Journal of the Royal Society of New Zealand

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tnzr20

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**To cite this article:** Silvia Serrao-Neumann, Iain White, Samuel M. Dean, Ryan Paulik, Belinda Sleight, Fernanda Terra Stori, Matthew D. Wilson & Emily M. Lane (2023): The need to reconfigure consistency and variability to best manage changing flood risks in Aotearoa-New Zealand, Journal of the Royal Society of New Zealand, DOI: 10.1080/03036758.2023.2211777

**To link to this article:** https://doi.org/10.1080/03036758.2023.2211777

JOURNAL OF THE ROYAL SOCIETY OF NEW ZEALAND
https://doi.org/10.1080/03036758.2023.2211777

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# The need to reconfigure consistency and variability to best manage changing flood risks in Aotearoa-New Zealand

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**ABSTRACT**

Flooding is Aotearoa-New Zealand's most frequent natural hazard, and there is high confidence that climate change is making extreme rainfall events more frequent and intense. Additionally, there are significant development pressures which could both increase the number of people and assets at risk and the flood hazard. To date, there is no publicly available consistent approach to accurately determine flood risk on a national scale, nor for how this may be changing; although there is a growing legislative requirement to provide quality information over multiple spatial scales. This paper draws on empirical data to gain insights on how to best manage changing flood risks in Aotearoa-New Zealand from the perspective of centrally organised entities. Findings confirm the need for a nationally consistent approach to flood risk management, better understanding of Aotearoa's communities and their vulnerability to floods, equitable access to quality information and decision-support tools, and better understanding of the economic impacts on differing communities, regions and places. The paper concludes that to achieve a flood-resilient Aotearoa, flood governance needs to be reconfigured to achieve national consistency in flood risk management whilst enabling targeted variability at the local scale.

**ARTICLE HISTORY**
Received 28 October 2022
Accepted 1 May 2023

**HANDLING EDITOR**
Darren King

**KEYWORDS**
Climate change impacts; flood governance; planning; vulnerability; equity; economic impacts

## Introduction

Similar to many other countries, flooding is one of Aotearoa-New Zealand's (herein referred to as Aotearoa) most frequent natural hazards (Mason et al. 2021). While flooding is partially a natural phenomenon, climate change is increasing precipitation extremes in many locations and poor flood risk management practices can further exacerbate the problem. Effective flood governance plays a critical role here because it establishes the frameworks for multiple decisions, such as the need for flood risk

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Supplemental data for this article can be accessed online at https://doi.org/10.1080/03036758.2023.2211777

assessments, the nature and dissemination of data gathered, and the consideration of social, cultural, economic and ecological impacts (Plummer et al. 2018).

More recent literature on flood governance (e.g. Plummer et al. 2018; Wiering et al. 2018; Bottazzi et al. 2019) identifies flooding as a complex, multi-layered issue that requires multi-level collaboration as well as an adaptive approach that enables dynamic responses. A multi-level governance regime is predicated on the principle of partnership and emphasises the need for high levels of policy cohesion between national, regional and local levels whilst acknowledging the complex relations that unfold over different territories and scales (Bache 2012). In the flood governance context, this means a departure from traditional approaches focused on protecting communities through hard engineering structures to incorporating a wider variety of diverse non-structural measures, and seeking collaboration and integration among government levels and social actors (Plummer et al. 2018; Bottazzi et al. 2019; Winter and Karvonen 2022). These may include greater community engagement in the development or review of land-use planning policies, early warning systems, and emergency evacuation planning to improve their social outcomes. There is, however, limited evidence for how to achieve this in practice (Morrison et al. 2018).

This topic is important because it is estimated that two-thirds of Aotearoa's population live in flood prone areas (Royal Society of New Zealand 2016). Additionally, built and rural environments exposure to flooding is extensive, with over 400,000 buildings valued at NZ$135 billion located in mapped flood hazard areas, and an additional 107,000 hectares of dairy farm conversion on flood prone land between 2008 and 2016 (Craig et al. 2021). Over the last two years alone (2020–2022), damages from floods represented more than NZ$500 million in insurance claims (Insurance Council of New Zealand (ICNZ) 2022). The insured damage in Aotearoa from more intense extreme rainfall under the high-emission climate change mitigation scenario (RCP 8.5) (IPCC 2014) has been projected to increase 25% by 2080–2100 (Pastor-Paz et al. 2020). Additionally, there are many indirect (cascading) and intangible impacts from floods that are difficult to quantify, including the potential withdrawal of future investment in affected areas and the immediate and long-term impact on people's health and well-being (Smith et al. 2011; Lawrence et al. 2020).

