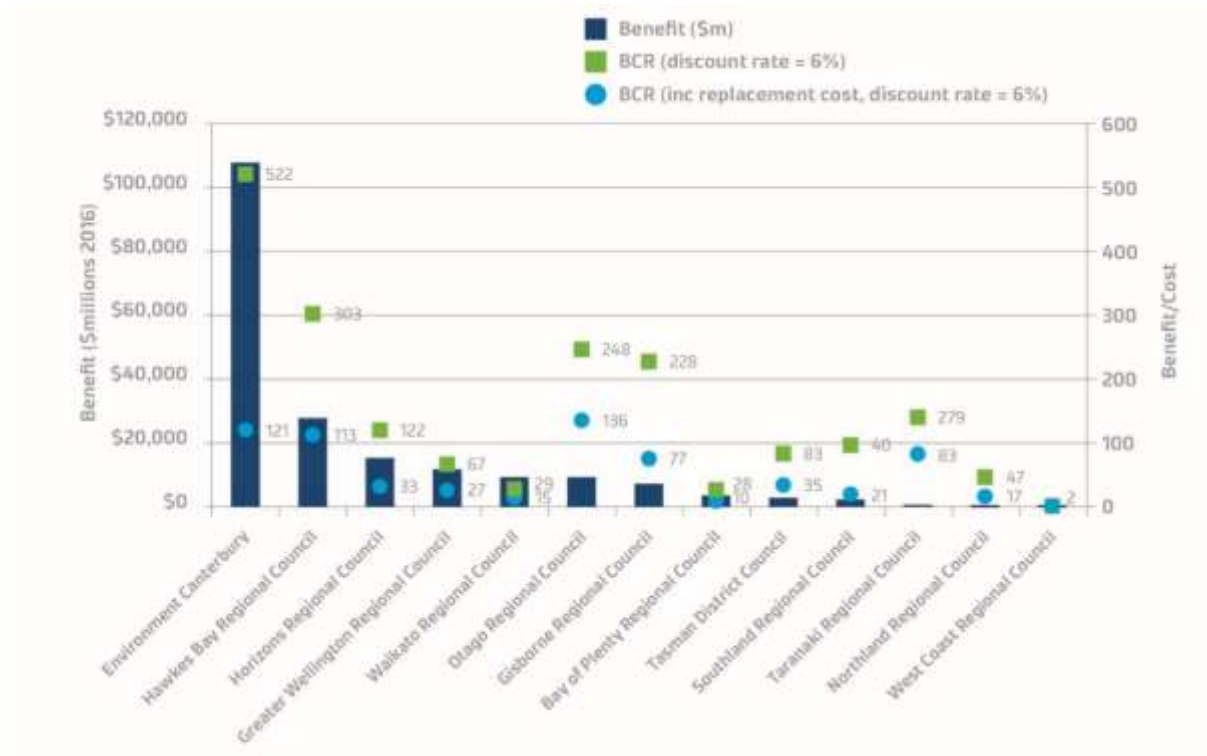


Figure 2.7: Benefit, costs and benefit cost ratios for schemes included in this assessment

