Earth Sciences New Zealand

Societal vulnerability to flooding: Auckland case study

Summary of qualitative insights and description of a causal diagram

Prepared for MBIE programme: Increasing flood resilience across Aotearoa

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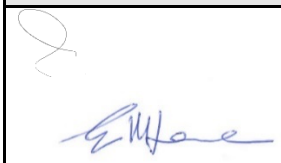	Reviewed by:	Stephen FitzHerbert Emily Lane
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Executive summary

Flooding is Aotearoa New Zealand's most frequent and consistently damaging hazard. It results in injuries and death, stress, loss of property, reductions in quality of life and delays in life progress (e.g., education), as well as significant financial cost for individuals and society. An increasing frequency and intensity of extreme rainfall and floods due to climate change will increase both the tangible and intangible effects of flooding over time.

The MBIE-funded research programme *Mā te haumaru o ngā puna wai o Rākaihautū ka ora mō ake tonu: Increasing flood resilience across Aotearoa* aims to improve understanding of flood risk and increase flood resilience in Aotearoa New Zealand. Among other things, the programme seeks to improve understanding of how flood impacts cascade (flow on) through Aotearoa New Zealand's social and economic systems. This helps us understand whether and how communities can tolerate future flood risks, and what efforts might be targeted to reduce future community vulnerability to floods.

To investigate flood impacts and resilience, three case study communities subject to repeat flooding were identified: Auckland, Waikanae and Little River/Wairewa. Semi-structured interviews were undertaken with a range of participants in each area. Findings from all case studies were initially collated into a thematic analysis, identifying important issues and topics that were raised, and commonalities across the case study areas. Then for each individual case study, the cause-and-effect relationships between key interview themes were identified and supplemented with key findings on local cascading (flow-on) flood impacts emerging via media reports. Additional analysis followed to explore causal relationships. These were developed into a causal diagram to capture the dynamics of cascading flooding impacts in each case study.

This report summarises the findings for the *Auckland* case study.

Eight key groupings of causal relationships were identified that represent the way in which Auckland communities may become more or less vulnerable due to flooding. These groupings, along with feedback loops that help explain their dynamics, comprise the causal diagram outlined in this report. The causal diagram demonstrates how each of the groups, loops and variables interact and influence one another over time. The eight key causal groupings for Auckland were:

- *Catchment/cross property level flood threat mitigation* – how experience of flooding influences the degree to which people and communities demand collective actions at the catchment/cross-property level to reduce future flood risk (e.g., hard and blue-green infrastructure). Additionally, how this demand for action sits within the wider context of the legislative and financial constraints that council faces.
- *Property level flood threat mitigation* – how experience of flooding influences the degree to which people personally take actions at the property level to reduce future flood risk or demand residential property buyouts. This includes whether homeowners have the ability to sell their flood-prone homes without government buyouts.
- *Council and government funds* – the influences on the availability of council and central government funds to pay for flood mitigation, recovery and response work

(including property buyouts). Additionally, how gaps between public expectations of financial assistance during a flood and the amount of financial support received can affect trust in authorities.

- *Community trauma* – the ways in which flooding can directly and indirectly cause significant stress and trauma during and following an event.
- *Dislocation* – the flow-on effects of flood-related dislocation on stress, overcrowding and access to work, education, family, and support systems.
- *Business operability* – the influences on local businesses' ability to operate following a flood event, including flood damage, staff availability, and insurance.
- *Insurance* – the relationship between insurance cover and the ability of local businesses to operate following a flood event, including the ability to afford cover.
- *Disruption to everyday life* – the ways in which flooding affects people's ability to function in everyday life due to damage incurred by homes and transport infrastructure.

Across the three case studies, we identified four high-level interactions that contribute an understanding of how flood impacts cascade through Aotearoa New Zealand's social and economic systems in ways that, if unaddressed, can increase community vulnerability to harm. These are *time*, *tolerance*, *adaptation willingness*, and *agency/hope*:

1. It takes *time* for the full consequences of floods to become apparent, and the time between events matters – if flooding occurs again before people are fully recovered, their trauma or stress accumulates, with implications for community wellbeing and relationships with councils. Time also fades memories – without knowledge of what has happened in the past, there is little motivation for change and actions to reduce the risk of future flood impacts.
2. *Tolerance* to flooding varies, particularly to the cumulative impacts from flooding. Threats to life, quality of life, property investments, and personal investments in future lifestyles all affected people's willingness to tolerate future flooding.
3. The *willingness to take adaptation measures* to reduce future flood risk is affected by both personal and collective experience or knowledge of past impacts.
4. Where there is personal, collective, and council *agency* to adapt to future flooding risk, people have *hope* for their future in place in their community. The perceived ability to manage flood risk supports, and is motivated by, connection to place and community.

Addressing these causes of vulnerability should happen across the 4 Rs of emergency management – Reduction of risk, Readiness and Response to events, and Recovery from events. This includes:

- Supporting people's ability to function in everyday life over the extended recovery period.

- Acknowledging and mitigating the trauma caused by flooding, no matter the scale of events.
- Promoting community connections and functioning before, during and after events.
- Creating and maintaining collective knowledge about flood events to increase the appetite for flood harm reduction measures.
- Building and maintaining collaborative working relationships between communities and their respective councils, and
- Supporting investment and regulations that manage and mitigate flood risks.

For communities in Auckland specifically, this raises questions about how best to increase understanding of the individual and collective actions that can be taken to reduce flood risk (and their limits), how to maintain productive working relationships between Auckland communities and council, how to minimise the disruption associated with evacuation and displacement, and how to sustain the community connections that are essential for residents' ability to tolerate and recover from flooding.

1 Introduction

1.1 Programme information

Flooding is Aotearoa New Zealand's most frequent and consistently damaging hazard. Floods can result in injuries and death (e.g., NZ Herald 2019; NZ Herald 2023; Weekes and Ryan 2015), as well as other significant impacts such as stress, loss of personal artifacts and family heirlooms, reduced quality of life and delays in formal education (Fernandez et al. 2015; NZIER 2004). At a financial level, floods in Aotearoa New Zealand regularly damage houses and infrastructure networks, causing months of disruption to communities and businesses. The Insurance Council of New Zealand (2024) estimates the annual cost of extreme weather to Aotearoa New Zealand to be generally in the order of NZD$350 million, with individual flood events being especially costly. For example, the New Zealand Treasury estimated total damages from the 2023 Auckland Anniversary floods and Cyclone Gabrielle to be NZD$9–14.5 billion (RNZ 2023a). Recovery planning for the Auckland Anniversary weekend floods of 2023 is presently in the order of NZD$4 billion (Scott 2023).

Flooding around Aotearoa New Zealand reflects a variety of factors including low-lying coastlines (rendering the area susceptible to coastal inundation during storms), steep hills (contributing to flash flooding) and often urbanised environments (where absorption of overland flows is limited by the scale of the drainage systems and or available land for over wash).