Furthermore, rapid urbanisation combined with increased climate change impacts on average rainfall patterns is escalating flood risks across the country (Kreibich et al. 2022; Lawrence et al. 2022). Increasing trends in the occurrence of both monthly and daily rainfall extremes across Aotearoa have already been observed (Srinivasan et al. 2021), with climate change having been shown to have contributed to increasing both the risk and intensity of a number of recent extreme rainfall events that led to flooding (Stone et al. 2022). From analysis of regional climate projections, it has been identified that in the future the amount of rainfall in a 1-in-100-year event can be expected to increase, on average, by 6 percent per degree of warming for a multi-day storm, and 14 percent per degree for a one-hour flash flood (Carey-Smith et al. 2018; Ministry for the Environment 2018). Hydrological modelling has projected that increases in moderately high river flows will be largest in western and northern Aotearoa (Collins et al. 2018). However, no Aotearoa-wide studies have yet considered the current or likely future impact of climate change on actual fluvial or pluvial flooding extents and depths. Some local government authorities have recently produced flood maps that

account for climate change driven increases in rainfall extremes, but there is no consistency in the methodologies for how this is done, their spatial coverage, or in how results are communicated to the public or central government.

Flood risk management in Aotearoa has predominantly followed the conventional approach by relying on engineering solutions such as stop banks (levees) and land drainage, which allowed the development of low-lying areas and provided a relative sense of protection to communities (Tonkin + Taylor Limited 2018; van Buuren et al. 2018). While new science and policy developments have influenced practice, such as relating to climate change, long-held ways of knowing and doing still exert a significant influence (White and Lawrence 2020). Primarily being the responsibility of regional councils, these flood mitigation and protection schemes do not account for urban stormwater drainage which falls under the jurisdiction of territorial authorities (cities and district councils, which are geographically smaller units within regions) as set out by the Resource Management Act 1991 (RMA) (Resource Management Act 1991) and the Local Government Act 2002 (Local Government Act 2002). Notably, under this legislation, territorial authorities are required to avoid or remediate natural hazards, including floods (MfE 2010). Securing funding to either upgrade existing or build new flood mitigation infrastructure at both the regional and city scale, however, is challenging as current structures age and climate change alters known risk profiles (Tonkin + Taylor Limited 2018; Hutchings 2022). This will likely continue to exert pressure on the country's funding capacity, and compete with other national priorities such as transport, health and educational services (Hutchings et al. 2019).

There are also competing interests set out by current national policies with implications for managing flood risks, especially in the urban realm due to pressure to accommodate population growth and meet housing demand. For example, both the National Policy Statement on Urban Development 2020 (NPS-UD) (New Zealand Government 2022a) and the Enabling Housing Supply Amendment Act 2021 (New Zealand Government 2022b) make provisions for easier urban intensification and a consequent increase in impervious surfaces from both greenfield and brownfield development which, if not managed properly, can intensify urban stormwater runoff and increase urban flooding risks (Endreny et al. 2018; Reu Junqueira et al. 2021).

There is also potential to increase the number of people living in flood prone areas if urban intensification doesn't account for changing flood risk profiles as a result of climate change. In particular, flood risk management across Aotearoa varies considerably across regions, and currently there is no consistency as to whether and how flood risk is determined now and into the future (Rouse 2012; Tonkin + Taylor Limited 2018; Paulik et al. 2019). Further, local and regional governments vary significantly in their capacity to manage and mitigate hazard risks (Reisinger et al. 2011). This leads to a lack of consistency in data availability and accessibility and modelling approaches (e.g. AEP modelled, flood modelling methodology, climate change methodology) impeding the integration of regional and local flood risk information and thus the generation of a consistent national level assessment. The Ministry for the Environment (2020) concluded that

> the devolution of climate change adaptation responsibility to the local level, together with the lack of guidance for responding to flooding and other climate change hazards, is leading councils to address climate change separately and differently from each other.

> Under this arrangement, councils are exposed to legal liability for both adaptation action and inaction. (p. 183)

Further, irrespective of the variable approaches used by local and regional governments to assess and manage flood risk, the outputs from analysis which are used for decision-making contain uncertainty (Steinschneider et al. 2015; Quigley et al. 2019). Uncertainty is not often quantified nor characterised, yet it can make the process more challenging and less reliable (Steinschneider et al. 2015; Anderson et al. 2022). Uncertainty is present to a variable yet unknown degree across all stages of flood hazard planning, especially when the potential impacts of climate change on the flood hazard are included (Meresa et al. 2021; Meresa et al. 2023). This has implications for the determination of flood hazard zones or design of mitigation measures. To account for uncertainty, solutions may take a precautionary approach, such as adding a freeboard amount (additional floor height above the high-water mark used as a safety factor to avoid inundation) to required building floor levels in flood zones or designing flood infrastructure such as stop banks to a 1% annual exceedance probability. However, this approach is questionable in an era of changing risk under climate change. This creates a significant additional layer of uncertainty which means that, even when we adjust our flood hazard planning to account for future risk, we may lack confidence that they will be appropriate for future flood mitigation. What is certain is that flood risks will not diminish in Aotearoa and in light of the above-mentioned issues it is imperative that we rethink our current flood governance regime.