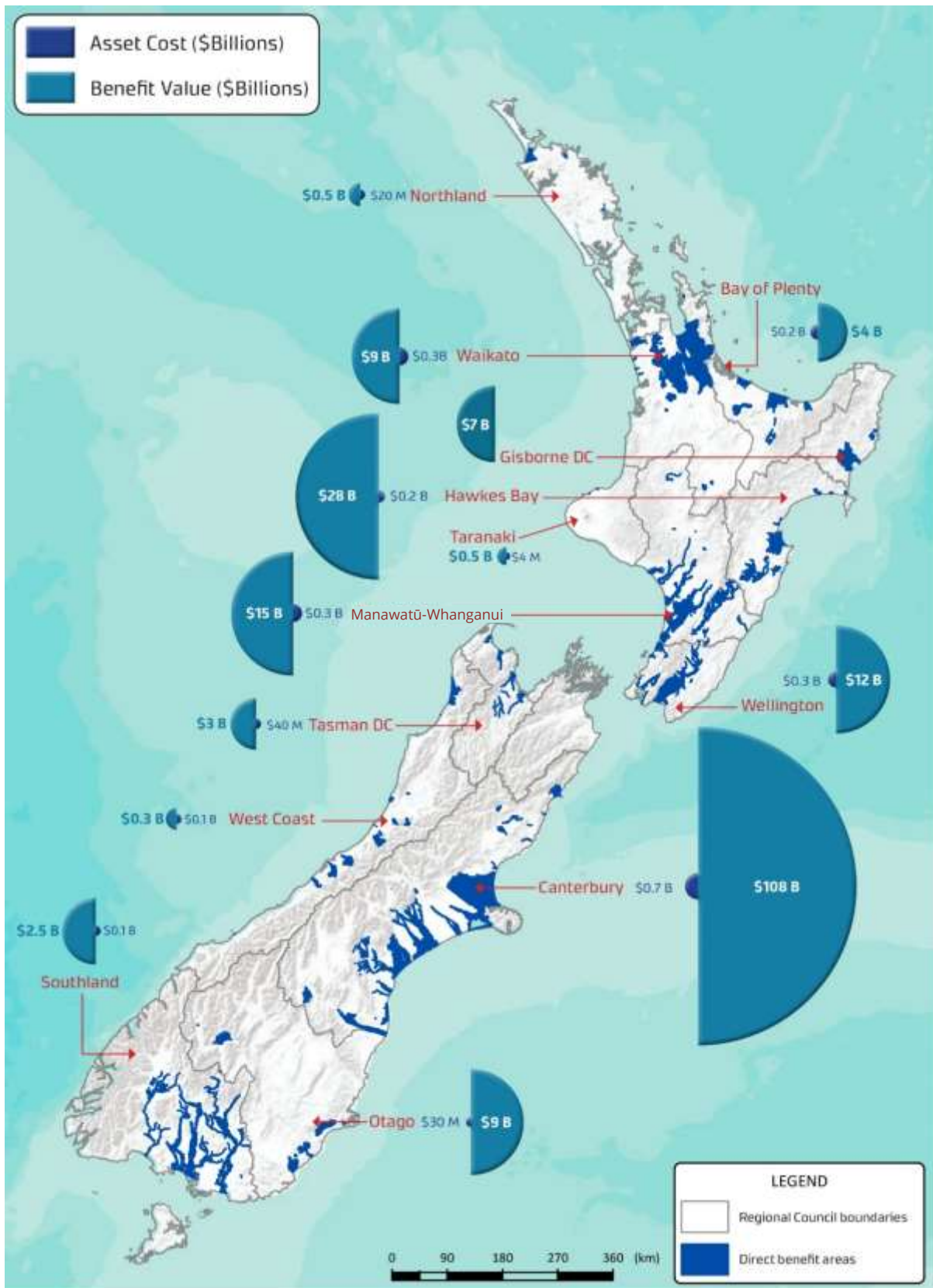


Figure 2.8: NPV of scheme benefits and capex + opex costs by region (values indicated where available, subject to rounding)

Exclusions

The economic assessment included in this assessment represents a snapshot of economic benefits and costs as at 2016. A longitudinal study of how these benefits and costs have changed historically and might change in the future was excluded from the scope of this review. We would expect that given the increase in New Zealand GDP and land prices over the past two decades the benefit provided by the schemes is likely to have increased over this period as a result. However, we are less certain on how scheme costs and their cost benefit ratios may have changed over that period. Special care would need to be taken in selecting time periods for such a longitudinal assessment, so the results are not overly influenced by selection bias.