As climate change is projected to increase the frequency and intensity of extreme rainfall, the effect is that floods are likely to occur more often (Ministry for the Environment 2010), increasing the scale and frequency of tangible and intangible flood impacts over time.

The MBIE-funded research programme *Mā te haumaru o ngā puna wai o Rākaihautū ka ora mō ake tonu: Increasing flood resilience across Aotearoa* aims to improve understanding of flood risk and increase flood resilience by providing better evidence for public policy (NIWA 2024). Among other objectives, the programme seeks to improve understanding of how flood impacts cascade through Aotearoa New Zealand's social and economic systems. This understanding provides the foundation for considering whether and how communities can tolerate future flood risks, and what efforts might be targeted to reduce community vulnerability to floods in the future.

This report outlines generalisable insights on the cascading nature of flood impacts across Aotearoa New Zealand. It is not intended to identify specific, prescriptive recommendations for action – this would require dedicated policy research and assessment.

To understand the cascading impacts of flooding, the following steps were taken:

- Three case study communities subject to repeat flooding were identified: Auckland, Waikanae, and Little River/Wairewa. The case study communities were consulted to identify the cascading impacts that they experience. The case studies were selected to capture a variety of flooding histories as well as data availability, community appetite for engagement, the research team's community connections, utility for meaningful change at local, regional, and national scales, and provision to increase understanding.

- Within each case study, residents, government and non-government agencies affected by flooding or involved in flood planning or response were identified for interview. Potential interviewees were identified using personal contacts, recommendations from relevant agencies, and via snowball sampling (where participants are selected based on characteristics relevant to the study, and on recommendations from other participants).
- Approval was obtained via NIWA's Human Ethics process to interview potential participants.
- Semi-structured individual or paired interviews were conducted with participants between mid-2022 to mid-2023 to discuss the cascading impacts of flooding. Most interviews were conducted online. Participants were asked about their experiences of flooding – the effects they experienced, how they coped and what they would hope to see in the future. Community members who had directly experienced flooding were also asked about their tolerance for future flooding, and how this may or may not affect their willingness to remain in place.
- Thematic analysis of the interviews was conducted to identify key themes from the interview transcripts (Braun and Clarke 2013). Comparisons between case studies allowed for the identification of commonalities and differences to how flooding impacts communities.
- To develop the causal diagram, the team reflected on the different themes from the interviews. Through a process of iterative refinement, we identified variables from these themes that could best be represented in a causal diagram (i.e., ones that can be phrased in such a way that they have a natural sense of direction - they could increase or decrease). Drawing on the interview data we then identified cause and effect relationships between these variables and collated them into a causal diagram, with a specific focus on seeking to identify feedback loops where possible.
- Each case study's draft causal diagram was supplemented with key findings on local cascading flood impacts derived from an analysis of media reports.

Causal diagrams are a tool developed under the discipline of Systems Dynamics, a conceptual framework aimed at helping us to understand the behaviour in complex systems over time. Causal diagrams are used to identify and display the various factors concerned with an issue and how they interrelate (Senge 2006; Sterman 2000). This helps us understand which parts of a system have the greatest influence and to identify areas where action might be expected to influence matters (Senge 2006).

In this context, the complex system under consideration is flooding – specifically the variety of cascading social and economic impacts of floods that communities experience and the interconnections between those impacts in communities.

1.1.1 Caveats

In this report we use the term 'community' to refer primarily to place-based communities; that is, people living or operating in a common location and geographical proximity. This definition can include residents, businesses and formal and informal organisations and groups. However,

we acknowledge that the term 'community' can mean many things to different people and that not everyone in Auckland may identify as belonging to that place-based community. (For example, some may identify foremost with their local suburb.) Further, they may identify with other non-place-based communities more strongly. Some people may also live or operate in Auckland but not hold the same views or participate in the collective activities that participants described to us.

In their own use of the term ‘community’, some participants may have adopted alternative or broader ‘catch-all’ meanings or identities. We have not amended or attempted to define their specific application(s) of the term, simply quoted the wording they used.

Our research was based on findings from a sample of individuals affected by flooding or involved in flood management across Auckland. As well, our interviews were conducted in 2022 and 2023 (with all but one taking place in 2023 following the Auckland Anniversary floods). Consequently, the insights gained are time bound to that period. More floods have occurred since this time (e.g., in March 2022, January 2023, February 2023 and May 2023) and people’s experiences, recollections, perspectives and attitudes can evolve as a result. In view of the sampling and timing of the research, the insights gained will not reflect all the experiences, values, opinions or worldviews of people in Auckland. Nevertheless, they should still provide generalisable insights of flood impacts that provide a useful basis for planning for much of the community.

This report sets the scene with a high-level overview of the Auckland region in Section 2. Section 3 presents the analysis of the initial themes from the interviews. Section 4 describes the causal diagram approach used and how to read them, and Section 5 presents the causal diagram for Auckland and its key feedback loops. Finally, Sections 6–8 discuss the implications of the findings generated by this study for the future efforts to increase flood resilience.

2 Auckland/Tāmaki Makaurau

The Auckland region/Tāmaki Makaurau is located in the north of the North Island on a narrow isthmus of land situated between the Waitematā Harbour and Hauraki Gulf to the east and the Manukau Harbour to the south-west (Figure 2-1). The name ‘Tāmaki Makaurau’ can be translated as 'Tāmaki desired by many', reflecting the area’s strategic location and abundance of natural resources (Auckland Council 2024a).