In this context, this paper aims to contribute to discourse on flood governance to best manage changing flood risks in Aotearoa from the perspective of actors involved with flood governance matters within centrally organised entities.[1] To this end, the paper draws on a set of empirical data collected as part of the 5-year Mā te haumaru ō nga puna wai ō Rākaihautū ka ora mo ake tonu: Increasing flood resilience across Aotearoa programme, which commenced in October 2020.

## Methods

The Mā te haumaru ō nga puna wai programme follows a transdisciplinary research approach (Lang et al. 2012) to develop a detailed nationwide flood inundation map which incorporates climate change projections to inform strategic and co-ordinated nationwide decision-making and regulations to support improved resilience to flood risk across the country. To achieve this, the programme is using a series of Science-Practice Roadshows to facilitate two-way information sharing between researchers, research partners and practitioners and to support the co-design of outputs to maximise their usability and usefulness (*cf.* Serrao-Neumann et al. 2020).

The first Roadshow, which is reported on here, was held on 28th October 2021, and comprised a 2-hour interactive workshop carried out through an online conferencing platform. Figure 1 outlines the structure of the workshop which included a panel session followed by three simultaneous but separate group discussions framed around a series of questions, and a subsequent joint report back session. Participants were invited from across a range of centrally organised entities – principally central government ministries and agencies, and sectors. A total of 18 participants from eight

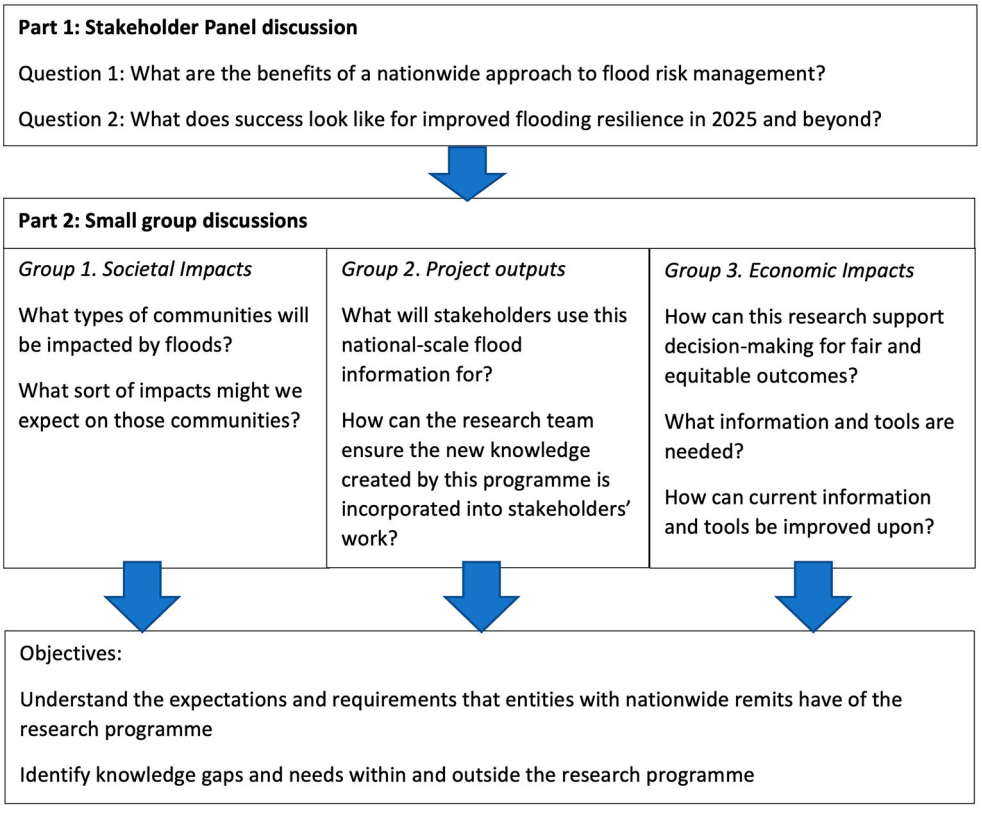


**Figure 1.** Overview of interactive workshop.

different sectors attended the interactive workshop, including: flood management (4 participants), housing (2 participants), land use planning (1 participant), emergency management (4 participants), finance (2 participants), iwi (1 participant), environment (3 participants) and governance (1 participant).