The economic assessment included in this assessment is traditional in that a factor was applied to the economic analysis to account for wider social and economic benefits of the schemes. This analysis excluded a formal assessment of the cultural and environmental costs and benefits given its overview nature and the complexities associated with assessing these values on such a large scale. We would expect that the calculated BCR would change if these values were included in a cost benefit analysis. We would also expect that if these values were included, the schemes overall would still provide a net benefit to New Zealand given the large economic BCR calculated in this assessment. Further detailed analyses of individual schemes or portions of schemes may reveal that some are not economic. Further work would be required to address these exclusions as well as understand infrastructure asset valuation practices and outcomes and forecast how the benefits and costs of the schemes might change in the future.

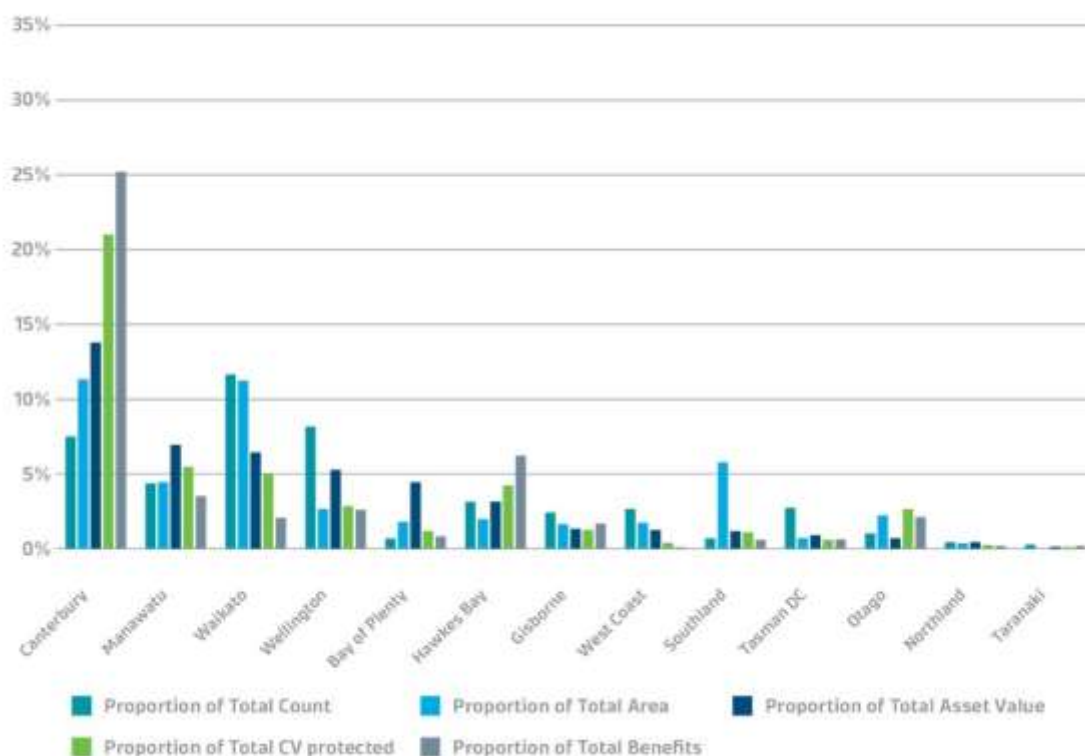


Figure 2.9: Scheme attributes as proportion of national total including economic information

Appendix 3: Additional information to support comments made elsewhere in this paper

What we value

Political manifestos

We can identify the preferences of ministers for supporting initiatives like flood protection and river management from their political manifestos. The Labour-New Zealand First (2017) coalition agreement signals some priority outcomes relevant to the government's role in flood control and river management. These include:

- *Regional Development*
 - *A \$1b per annum Regional Development (Provincial Growth) Fund, including:*
 - *Other large-scale capital projects as articulated in the policy for the Provincial Growth Fund, to create jobs, enable long-term sustainable growth, and enhance social inclusion for all New Zealanders.*
 - *A commitment to relocate government functions into the regions.*
- *Hold a Public Inquiry "A decade after Shand" to investigate the drivers of local government costs and its revenue base.*