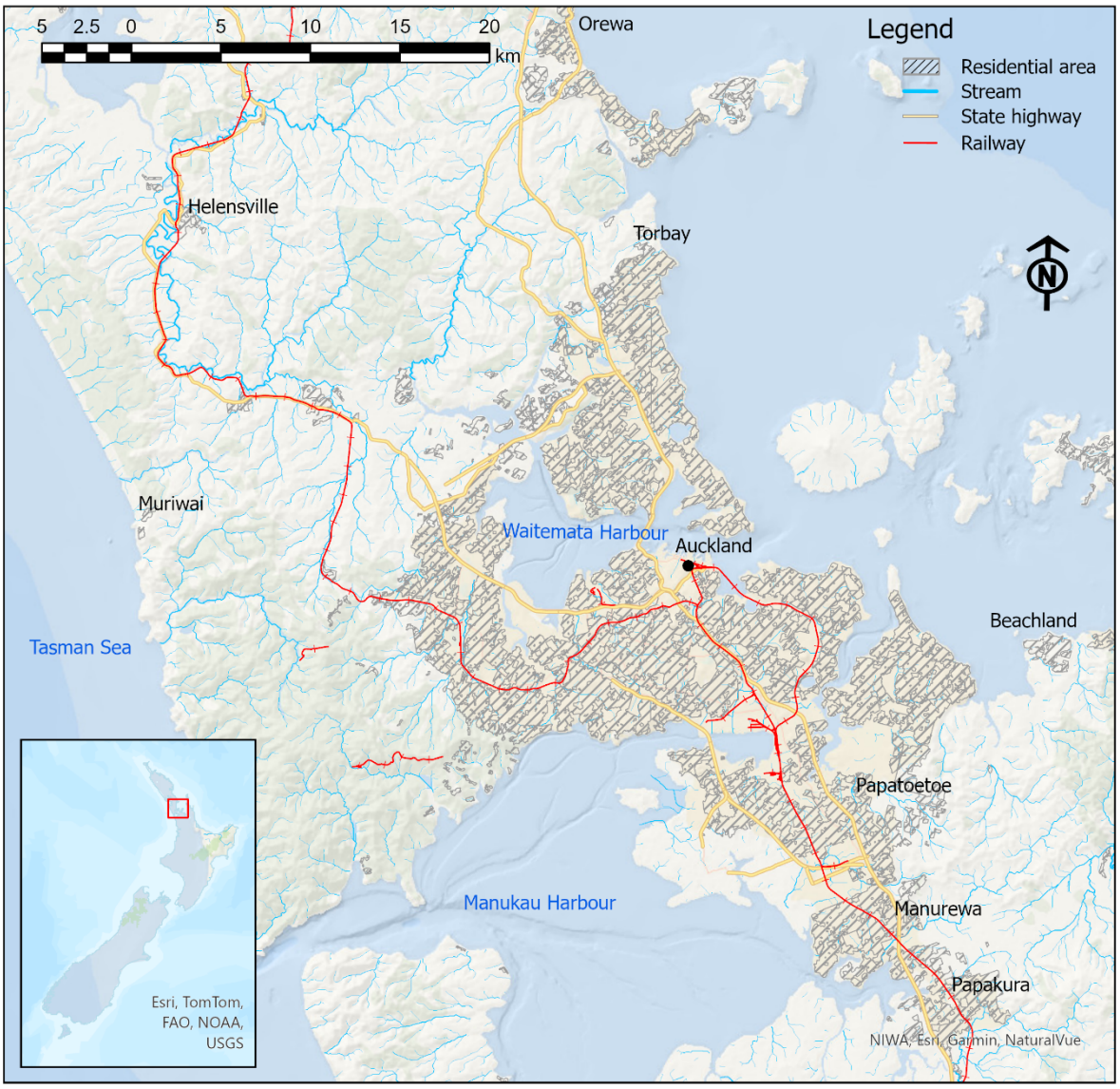

Figure 2-1: Auckland Tāmaki Makaurau, Aotearoa New Zealand.

With over 1.6 million residents, the Auckland region is Aotearoa New Zealand’s most populous, home to approximately 33 per cent of the country’s total population (Stats NZ 2024). Auckland’s population is spread over a wide geographic area and is diverse, with 49.8 per cent of residents identifying as European, 31.3 per cent identifying as Asian, 16.6 per cent identifying as Pasifika, and 12.3 per cent identifying as Māori in 2023 (Stats NZ 2024).

Auckland has a history of flooding, with flash flooding during heavy rainfall events a particular problem given the presence of both steep and short catchments (Auckland Emergency

Management 2025). According to the Insurance Council of New Zealand, at least 14 major flood/storm events affected Auckland between 1984 and 2019, averaging an event roughly every two years (Insurance Council of New Zealand Undated). However, some years were especially difficult. For example, 2016 saw three flood events reported for Auckland (Insurance Council of New Zealand Undated). Likewise, 2023 was an eventful year for Auckland, with flooding occurring over January, February and May. In the 2023 Auckland Anniversary weekend floods (27th January–2nd February 2023), Auckland received half its annual rainfall over the course of four days, resulting in the deaths of four people and moderate to significant damage to over one thousand homes (Stuff 2023). Similarly, floods associated with Cyclone Gabrielle (February 2023) resulted in the deaths of two firefighters in a landslide while 224 buildings were rendered uninhabitable (RNZ 2023b, Our Auckland 2023). Subsequently, a moderately heavy rain event in May 2023 led to significant flooding in areas of the city due to saturated ground conditions from prior rainfall events (Auckland Council 2023).

As part of the response to these events, Auckland Council implemented the 'Making Space for Water' programme in 2024. This 10-year programme, worth $760 million, aims to improve Auckland's preparedness for flooding and reduce future flood risk by undertaking a wide range of initiatives, including enhancing stormwater systems (Auckland Council 2024b).

3 Thematic analysis results

Across all three case studies, 53 people were interviewed either individually or in small groups, as per their preference. The breakdown by case study is as follows:

- Auckland – 18 interviews with 23 people.
- Waikanae Catchment – 14 interviews with 17 people.
- Little River – 12 interviews with 13 people.

In Auckland, the breakdown of participants by type was:

- Council staff, across various roles (7).
- Residents (9).
- Government agency staff (4).
- Non-governmental organisations (3).

3.1 Thematic analysis summary

Once the interviews were completed across the three case studies, the issues and topics raised were reviewed by the research team. Multiple common themes were identified as well as those that were specific to one or two of the case studies. The findings below focus on themes pertinent Auckland.

Insurance coverage for businesses, homes, and personal possessions was raised as a challenge for recovery in all case studies. In Auckland, for example, many participants experienced delays in receiving communication from their insurance companies about what to do following the flood, leaving them unsure whether to remove contaminated material or not:

> *... It was really hard to get information about what you're allowed to do with insurance. And so that was a massive problem. And so there was lots of people saying, 'No, don't rip up your carpet, because the insurance company will want to see it' and everyone was saying, 'rip it up because your floorboards will get wrecked'. And so we cut it and ripped out in the end because it was obviously contaminated.*

Delays in communication with insurance companies and in receiving payouts also hindered some participants' recovery:

> *... the left hand wasn't talking to the right hand, they [insurance agencies] were ... Yeah, it was pretty bad.*

> *... I only got the payout, you know, it took me like two months of hassling the insurance company and that was a debacle ...*

Not all experiences with the insurance process were negative. Positive experiences with insurance companies demonstrates that when the process goes well for customers, insurance assists in recovery and moving on from the floods:

... insurance has been good. They paid out quickly for our cars and contents, so that was good. The house stuff, there's been a little bit of back and forth and some stuff that we felt like they needed prodding on.

In common with those from other case studies, there was some concern in Auckland about the future affordability and availability of insurance, and that some people were not reporting flood damage to insurance companies for fear of losing coverage or seeing their premiums increase. Media reporting from Auckland noted that many businesses had dropped their insurance cover following the financial pressures associated with the COVID-19 lockdowns, with implications for their ability to operate post-flood (RNZ 2024).

Community trauma was an important impact of flooding in all case studies. Experiences of trauma in Auckland were associated with dealing with the flood event itself, as well as the stress or emotional pain arising from knock-on effects such as displacement and uncertainty about the future status of their homes. For some Auckland participants, the emotional toll of the floods was considered to linger even well into the recovery phase, especially where repeat or successive events occurred:

... I was definitely stressed for ... probably for the first three and a half weeks... because the acute period was quite long, because it was flooding, then flooding again ... then like four or five days of being like, 'hey, it's going to be okay', and then [Cyclone] Gabrielle ...