Empirical data were collected in accordance with the University of Waikato's Human Research Ethics protocols (Project # FS2021-50). Audio and video recording of the discussions were enabled on an online conferencing platform. Audio recording of the discussions was transcribed verbatim. Using NVivo software, transcripts from all sessions were coded and analysed thematically (Bowen and Bowen 2008), primarily through inductive coding (Roberts et al. 2019). Transcripts of the stakeholder panel discussions were read multiple times to extract key themes discussed by participants for each of the questions outlined in Figure 1.

It is important to note that the questions proposed for the small group discussions were used as prompts and not as closed-end answers, hence discussion points were not structured and evolved to different topics as participants interacted. The analysis of transcripts from the small group discussions involved two steps. First, to verify discussion transcripts, video recordings of the discussions were watched to match participants' comments with the notes posted in each session. Second, nodes were then created based on emerging themes. This was a highly iterative process reviewed many times by the

authors to refine the definition and identification of themes and nodes (see Tables SM1-SM3 and Figures SM1-SM4 in the Supplementary Material for more details on identified nodes).

## Results

Results are presented in two parts. Part one reports on findings from the stakeholder panel discussion on how to improve flood risk management. Table 1 outlines the key themes that emerged from the thematic analysis based on the two questions that were used to frame the discussion (see Figure 1). Overall, these themes revolved around the following points: the need for a nationally consistent approach to flood risk management; improved collaboration between regions; access to quality information; dealing with equity issues; and, a more resilient planning system with enhanced policy coherence between national and local policy objectives and between policy arenas, in particular housing and flood resilience.

Part two summarises the group discussions by highlighting four key messages based on core themes discussed during the small group sessions and reported back by participants (see Table 2). These included: the need to recognise the diversity of our communities and their vulnerability to floods; improved access to decision support tools at all levels; need for policy review and changes; and, better understanding of economic impacts on [differing] communities, regions and places.

### *Part 1: summary of key themes from stakeholder panel discussion*

Findings from the stakeholder panel discussion confirmed that there is a need in Aotearoa for a consistent approach to flood risk management. In particular, participants highlighted the disparity in how communities across the country are served by current flood defence infrastructure and the availability of flood risk information, along with differing community expectations regarding the level of service allocated to them.

> I think the nationwide approach, we've really been striving for consistency across the country. To some degree, we all like to be special and different, but if you put yourself in the place of a consumer, a land-use owner, a household; it doesn't really matter whether you're in Invercargill or Cape Reinga; if your house gets flooded, your house gets flooded. And you will suddenly end up with the same sorts of expectations about why

**Table 1.** Key themes emerging from the stakeholder panel discussions.

| |
|---|
| **Question 1:** *What are the benefits of a nationwide approach to flood risk management?* |
| Consistency in the risk assessment process |
| Consistent approach to flood risk management |
| Enabling collaboration |
| Ensuring Equity |
| Providing access to quality information |
| **Question 2:** *What does success look like for improved flooding resilience in 2025 and beyond?* |
| A flood resilient planning system |
| Access to quality information |
| Assessment criteria to measure success |
| Ensuring Equity |
| Policy alignment to avoid trade-offs |

**Table 2.** Core themes emerging from small group discussions.

| Group 1. Societal impacts | Group 2. Project outputs | Group 3. Economic impacts |
|---|---|---|
| ***Equity*** [a] | Communication and awareness raising | **A flood resilient planning system** |
| *Financial* | Data and information | Data information and management |
| *Health and wellbeing* | **Decision-making** | **Decision support tools** |
| Infrastructure | ***Equity*** | *Financial* |
| Māori/Iwi communities | *Financial* | *Health and wellbeing* |
| Risk awareness | Information review cycles/ updates | Insurance |
| Spatial scale | Partnerships | *Risk assessment and management* |
| **Vulnerable communities** | *Risk assessment and management* | Risk communication and awareness raising |

[a]Words in italic indicate theme similarity across discussion groups; words in bold indicate themes about which participants spent longer time discussing during the sessions and when reporting back to the whole group.

> has it happened to me? And why hasn't it happened to someone else? (Participant 1, flood management sector)

It was also stressed that a key benefit of a nationwide approach was to ensure consistency across the country, including by having a baseline approach that is standardised (Participant 2, emergency management sector). Further, consistency may also imply a consistent methodology for how flood risk is assessed, as outlined by a research specialist:

> We need a consistent, institutional architecture, around risk assessment, which is slightly different from just a methodology; and different methodologies will be more appropriate for different risks. (Participant 3, environment sector)