The Labour-Green confidence and supply agreement (2017) also signals priority outcomes relevant to flood protection and river management. These include:

- *Preamble*
 - *Together, we will work to provide Aotearoa New Zealand with a transformational Government, committed to resolving the greatest long-term challenges for the country: sustainable economic development including increased exports and decent jobs paying higher wages, a healthy environment, a fair society and good government. We will reduce inequality and poverty and improve the well-being of all New Zealanders and the environment we live in.*

Climate change challenges our values

Climate change will make flood consequences much worse

Extreme weather (Local Government New Zealand, 2014) events result in flooding, accelerated erosion (many landslides are triggered by heavy rain) and wind damage to buildings, infrastructure and crops. New Zealand currently experiences one major flood every eight months, and this can be expected to increase with climate change.

Climate change (Ministry for the Environment, 2010) is expected to influence flooding in several ways: through changes in rainfall, temperature, sea level and river channel processes. These changes will exacerbate the existing effects of flooding on infrastructure, including on:

- Rooding.
- Wastewater and storm-water systems and drainage.
- Flood mitigation works.
- Water supply and irrigation.
- Private and public assets, including houses, businesses, schools and production systems.

Extreme consequences from flood events are a global problem

Global research (Environmental Research Web 2018) indicates that both the frequency and magnitude of extreme flood events has increased, with the total number of extreme floods increasing by an average of 26.6 per cent over the researched time-period (20 years). The increases were greatest in the northern hemisphere, with European catchments experiencing a 44.4 per cent increase in extreme floods and 21.4 per cent for the US. The changes have been less dramatic in the southern hemisphere, with an increase of 14 per cent for Brazil and 11.6 per cent for Australia.

One of the consequences of climate change is a need for a step-change in management of flood risk and flood flows

Flood risk

Climate change effects on flooding may influence flood risk management priorities and may even increase the risk from flooding to unacceptable levels in some locations (Ministry for the Environment, 2008).

Climate change is expected to lead to increases in the frequency and intensity of extreme rainfall, especially in places where mean annual rainfall is also expected to increase. Therefore, changes in seasonal and annual rainfall patterns, as well as changes in extreme rainfall, will be important factors for understanding future flooding. Generally, wetter conditions in some areas may also change the antecedent or initial conditions, so that floods could occur more often.

Places that currently receive snow are likely to see a shift towards precipitation falling as rainfall instead of snowfall as average temperatures rise and freezing levels climb to higher elevations. Changes in climate can also affect the magnitude of a flood by indirect means. For example, any change to the balance of sediment transported within a river, storminess, sea levels or even the cycles of natural variability in the climate can all influence river processes and flooding.

In addition, climate change will result in a gradual rise in sea level throughout the rest of this century significantly changing the design conditions for flood control adjacent to the coastal marine area and requiring both additional capital works and far greater maintenance to achieve the original design protection. The intensification of land use in floodplains will also require a re-assessment of the design event given the economic consequences of super-design storms.

With over a hundred cities and towns located on flood plains, New Zealand has a long history of living with floods. Making decisions on how best to protect life and property from floods has been ongoing since settlement.

Climate change is already potentially irreversibly affecting our natural systems, and we can expect more severe effects on the environment and on human systems as the change continues. On land, this could have a wide range of important effects.

Rising sea levels and more frequent intense rainfall events are projected to increase the risks of coastal flooding, erosion, and saltwater intrusion to groundwater, threatening low-lying infrastructure, cultural sites, and habitats (Parliamentary Commissioner for the Environment, 2015). We can expect tides, waves, and storm surges to reach further inland more regularly. Coastal flooding, usually due to storm surges coinciding with very high tides, already causes disruption and damage in some places.

Sea-level rise poses a threat to Māori interests, assets, and values (King et al, 2010; Manning et al, 2015). Many Māori communities have ancestral ties with coastal areas, and these relationships are maintained with cultural heritage (e.g. marae, papakāinga and urupā) and mahinga kai (food-gathering sites). These interests and activities are deeply connected to identity and well-being.