...The psychosocial stuff and [impact on] wellbeing is big. If we're talking about those initial few hours, I mean, we're talking about families carrying their grandmother on their back in the floodwaters up to here [indicates chest height], those are traumatic experiences. And we've had it up until ... Gosh, I mean, we were having some of that heavy rain right up until June. Every time it rains that anxiety goes up.

Ongoing uncertainty, stress and sleeplessness were compounded by a fear of future floods:

... whenever it rains now in Auckland, it's the fear of and anxiety ... huge amount of anxiety when it rains. I think everybody watches the weather now.

... I know there's people who don't want to go back to their homes again, they don't want to rebuild. It's just too traumatic. They're living on a knife edge every time it rains. Is the flood going to come through again? Are we going to lose it all again?

In Auckland, council and government agency staff were also commonly traumatised. Staff reflected on the stresses associated with the emergency response and recovery phases, including becoming "burnt out" and even physically unwell. Some participants observed that agency staff were subjected to abuse from community members as community stress levels rose:

... it really worries me about the impact on the wider people involved in this work... The people who are on the front line, who are dealing with customers. How do they do they do it? ... and all the abuse people get and all the perception of council staff, how are we going to maintain people in these critical but hugely complex roles without giving them the recognition and the reward, the... You just need a thank you. And instead people get abuse.

... the things that stick most in my head are probably afterwards and sitting across from the people that have been affected and having them, you know, in tears or yelling at me or screaming at me or pleading with me ... And that, um, that stuff sticks with you.

During the emergency response, practising tikanga (e.g., starting each day with a karakia, singing waiata) supported the wellbeing of council staff, helping them to engage in their work with a clear mind and reminding them to look after themselves throughout the process.

... so we were able to provide whakataukī to keep us in check, a beautiful karakia that really links into what we're trying to achieve, and just a constant reminder that, you know, look after each other, people, because if we cannot look after ourselves, we cannot look after our communities. So we are [a] priority in terms of looking after each other. And then we can get out there and give our communities 100%.

Community support during or following flood events is generally common in Aotearoa New Zealand. In Auckland, the sense of community as a social support network was important in providing assistance and bolstering positive wellbeing during stressful periods:

... the one thing ... positive, which I've already kind of alluded to, is the ... It's the re-establishing of one's faith in humanity. There were a lot of really amazing people on the night of the flood. So like, I think the poor people across the road who were chest deep, the people who are next door to them went down there and pulled them up and everyone was housed and given glasses of wine and fed and dry clothes and things like that. So it was actually ... from a neighbourhood point of view, that was amazing.

In the Auckland case study, a major focus was on the *displacement of people* due to flooding, whereas this was not discussed in the other two case studies. Displacement occurred at a large scale and for a sustained period, with a shortage of suitable accommodation putting severe pressure on an already strained local housing market. Participants described many flow-on effects of displacement, including financial and family stress, the need for children to change schools, families having to move in together or be separated from one another, people becoming isolated from their social support networks, and compromised access to work, with implications for the ability of businesses to operate.

... With the displacement that came about during the floods, not only were people ripped from their place of belonging and their psychological sense of place and safety, they were removed from their services. And those services include educational services and their religious services.

... [Experiences] would definitely be mixed on whānau having to squeeze into smaller homes. You know, it was about them connecting back, knowing that the rest of their family were there for them. But then at the same time, what comes with that, the overloading, the power bills being astronomical, the food ... and where it was scarce on food anyway, so, you know, the food being minimal, having limited clothing and bedding.... Yeah, there was a lot of sicknesses. The other thing too is, with the overcrowding and people coming up there, that caused a lot of stress on the whānau, having to live together in crowded spacing and, you know, having to get on if they didn't get on before.

... In Māori and Pacific families anyway, we've always ... Well, if I speak from a Māngere point of view, we've always lived with each other anyway. Like I grew up in a home where I had both my grandparents in there and everything like that. So ... a lot of our families that were already living together were then displaced from each other. So for us it was actually the opposite of what

happened out West, where families had to come together. We actually got split apart because we were already living in the same home … And so the cultural and family dynamic actually was ruined, you know?

… a lot of what the whānau asked for during that time, besides the kai and the linen, was petrol vouchers so that they could go backwards and forwards to their homes to get the things out or to keep checking on their homes or to clean their homes up, but to go and also see their other family members that were elsewhere.

Due to housing shortages, some displaced residents were also forced to move into unsuitable accommodation, for example accommodation that was not accessible for those with mobility issues, was not large enough, or did not have adequate cooking facilities.

… we had families with little kids trying to live in these motels with no kitchen facilities. So, what we were finding is that they were taking the kids home to the damaged home and still trying to cook or just some respite for mum because there was just no space for the children themselves. It was… You know, just the stories from the mothers, they were just desperate to get out of there.

The *influence of flooding on relationships between community and council* was widespread. In Auckland, the scale and recency of flooding at the time of data collection for this project meant that tensions towards council were still high amongst many residents. Heightened tension played out through lowered levels of trust and satisfaction with council and central government, which in turn exacerbated council staff trauma levels.

… The level of hurt in the community and the sense of anger in some places has been quite strong and to a point when there's another flooding event, I'd get a request and of course have to go through the channels, I know the answer is no, but I have to deliver the message, I'm the one who's going to feel it. And that's often the case. So, I've made some decisions in some places that it's not safe to reconnect for that [process of] reconciliation. Because I can sense the level of hostility. I am re-engaging with, as we speak, that community now, but this is six months after. It's taken that long.

Despite this, there were also instances of positive interactions between community and council. For example, one Auckland resident described how talking about the floods with council staff at a public meeting opened up a positive communication channel, in which staff provided information and support that helped badly affected residents to advocate for higher-level support; “they’ve been really good to us… [they’ve] been great”.

Specifically, *public expectations of council and government agencies* led to tensions when those expectations of flood response and mitigation did not match council and government agencies’ actual capacity or legislated responsibilities. In practice, limits on available funds, staffing constraints, concerns for staff safety, and the sheer scale of major flood events constrained council and government agencies’ ability to respond in what many residents considered to be a sufficient timeframe and manner. In this way, delays or lack of action led to frustration from residents and harmed community-government relationships.

… The official response [during the flood] from the council was appalling. The mayor is an idiot, obviously … I feel for the council staff because I think they were just overwhelmed. And if I think about emergency services, completely overwhelmed … And the council definitely was not prepared. The government, I thought, handled it reasonably well and they were the right sort of empathetic, let's put

resources in, type of thing. But since then, I've not really seen much evidence, at least in our particular area, of an official response …

… there was a sense of abandonment. And I think that … it depends on what community you belong to, but there was an expectation of what a Civil Defence emergency response would look like, from community. And so for a lot of our communities, they didn't really see the visibility of Civil Defence.

… we were hearing from Civil Defence, stay home… don't go out until we've effectively confirmed that these areas are safe. On the other hand … we were getting calls from community groups saying, why aren't you out there? … As a government agency, we actually needed something official that said it was okay [to send staff out]. We couldn't be seen to just go out there and sort of put our staff at risk, notwithstanding the good intentions … But I think definitely from a community group perspective, they saw us as being perhaps reluctant or not very quick, or not responsive enough.