Such institutional architecture would imply that all agencies carrying out risk assessments, for a variety of hazards, do so in a coherent matter. This is because while different hazards (i.e. slow onset hazards, such as sea level rise, and fast onset ones, such as flash floods) may require different risk assessment methodologies or rely on different policy triggers, the results may need to be integrated to advance multi-hazard perspectives. This would also provide more evidence concerning how the identification and implementation of hazard specific mitigation measures may result in negative trade-offs or maladaptation. Additionally, creating a national-level, consistent and integrated hazard approach, is the basis for improved collaboration between regions and gain better oversight of the increasing flood risks, the cascading effects, and the corresponding management options. This would make flood risk management more effective and efficient in comparison to having individual regions working by themselves in diverse ways:

> I think by sharing and working together, and having that overarching view, we can really make a much better difference, as is to how we get this flood risk dealt with. It's going to be there and it's only ever going to get worse and worse, and by having a national perspective of it, we all put our minds together and we can get a collective outcome; it will be much better, than all of us beavering away on our own individual little spaces and trying to share, to get it and do our bit for our area. (Participant 1, flood management sector)

Another point of consideration raised by panellists was the need to make access to quality flood risk information more widely available. This means providing nationwide information in a way that is accessible to a range of audiences, especially for people who make decisions about land use and development on a regular basis such as government agencies, insurers and landowners. This is particularly important to avoid placing more people at risk of flooding:

> And also provide the information in a way that is accessible to people like myself, but most importantly, to the people on the ground; to the people that make decisions every day. Not just the councils that make obviously, really, really important decisions around where houses are being built; but people that are buying houses, people that are building houses … (Participant 4, finance sector)

> So, we really need good information and good data that's easy to access and make decisions on, so that we can actually reduce risks and not keep developing in these dodgy [at risk] areas. (Participant 2, emergency management sector)

Quality flood risk information also implies that this information, and the way it is produced, is nationally standardised. For example, currently there is no agreed national level guidance for modelling urban stormwater or for displaying 'risk' thresholds. However, given the changing flood risk profile due to climate change (Stone et al. 2022), it is important that flood risk information is consistently generated across the country based on agreed sources of information and data, agreed baselines, agreed ways of quantifying and displaying risk, and agreed modelling approaches (e.g. approaches that account for climate change projections and not only historical flood data).

Ensuring equity across the country was also raised by panellists as an important point. Relating to the discrepancy in how communities are served by flood risk management strategies and information, it was stressed that current inequality may be exacerbated with climate change:

> I think that the whole equity issue, around who gets protection, who doesn't, who lives in these hazard-prone areas; equity is going to be a huge issue going forward in the future, with climate change. (Participant 2, emergency management sector)

Participants also raised that we need a flood resilient planning system and better alignment to enhance policy coherence. In particular, at-risk areas should not be ear-marked for urban development and we should avoid the current situation where national policy statements have conflicting objectives with no clear hierarchy, such as development intensification versus management of natural hazards.

> … so that we're not continuing to put development in places where we all know it shouldn't go, but for a whole range of different reasons, we continue to develop in places that we know are going to get exposed to flood risk. (Participant 1, flood management sector)

> … at the moment, there's a number of different tensions and drivers; the bill that's come across for more intensified development. So, we've got a real push–pull with the national policy statement on urban development, for development, and natural hazards are a qualifying matter, and the bar is quite high; and … is very concerned about how high that bar is for qualifying matters. (Participant 2, emergency management sector)

These tensions and drivers are at the forefront in those urban areas which are under increased pressure to accommodate population growth and increase housing supply. On the one hand, there is a need to address the national housing deficit (New Zealand Government 2022a, 2022b); on the other, increased urban densification, if not tightly integrated with hazard planning, can increase impervious surfaces and urban runoff leading to floods (Endreny et al. 2018; Reu Junqueira et al. 2021). This, however, is not the only conundrum the planning regime has to deal with. A flood resilient planning system may also consider opportunities to discuss and implement planned retreat, or

where the science is clear, start the conversation with communities that might be at high risk before major events happen, such as the ones that affected Westport in 2020 and 2021 (Ministry for the Environment 2022) or be in position to quickly discuss options in the aftermath of events, like those that occurred in Auckland and Hawke's Bay in 2023 (National Emergency Management Agency 2023a, 2023b).

> It'd be great if there was a framework in place for triggering managed retreat from some of these areas. So, when an event does happen, like in Westport, there's not this huge time component taken up in decision-making, around what should we do? We do need to relocate, but are we going to do it now or later? Meanwhile, the insurance is paid out, people have started repairing; then they don't really want to move, because they've invested back in their homes. (Participant 3, environment sector)

### *Part 2: summary of key messages based on core emerging themes from group discussions*

Participants emphasised that floods impact communities in very different ways. They also stressed that many of these impacts are likely to be intangible and compound current conditions of marginalised communities:

> You need to overlay that vulnerability aspect on, because you could have two identical houses next to each other, identical flooding; but their impact will be very different depending on just their individual circumstances … different aspects of vulnerability. (Participant 5, flood management sector)