How we currently protect value

In New Zealand, floods present a substantial and recurring risk to the regional economic development and the productivity potential of the regions. Each flood destroys assets owned by public and private entities as well as those owned by households.

Government policy is currently focussed on remedy for damage caused after a flood event, rather than mitigation of flood risk prior to the event. An excessive emphasis on remedy after the flood event and therefore an implicit acceptance of often irreversible asset destruction is contrary to: lifting productivity potential in the regions; jobs creation; social inclusion; and healthy societies; and improvement of the well-being of all New Zealanders and the environment we live in.

This focus has at least the following consequences:

- The Government bears an excessive unfunded future liability in its fiscal accounts to remedy damage from flood events. Risks of this kind may be viewed as fiscally irresponsible, as has been pointed out by the Australian Productivity Commission (below).
- Vital infrastructure such as roads, rail, and other public, private and household assets are placed at unnecessarily high risk of damage leading to disruption to economic output, and social and environmental well-being.

This disruption affects:

- Industries important for the nation's economic growth, such as tourism.
- Access routes, such as road and rail, essential for the nation's commerce.

Any insurance pay-outs for loss cannot fully redress the impact of the disruption. The whole nation bears continually increasing insurance premiums as successive flood events take their toll, while at a local level, individuals can find themselves either unable to re-insure or facing extremely high premiums.

The environmental damage to ecosystems from soil erosion and sedimentation of marine environments from floods, and subsequent loss of productivity of these ecosystems, is not accounted for in fiscal costs of central and local government but results in lowered production. The environmental damage to ecosystems from soil erosion and sedimentation of marine environments from floods is also damaging to the cultural value and amenity of marine environments.

Central government as an owner of land, roads and rail is exempt from rates and so does not contribute to local authority revenue that is applied for flood management infrastructure that would otherwise mitigate flood risk. This has at least the following consequences:

- There is an unfair burden borne by ratepayers since the central government as a beneficiary of flood risk mitigation is not contributing to meet its share of this burden.
- There is insufficient funding from regional authorities to meet the flood infrastructure requirements to protect assets of both ratepayers and central government. This leads to losses for both, in flood events. If central government did fairly meet its flood risk mitigation burden, both ratepayers and government would be better off, from reduction in losses from flood events and ongoing productivity.

Insufficient funding for regional authorities signals:

- Unsustainable local government resources.
- Unfair societies and unsupportive central Government.

Cost of failure of flood protection

Cost to the nation

After earthquakes (Local Government New Zealand, 2014), flooding is second in terms of insurance payment. It has a combined total (for about 60 flood major events) cost of approximately \$865 million since 1969 (in 2011\$).

The costs of hazard events (LGNZ, 2014) are not counted just in terms of the cost of replacing buildings and other property. Nor even in the number of human fatalities. Very significant costs can result from the economic and social disruption caused. Sometimes these are tangible (such as the number of hours or days businesses cannot operate at full production). Sometimes they are intangible, including social and cultural impacts that have both an immediate and sometimes on-going effects on people's lives (including their willingness to want to continue to live in areas subject to hazards). Other costs are associated with the public cost of responding to events. For example, government expenditure on civil defence responses during flood emergencies alone averaged about \$15 million per year over the period 1976-2004.

The 2004 Manawatu floods provide an illustration of the extent of these types of costs. Insured losses from that event were \$112 million. However, the cost to the agricultural sector alone in uninsured losses (lost production and uninsurable rehabilitation costs) were calculated at \$185 million. The cost of emergency services and infrastructure repairs was put at a further \$90 million. The flood was modelled as having a 150-year return period.

Cost to sectors

Estimates by Ericksen (1986) cited by the NZIER (2004) shows that for flood losses in Nelson and New Plymouth in 1970 and 1971, losses associated with central government works and services (roading, railways, bulk power supply, flood control and drainage works) amounted to 49 per cent of the total value of all direct losses⁴¹.