In Auckland, the mismatch between public expectations of government services was exacerbated by expectations that council would maintain the level of financial support to residents that was made available during the COVID-19 crisis. As the COVID financial support came from central government, not council, the absence of this level of support following floods contributed to confusion and dissatisfaction with council in the flood-affected community.

… The COVID response really didn't serve this [flood] response very well. This sounds shocking but I think there was an expectation that the authorities do certain things, but this is a particular, different event. It's not led by the health authorities. So I think automatically some community groups … thought that there'll be a whole lot of money coming their way.

Tensions between community and council also arose when public expectations of flood threat mitigation did not match with council's actual *legislative ability to undertake action to reduce flood risk*. Where this gap between expectations and legislative scope exists, it can lead to public pressure on council to increase flood risk reduction measures, and strain community trust and satisfaction with council. The legislative constraints within which local government operate were discussed extensively in Auckland. Many participants recognised that the council is limited in their ability to support good urban design that reduces flood risk, as well as prevent development in high-risk areas or areas that will become high-risk in the future. In particular, demand for housing adds pressure on both local and central government to allow development. Council staff themselves felt that their ability to best serve the needs and aspirations of their community was limited by their legislative requirements.

… We can see the problems, but it feels frustrating not to be able to influence the central government discussions … And then, of course, council is only resourced to the level to respond to its legislative requirements.

In Auckland, participants described *limited public awareness of flood risk* despite flood maps and information being publicly available. When the public is unaware that such information is available, this can reduce the number of property-level actions taken by households to lower their flood risk (e.g., installing private pumps). It can also mean people buy in at-risk areas in the first place. Flood risk information can also be difficult for people to understand, undermining their awareness of risk despite best efforts to understand it.

… We definitely looked at [the LIM report] … and we knew it was in a floodplain. But, you know, half the houses in [the suburb] are in a floodplain. And we knew that they'd done all this work in the park

in response to previous flooding and some drainage stuff as well. So we sort of had this false sense of… Yeah, I think when my partner looked into it, [they] found more stuff talking about the remediation that had been done than about the actual danger that was there. Like there was nothing to suggest it was more dangerous than other properties on the floodplains… Now, we know. I mean, it seems obvious now that we know, but we're … not engineers or, you know, experts in anything like that.

If residents do not feel they have been made sufficiently aware of the flood risk to their property, this can lead to reduced trust in council when flooding occurs.

Inequities were widely discussed by participants, such as those that can arise during the flood response and recovery, and also in people's ability to stockpile emergency resources in preparedness for future flood events. One Auckland-based participant spoke about how having a network of well-resourced family and friends supported them in a way that they knew was not available to everyone:

… like I said, we are pretty privileged. We've been really lucky and well supported through all this. And one thing I've really thought about is like for the people and communities that aren't in such a fortunate position, it would have been really, really hard… yeah, our house flooded really badly but for lots of different reasons, we haven't fared so badly. And I just really feel for people in harder situations, and they should be supported.

Several Auckland participants reflected on how some groups are more able to advocate for themselves following a flood event (e.g., those in wealthier communities with strong political capital) while other groups or communities in Auckland are not heard or may experience delays in receiving external support (for example in Māngere, where many felt "forgotten about").

… those vocal ones do get action, which is good. But then I do worry about the people who just aren't as vocal, and I don't want them to be missed. You want equity.

… [There have been instances of] individual households or sometimes a collection of households who have the economic means to bring about legal challenge. And that inequity of approach which can force a decision at a local council level that is not fair, and equitable and not necessarily … It's ahead of what the national situation or guidance should be. I think that is a problem.

… For those that have the economic means, we have, you know, we've got choices. We can have the insurance. We can choose to move … But for those that don't have the economic means …

Participants also talked about how some communities, such as some migrant and former refugee communities, were disproportionally affected due to not understanding the emergency response and recovery systems, not always trusting in government agencies, or those response systems not being culturally appropriate.

… We often hear from the usual, excuse the expression, the people who 'know the system', who can pick up the phone and get them there really quickly … So, the communities that don't normally have a voice, and I'm talking about our multicultural communities, they often fall between the cracks.

… Our former refugee community really struggled to understand, I think, any of the government agency messages about how to connect to the support … So, the whole system itself was trying to do its best but clearly it wasn't something that worked for everybody. Not everybody understood how to access, you know, CDEM sites. Not everybody understood what the government agency support might look like.

Participants described ways in which these negative outcomes could be reduced. This included council and government agencies undertaking further engagement and relationship-building with communities, as well as liaising with and resourcing community groups and marae for the roles they undertake in emergency response and recovery.

Impacts of recurring flooding was an important theme in all three case studies. Recurring flood events can affect residents in ways that are unique when compared to a 'one-off' event. Experience of flooding can increase people's ability to respond in future events as they may have learnt what to do during a flood, how to increase their future preparedness, the need to be more proactive in reporting problems with water infrastructure (e.g., blocked drains), and also to have more realistic expectations of the flood response and recovery process.

> *... I knew what to do. You know, like, I knew the process I'd have to go through with the insurance company to get this all pushed through quickly. So that helped in that way.*

> *... by this time, we'd had two floods, so we kind of knew what to do. So in the first one, it was little things like we were wading through knee deep water when I suddenly thought oh we need to switch the power off. Because it's like over the sockets. So stuff like that, we kind of knew to do that as quickly as we could and to be quick about running, getting furniture up if we could.*

Although experience of recurring/chronic flooding may have some positive effects (such as increased preparedness), when flood events follow relatively quickly after one another or are 'back-to-back', this can reduce people's ability to recover mentally and/or financially and therefore exacerbate experiences of stress, trauma, and burnout. For many participants in Auckland, even the possibility of another flood event occurring so soon caused distress.

> *... I definitely feel a lot more nervous than I did last year...and, you know, we haven't had a chance to recover from January as yet. And I just can't ever see us having that chance to pause and recover and reset because these are just going to keep on happening. I don't know that for sure, but it's just what I feel.*

The impact of recurring/chronic flooding can therefore be complex, increasing people's emergency preparedness but also potentially undermining their wellbeing in other ways.

Tolerance of flooding and the question of whether residents want to remain in flood-prone areas arose in all cases. Where the ability to function in everyday life – or to do what one enjoys – is strong, the likelihood of people moving away is reduced. In Auckland, the question of tolerability to flood risk arose particularly in the context of demand for property buyouts. That is, trauma and damage from past floods, compounded by the threat of more floods and risk to life, increased demand for buyouts.

> *... being told that there was no infrastructure solution, that was the tipping point for me.... There was a point where we thought, if we can get council to do this, if we can get the neighbours to do that, if we can build some drains, then we can manage the flood risk. But having water in the house three times in one year is not... That's not acceptable for anyone really, because the fixing it is massive. It's expensive, it's time consuming, it's a hassle, it's a health risk... People could die on our property. That's what I realise now. That's not an acceptable risk for anybody.*

Conversely, if actions can be taken to reduce or remove flood risk, then most flood-affected participants discussed wanting to remain in place.