> … we've got 70,000 houses in our nationwide social housing portfolio; and a lot of these houses are in lower socio-economic areas, and a lot of those areas are next to rivers. (Participant 7, housing sector)

Hence, in-depth understanding of vulnerability across differing social groups is critical to policy implementation to ensure they do not exclude the most vulnerable people from decision making (Adri and Simon 2018) or exacerbate their vulnerability. It is also important to acknowledge that vulnerability to social and environmental changes is multifaceted and requires an understanding of a complex array of drivers, scales and processes (Fekete et al. 2014). In particular, vulnerability is determined by the interplay between 'geographic location, production system, social identity and income' (Ribot 1995). For example, it was recognised that Māori communities may be disproportionately affected because their loss is not confined to physical structures, but extends to their cultural practices:

> … most iwi are named after tūpuna (ancestor), but some of them are also named after historical events; and those historical events are associated with landmarks or locations. And so you know, with losing and damage to those sites, you're effectively impacting the history of those people … a lot of what we've talked about, Mātauranga Māori, Te Ao Māori, is interwoven into the whenua and into the water. And, so when damage is created on either side, whether it be land or water, it will have those social impacts, environmental impacts and future impacts to come. (Participant 6, iwi)

At the core of improving how flood risk is to be understood and managed, participants identified the need for decision support tools that are not only fit for purpose by a variety of actors and agencies, but suitable and widely accessible to different audiences. This is to

ensure that decisions are made based on the best available information about flood risks, including how risk profiles may change due to climate change impacts so as to avoid policy failures and maladaptation in the future. This also means that there is a need for policy to be reviewed in a more dynamic way to account for the latest developments and findings regarding flood risks, including the inherent uncertainty to how flood risks are modelled or to include multi-hazard perspectives.

> We're making some assumptions here, that these are maps; and we're dealing with a dynamic situation; which is managing risk in the future, some of which is uncertain … is sort of trying to get something that could be live; why wait six years to update information, why can't we have live interactive stuff, where data gets put into it on a platform. (Participant 3, environment sector)

Finally, discussions also pointed to the need to better understand the economic impacts of floods given the diversity of communities and regions across the country. In particular, not only do their vulnerability and exposure to floods vary, but also their capacity to manage flood risks, especially when economic impacts cannot be separated from social ones.

> We keep trying to take the impact on people back to dollars; and then use dollars as the proxy to make decisions off. But when you sit across the table from these people who have been flooded and they've been fearing for their lives, and they've had their children inside and the water levels are moving through, up on the exterior glass in the lounge, which isn't safety rated, let alone waterproof; you get a very different feel about people's tolerance for risks, prior to an event happening, and then the trauma they experience after. (Participant 16, flood management sector)

> It's not all about economics, there's a whole lot more that's involved in this decision making; it's actually about people and the environment, and various other things. So, we've had a too narrowed perspective in the past and we actually need a broader perspective that actually has some real weight to help us make some better decisions. (Participant 1, flood management sector)

## Discussion: the need to reconfigure consistency and variability within a multi-level flood governance regime

This paper has sought to add to discourse on effective flood governance in Aotearoa by revealing the perspective of actors from centrally organised entities responsible for managing or reducing risk. Workshop participants identified a range of problems with the current flood risk policy settings and the risk management practices they foster and some opportunities for improvement. In particular, they identified multiple issues related to the lack of national consistency in the current flood risk management regime, from inconsistent methodologies used to assess flood risk, through to disparities in flood risk management on-the-ground, or resource allocation to affected regions and communities. Participants also acknowledged that there are many localities and communities across the country which are currently at-risk and that the current planning regime continues to allow development that they fear will exacerbate the problem. While these issues span a variety of factors, they point to the need for a multi-level flood governance system and policy agenda that is designed to provide both a consistent national framework and space for targeted variability at local levels to allow for innovation, culturally

appropriate approaches, and integration with other policy. We use the term targeted variability to recognise that while a more comprehensive and consistent national strategy is needed, as communities have different risks, preferences, or resources, we also need to leave scope within this framework for flexible approaches to enhance effectiveness and equity. For example, more targeted outreach or engagement in areas with high social vulnerability. The following discussion elaborates on this reframed policy agenda in more detail.

We should first acknowledge that this policy context is not unique to Aotearoa. A key challenge of any national flood management regime is to outline a clear multi-level governance framework where consistent, national policy is reconciled with the need for local variability, uncertainty, collaboration and autonomy (Kaufmann 2018; Plummer et al. 2018). Other jurisdictions with more complex governance arrangements, for example the European Union, have advanced policy coherence across different catchments and countries by agreeing core principles of risk management and a common framework for understanding and mitigating risk (European Union 2007). Within this, there may be regional and local discretion and variability in designing policies and plans that are suited to diverse contexts, as long as these are aligned with the overall aims of the flood legislation (Wiering et al. 2018). Further checks and balances, such as transparent reporting against risk reduction goals, provide a further means of achieving coordination, comparability and a measurable risk reduction and resilience regime.