Using Ericksen's estimates for Nelson and New Plymouth as a guide, and assuming benefits are proportional to direct losses in this case, the private sector benefits from flood hazard mitigation

⁴¹ We note this percent was calculated on the basis of just two storm events.

amount to 39 per cent of all direct benefits, not including the benefit of averting lost income and production. Private sector benefits are accounted for by: losses associated with farm land; disaster fund pay-outs; insurance industry pay-outs; and uninsured property.

The Nelson and New Plymouth studies showed that losses backed by private insurance claims represent around 19 per cent of direct costs, excluding loss of income and production. This shows the burden of private insurers is ultimately borne by the nation in terms of higher insurance premiums.

Due to the complex systems and environments where river management is practiced in New Zealand, the occurrence of a potential shock can have an impact far beyond the immediate community that receives direct benefit from the scheme. For example, the March 2016 flooding of the Franz Josef township and closure of State Highway 6. This highlighted that the failure of flood protection in a small settlement on the West Coast can have a disproportionately large impact on national and economically-important tourism opportunities and connectivity.

There is a national benefit in simply having a connected and communicating nation. Asset failure compromises this.



Fig 1 Case study of flood hazard impacts Source: MCDEM Business Plan (2018)

What needs to change

The Australian Productivity Commission view

Internationally there are widespread views that management of natural disasters should place more emphasis on risk mitigation prior to the event, rather than remedy of loss after the event.

The Australian Productivity Commission (2014 at p 237) made recommendations that help us see the kind of initiatives that ministers can establish in New Zealand.

The Australian Government should commit to developing a more refined and forward-looking risk-based formula for the allocation of mitigation funding, in consultation with the states, and within five years. This should aim to distribute funding on the basis of where the net benefits to the community are likely to be

greatest in terms of reducing the economic costs of disasters (including damage to private and public property, injury and loss of life). The formula should be forward looking and reflect relative levels of future natural disaster risk across jurisdictions, the community's vulnerability and exposure to different types of natural hazards, and the likely effectiveness of mitigation measures. There would also be scope to review the minimum funding shares for smaller jurisdictions.

The Australian Productivity Commission (2014) noted the following concern for funding for natural hazard risks: natural disasters can have significant impacts on government budgets and balance sheets. This means that governments need to understand and manage the financial liability they are exposed to and put in place measures to finance natural disaster costs.

There are two broad options: drawing on a provision set aside before disasters occur (ex-ante financing), and, obtaining funds when a disaster occurs (ex-post financing). Both approaches have advantages and disadvantages, and the optimal approach will likely consist of provisioning for some risks ex ante and choosing to bear others ex post.

In New Zealand, since local government reform in 1989 and the change in government assistance from 1988 (acknowledging the up to 5-year transition), there has been an excessive emphasis on ex-post financing. This is likely to be unsustainable in the long-term. A balance of approaches is sustainable. The Australian Productivity Commission (2014) says that the imbalance at present is fiscally irresponsible:

Natural disasters can have significant impacts on government budgets and balance sheets. This means that governments need to understand and manage the financial liability they are exposed to and put in place measures to finance natural disaster costs. There are two broad options: drawing on a provision set aside before disasters occur (ex-ante financing) and obtaining funds if and when a disaster occurs (ex-post financing). Both approaches have advantages and disadvantages, and the optimal approach will likely consist of provisioning for some risks ex ante and choosing to bear others ex post.

The current budget treatment by the Australian and state governments is likely leading to governments retaining more risk than is optimal. This is because of inadequate understanding of the full range of contingent liabilities posed by natural disasters, and the overwhelming reliance on ex-post financing for recovery costs. Such an approach also accentuates the bias against natural disaster mitigation. This is because mitigation is funded on an ex-ante basis and is included in budget forward estimates, and consequently traded off against other spending priorities.

Natural disasters are a regular occurrence in Australia. This means that governments need to acknowledge and disclose the extent and uncertainty of the financial risks that natural disasters pose to their budgets.

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Edgecumbe flooding, April 2017



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