> *... I'm still not planning on moving out. At least, you know, unless it was unrepairable, basically. And then we're gone. But yeah ... Like I said, they're gonna put this drain in and if that was known that it wasn't going to work, it wasn't going to be foolproof then yeah, we'd go. Because you know, we're paying for a four-bedroom house and if we don't have one, then ... we're not going to stay there.*

> *... I think at this stage, lifting the house is probably the main thing that's giving us that peace of mind. And if we were getting one flood like that every five years or something, that's manageable. If it became annual or every six months or something like that, that might be a problem.*

The ability to move is also commonly constrained by other factors such as existing ties to the local area (e.g., kids enrolled in local schools) and finances, with some participants describing feeling 'stuck' as they cannot afford to move even though they would like to.

> *... I would move out tomorrow but I'm in the situation where my kids [attend local educational facilities] ... And those keep us here. And also, yeah, I've got nowhere else to go ... I couldn't buy another property in Auckland ... Property prices are just too expensive for anyone really.*

There was also some concern that owners of flood-affected homes would have trouble selling their properties if they wanted to move.

> *... I'm in a situation where, oh, God, you know, who's gonna want to buy my house? There must be other people in the same position.*

The *need to reconsider land use* was a widely discussed theme in Auckland. Following the Auckland Anniversary floods, conversations quickly emerged about the continued liveability of some areas in the region, particularly in regularly flooded suburbs such as those in West and South Auckland. Participants and media coverage spoke of the urgent need for land use to be reconsidered across the city, both in terms of buyouts to allow those living in highly flood-prone areas to be able to move (Milne 2023), and as part of adaptation responses aimed at reducing future risk through urban redesign (e.g., converting pockets of land to increase natural drainage).

> *... Like if you build a stormwater detention pond, it can ... be a wetland or it could actually be a big drain basin that fills up with water and floods and then drains out slowly through a floodgate and becomes a flat playing area again. There's different ways of handling it, but it's just making a place for the water to go, really. And when it's not going, it's a place for people to enjoy. It's creative thinking.*

Auckland Council has since launched the 10-year Making Space for Water programme, aimed at improving preparedness for flooding and future flood risk reduction through various means, including implementation of blue-green projects to increase natural drainage capacity (Auckland Council 2024b).

A formal process for central government-supported residential property buyouts in Auckland was also being worked through during the data collection phase of this research, with media coverage at the time reporting residents' experiences of being in a state of limbo about their future (e.g., Ikram 2023; Johnston 2023). Participants noted how council's ability to fund such buyouts is dependent on the level of financial contribution from central government, existing council funds available to spend, and their financial reserves following previous major events (e.g., COVID-19).

As well as the wide range of impacts identified, the thematic analysis highlights the extent to which the social impacts of flooding interconnect and flow-on for Auckland's communities and organisations over time. The next sections describe these causal relationships.

4 How to read the causal diagram outlined in this report

Simply put, causal diagrams are collections of variables (e.g., characteristics of places, people, environments) connected by arrows of influence. This allows us to trace influence along pathways, through multiple variables. They have a particular interest in circular pathways of influence, as these create feedback loops which influence how variables behave over time.

Causal diagrams contain two types of feedback loops that drive system behaviour. *Reinforcing feedback loops* lead to exponential growth or decline, exemplified by phenomena like compounding interest or algae blooms, while *balancing feedback loops* stabilise systems by seeking equilibrium, akin to a thermostat. Recognising these loops helps understand how variables behave and interact within a system, providing a basis for strategic interventions.

To read a causal diagram, you need to understand the below:

1. As you follow influence through a diagram, it is effectively describing to you how "more or less of this (current variable), leads to more or less of that (the next variable)".

2. *Variables* are written in such a way that they have an *inherent sense of direction*. That is, they can either go up or down. For example, 'morale' instead of 'increased morale'.

3. There are two types of arrows which denote two types of relationships between variables:

    3.1 *Solid arrows* denote a *same relationship* (variables move in the *same direction* – if one goes up, so does the other, and vice versa).

    3.2 *Dashed arrows* denote an *opposite relationship* (variables move in the *opposite direction* – if one goes up, the other goes down, and vice versa).

4. Two small lines across an arrow represents a *relative delay*. This influence will take longer to present than others represented in the diagram.

5. Sometimes a variable of particular interest is shown as a *metaphorical bathtub*. This is an analogy used to help us better understand accumulation. Some variables may influence whether the bathtub variable *increases* (things *flow into* the bathtub); while others may influence whether the bathtub variable *decreases* (things *drain* the bathtub).

6. It is important to note that *bathtubs* are used as a *metaphor*. There is no actual limit to their capacity (i.e., they will not ever overflow if they 'fill too much'). They are used as a way of highlighting with more nuance, where things accumulate or reduce.

7. *Bathtubs* can be part of *causality chains and feedback loops*.

8. Causal diagrams are agnostic in the things they describe. They simply help us describe the influences that make things go up or down. Whether changes in these variables is 'good' or 'bad' depends on the perspective of the reader.

Figure 4-1 demonstrates how the above concepts work.

While straight forward, these concepts can take some getting used to. To help with this, they are explained in more detail in Appendix A.

We are particularly interested in how various feedback loops interact and the impact this will have on the way variables of interest trend over time. Causal diagrams do not seek to quantify how these things may trend over time. They provide a valuable tool to aid understanding of the broad directions that variables may trend, in response to changes in other variables captured in the diagram.