Turning to the issue of flood risk governance and policy agenda in Aotearoa, our findings suggest that multiple areas would benefit from a consistent national approach. The first relates to the underpinning issue of flood risk data. While there is a national mandate to provide flood risk information (i.e. Section 31 (1) and b (i) of the Resource Management Act 1991), there is no guidance on how this should be conducted. Without common understandings of key terminology, thresholds, risk scenarios, or timescales, and a shared methodological approach that adheres to defined data availability and quality standards, it is impossible to ascertain two crucial aspects: either a national picture of flood risk, or to benchmark our current risk against future risk reduction targets, which is fundamental in monitoring policy implementation and success. A further issue is that this approach fails to capture and acknowledge issues connected to unevenness of capacity, skills and resources, and subsequently where national investment could be most effectively targeted to enhance the quality of local or regional flood risk data. A national approach that shifted from *requiring* data to be collected and disseminated to also delineate *how* it should be collected and disseminated is fundamental to a coherent national strategy.

The fundamental issue of flood risk data variability (i.e. data availability, quality and quantity) also affects the way in which this risk is perceived and acted on. More standardised approaches to the collection of information would provide the platform for more consistent treatment of uncertainty, more coordinated national risk communication practices, and enable a deeper understanding of why and how users act on those messages. Consistency in the presentation of flood risk data also enables more shared best practice on its application in decision-making, reporting against national risk reduction objectives, or analysis of its weighting against other public policy priorities. The current national approach is a common one in public policy, which seeks to avoid being too prescriptive and enable diversity of interpretation, and can be successful (Wiering et al.

2018), but for the specific issue of flood risk management it has created significant *ad hoc* variability in an area that would benefit from significant consistency.

The need for greater consistency is, therefore, key to enhancing national scale policy, and of enabling coherence across both the broad policy framework and the technical practices of data collection, assimilation and dissemination underpinning this. However, it is important to note that, for some locations or communities, targeted variability is a key facet of effective flood risk management policy. No matter how much scientific rigour is pursued and applied, uncertainty is an ever-present feature, but one which is infrequently quantified and less understood (Quigley et al. 2019; Hanna et al. 2020; Anderson et al. 2022). Science is moving rapidly with regards to climate change (Wing et al. 2022) and so any approach needs to be flexible enough to integrate new knowledge as it appears without creating a more uneven policy landscape. Yet, even if we use the best possible data, model representations and other approaches in flood risk management, uncertainty will still be present (Moure et al. 2023), resulting from a complex combination of errors associate with source data, sampling and model representation (Meresa et al. 2021). These epistemic uncertainties can, at least theoretically, be reduced through improvements in data and methodologies. They are, however, compounded by uncertainties which are aleatoric in nature, caused by issues such as internal variability in the climate system. This means that while effective flood risk management policy will always need to account for uncertainty, we can provide more certainty for decision makers by being more consistent in how we treat data and the subject of uncertainty more generally.

The second overarching issue relates to how this uncertainty stretches from potentially quantifiable epistemic or aleatory uncertainties, to more qualitative uncertainties (Hanna et al. 2020; Moure et al. 2023; Noll et al. 2023). These may include the political context of local flood risk management decision-making, where there may be competing and complex drivers, and the uneven impacts on diverse communities at risk (Quigley et al. 2019; Rözer et al. 2022). Approaches that become too focused on consistency (e.g. using dollar values to guide risk assessments) can be blind to equity, difference, or local contexts (Parsons and Fisher 2022). For example, despite having a centralised legislation, European jurisdictions vary in the way flood governance changed to challenge or displace traditional flood defence approaches (Wiering et al. 2018). In the Dutch system, for instance, the dominant defence approach impeded the emergence and establishment of alternative approaches (Kaufmann 2018). This highlights the difficulty in developing governance systems that are simultaneously fit for the local context while benefiting from wider, broader institutional coherence and consistency (Fraser et al. 2020). Ideally, the national system would allow individual communities to develop distinct adaptation pathways and trigger points that acknowledge a multi-hazard perspective and progressively reduce risk over set reporting timeframes. They would also use strategic spatial planning over longer time horizons to help reconcile and provide guidance on the perennial tensions relating to economic growth, climate change, and short-term politics.