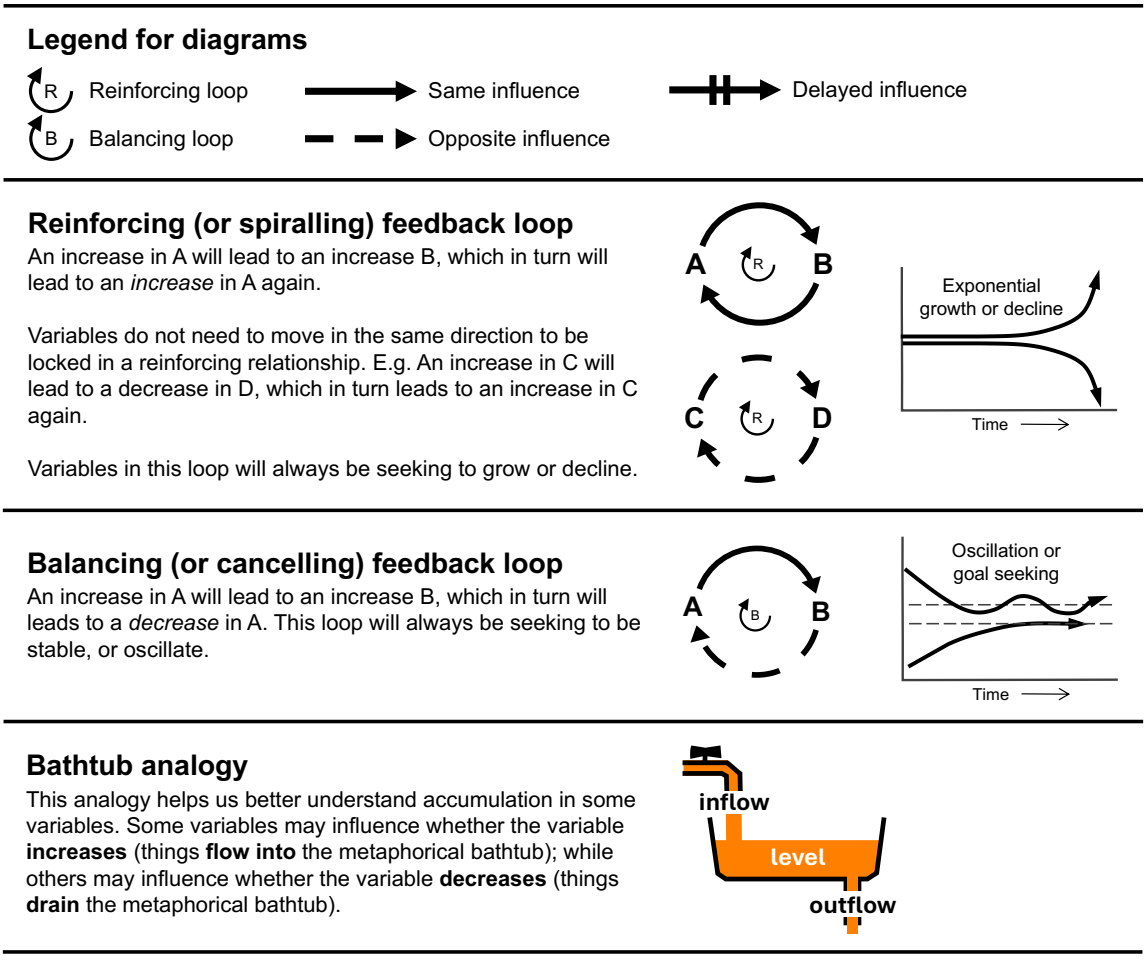

Figure 4-1: How to read a causal diagram.

5 The Auckland causal diagram: Key feedback groupings and loops

The causal diagram for Auckland is presented in Figure 5-1. It draws on the thematic analysis of the interviews, focusing on the cause-and-effect relationships discussed, and is supplemented by cascading flood impacts reported in the media. While the thematic analysis included discussion of themes directly related to flood emergency response, the causal diagram focuses primarily on cascading impacts that play out over a longer timeframe, into the recovery phase. Therefore, some of the thematic elements that relate to emergency response are not shown in the causal diagram.

Eight key causal groupings, along with feedback loops and variables that comprise them, are represented in the diagram by colour. The eight key causal groupings are:

- Catchment/ cross property level flood threat mitigation.
- Property level flood threat mitigation.
- Council and Government funds.
- Community trauma.
- Dislocation.
- Business operability.
- Insurance.
- Disruption to everyday life.

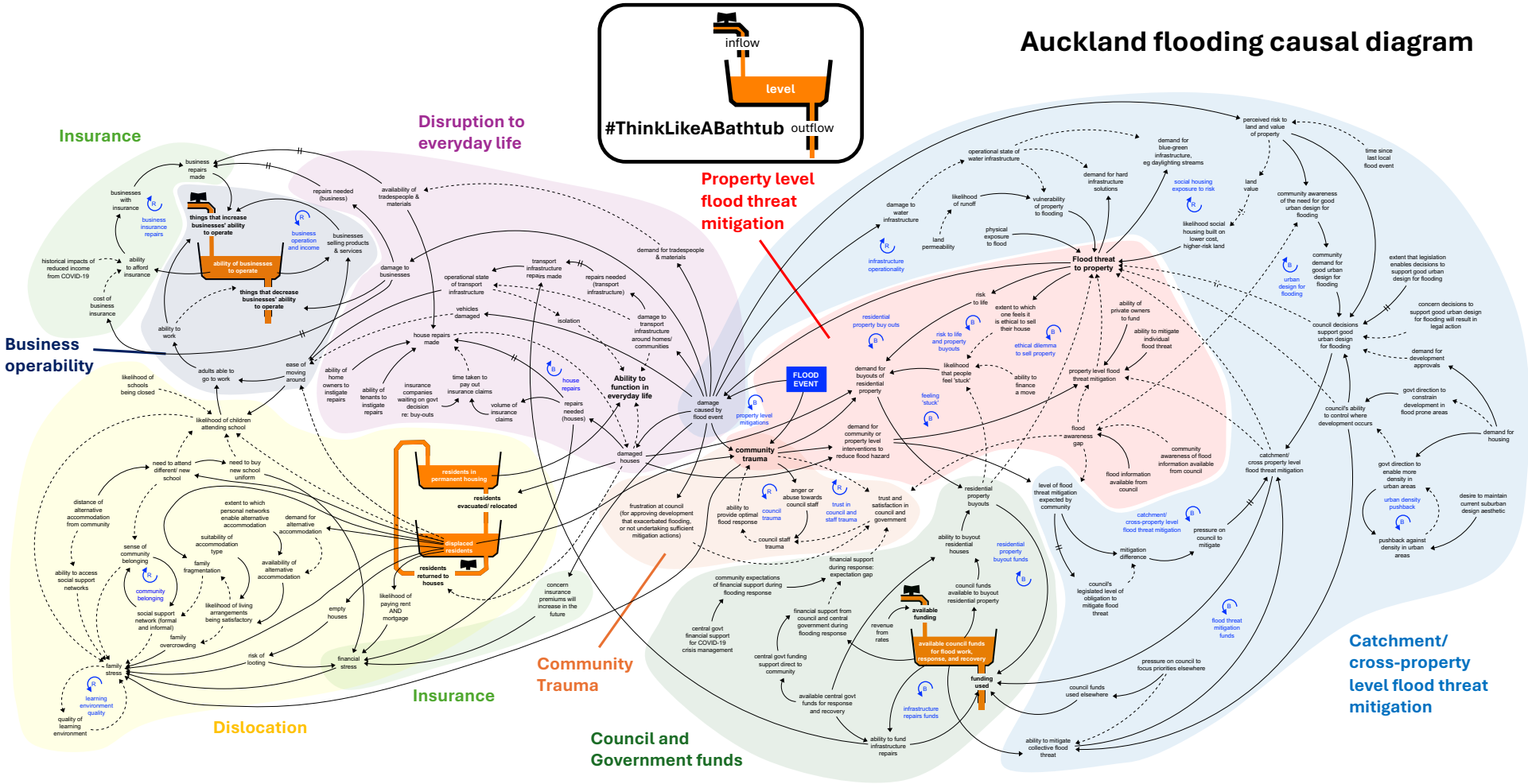

Figure 5-1: Auckland causal diagram.