Given the close relationship between flood risk management to land zoning, uses and resources, national policies could also provide targeted variability to help exacerbate historical injustices, such as the ones associated with settler colonisation. In particular, the discussions emphasised that flood impacts on Māori communities can not only be

experienced differently but also raise more complex issues of loss of cultural practices and connections to place and knowledge. Historically, some flood mitigation measures have failed to recognise Māori interests, values and customary practices (Parsons and Fisher, 2022) and may not reflect fundamental principles of self-determination, such as enshrined within the United Nation's Declaration on the Rights of Indigenous Peoples (United Nations 2007). It is also difficult to establish the full scale of flood impacts on communities across the country as knowledge about their social vulnerability and recovery is limited (Mason et al. 2021). Difficulties in calculating the impacts is further compounded when multiple events happen simultaneously and attention shifts to larger events with catastrophic impacts (Wisner and Gaillard 2009). This was seen in August 2022 when Nelson and other parts of the country were affected by severe floods, but the former dominated the news headlines (RNZ 2022).

Further, in any locality, flood risk management is only one of many policy aims and typically not the highest risk profile. For example, currently, local authorities, are paying significant attention to many related issues such as infrastructure provision, economic growth or managing the impacts of a deregulated housing supply regime. Hence, the focus on natural hazards shifts up and down priority lists based on how intense their impacts are, configuring a typical reactive approach to disaster risk management (Gray et al. 2021). Increasing climate change impacts may place flood risk management as a high national priority but competition for funding will likely continue (Hutchings et al. 2019), and, as seen elsewhere, effective flood governance change may not eventuate (Kaufmann 2018). This involves approaches that go beyond a more egalitarian distribution of national funds to recognise the wider intersecting disadvantages and variable support needed to offset technical risk analyses that tend to see people and communities as homogeneous entities in a given spatiality (O'Hare and White 2018).

The evidence in this paper argues that a flood resilient Aotearoa requires enhanced policy coherence by providing a multi-level flood governance framework that promotes greater national consistency, while also highlighting those areas that may require more targeted local variability. How we know risk, measure it, compare it, or make it visible needs to be more consistent, and coordinated, but without compromising the potential for data to assimilate new knowledge and inform decision-making as science emerges, such as with regard to emerging perspectives on the need to consider multiple hazards. How we act on risk needs to allow local variability, such as within spatial planning approaches that can reconcile competing objectives over longer timeframes, and become accustomed to a more dynamic policy context where information may be updated in an emergent fashion.

## Conclusions

This paper has sought to add to discourse on effective flood governance in Aotearoa by revealing the perspective of actors from centrally organised entities responsible for managing or reducing risk. This is important as the current practices need to both be effective, and acknowledge the extent to which climate change is set to escalate the intensity and frequency of extreme rainfall events. While many insights can be extracted from the discussions, we identified two pressing issues that need to be addressed within a multi-level flood governance framework designed to achieve greater policy cohesion and a flood-resilient Aotearoa, namely: national consistency and targeted variability.

First, our findings pointed to the lack of national consistency in the way flood risk is assessed, determined and understood. They also confirmed the disparity in local and regional capacity not only regarding the unevenness in which flood risk assessment is performed due to data issues but also their differing technical and financial capacity. It was also confirmed how current policies, especially related to land use planning, have competing priorities such as accommodating growth and addressing natural hazards, therefore raising the potential for placing more people at risk of floods. Participants also highlighted the potential of spatial planning in assimilating risk science with economic growth imperatives and providing clarity that can help decision making. This leads to the second point: targeted variability. While national consistency is required, our findings stress the need to also allow for targeted variability in flood management practice to acknowledge the complex relations that unfold over different territories and scales. This should be guided by the local context so as to address equity issues in the way communities are affected by, respond to and recover from floods. A key message was the broad dissatisfaction with the current regime and the need for a significant review to avoid passing on avoidable risk to future generations.

We acknowledge our findings have limitations because they only report on the perspectives of a limited number of actors involved with flood governance matters within centrally organised entities and further research is required to provide a clearer picture of these issues across the country, especially concerning how targeted variability in flood management may help resolve equity issues on-the-ground. Nevertheless, as climate change may escalate current social vulnerability issues, the findings emphasise it is imperative that we work towards a multi-level flood governance framework that is much more nationally consistent, but while still leaving scope for targeted variability to better manage changing flood risks and thus minimise the harm floods can inflict on our communities, especially our most vulnerable people.

## Note

1. These include government and non-government entities that have a national-level body of representation such as central government agencies and private sector organisations (e.g., finance, infrastructure).

## Disclosure statement

No potential conflict of interest was reported by the author(s).

## Funding

Funding for this project was provided by the New Zealand Ministry of Business, Innovation, and Employment (MBIE) Endeavour Fund through the National Institute of Water and Atmospheric Research (NIWA) programme *Mā te haumaru ō nga puna wai ō Rākaihautū ka ora mo ake tonu: Increasing flood resilience across Aotearoa* (contract C01X2014).

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