The feedback loops and groupings provide useful insights into how the variables (e.g., characteristics of places, people, environments) change over time. Therefore, they can reveal where key points of influence lie that may be targeted to reduce harmful impacts and increase resilience.

Within the eight causal groupings, 19 key feedback loops were captured in the causal diagram for Auckland. Eight are reinforcing, with the effect that a change in one variable results in amplifying or 'spiralling' growth or decline. Eleven interactions are balancing, with the effect that the direction of change in one variable ultimately encourages a balancing or cancelling effect in that same factor. As well, one factor – resident displacement – did not occur as a loop but is noted because it was prominent in generating negative flow-on effects on issues such as work, education, costs and stress, while influencing a number of other loops (Table 5-1).

Table 5-1: Causal groupings and associated feedback loops.

Causal group	*Feedback loop*	Reinforcing or balancing
Catchment/ cross property level flood threat mitigation	Infrastructure operationality	Reinforcing
	Social housing exposure to risk	Reinforcing
	Urban design for flooding	Balancing
	Urban density pushback	Balancing
	Catchment/ cross-property level flood threat mitigation	Balancing
	Flood threat mitigation funds	Balancing
Property level flood threat mitigation	Residential property buyouts	Balancing
	Risk to life and property buyouts	Balancing
	Feeling 'stuck'	Balancing
	Ethical dilemma to sell property	Balancing
Council and Government funds	Residential property buyout funds	Balancing
	Infrastructure repairs funds	Balancing
Community trauma	Council trauma	Reinforcing
	Trust in council and staff trauma	Reinforcing
Dislocation	Residents displaced from their homes	* Not a loop
	Community belonging	Reinforcing
	Learning environment quality	Reinforcing
Business operability	Business operation and income	Reinforcing
Insurance	Business insurance repairs	Reinforcing
Disruption to everyday life	House repairs	Balancing

* 'Residents displaced from their homes' is not a feedback loop of influence. Rather, it is an 'either/or' placement of people in their home or being displaced from it. Drawing on the bathtub analogy, this has been represented with two bathtubs. This is explained in more detail in Section 5.5.1.

The feedback loops are described in greater detail in the following subsections. The descriptions concentrate on variables and pathways related to the feedback loops and bathtub analogies in the diagram. The contributions of other variables can be understood by following

their influence across the wider causal diagram. The sequence in which the loops are presented does not imply priority or scale of influence.

5.1 Catchment/ cross property level flood threat mitigation

The *catchment/ cross property level flood threat mitigation grouping* comprises a good third of the diagram. It is made up of six feedback loops, of which four are balancing and two are reinforcing. This grouping includes matters such as infrastructure operationality, as well as demand for better urban planning and design. These factors can reduce flood risk and are strongly influenced by both community awareness of their importance, and by the direction of national government to intensify urban densification, where densification is undertaken in places or in ways that do not align with good urban design to accommodate water. However, these influences can also be at odds. Communities may seek lower levels of densification, while council may feel pushed towards higher levels of densification and may have limited influence over central government directives to increase densification. The effect of these at-times conflicting pressures can be community disappointment with council decisions and strategies in the face of ongoing flood risk and exposure.

5.1.1 Infrastructure operability

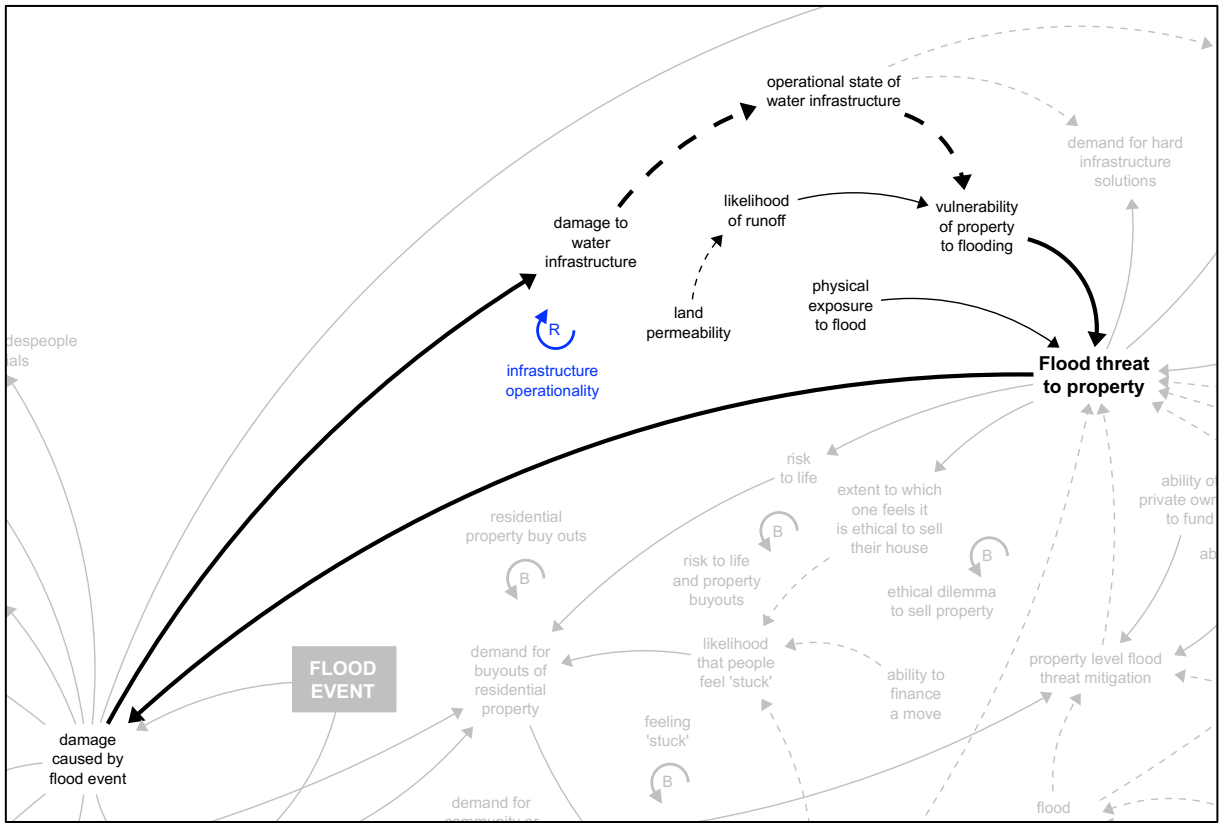

Figure 5-2: Infrastructure operability loop.

There is a reinforcing relationship between the *damage caused by a flood event* and the operability of water infrastructure (Figure 5-2). The greater the *damage caused by an event*, the higher the *damage to water infrastructure*, the lower its operability, and the higher the *vulnerability of properties to flooding*. The higher the *vulnerability to flooding*, the greater the *flood threat* and damage caused by flood events. Over time, *damage caused by flood events*

might be expected to worsen infrastructure operability and increase flood threats. A mitigating factor for this reinforcing relationship is when land permeability is increased, allowing for excess water to drain away during heavy rainfall events.

5.1.2 Social housing exposure to risk

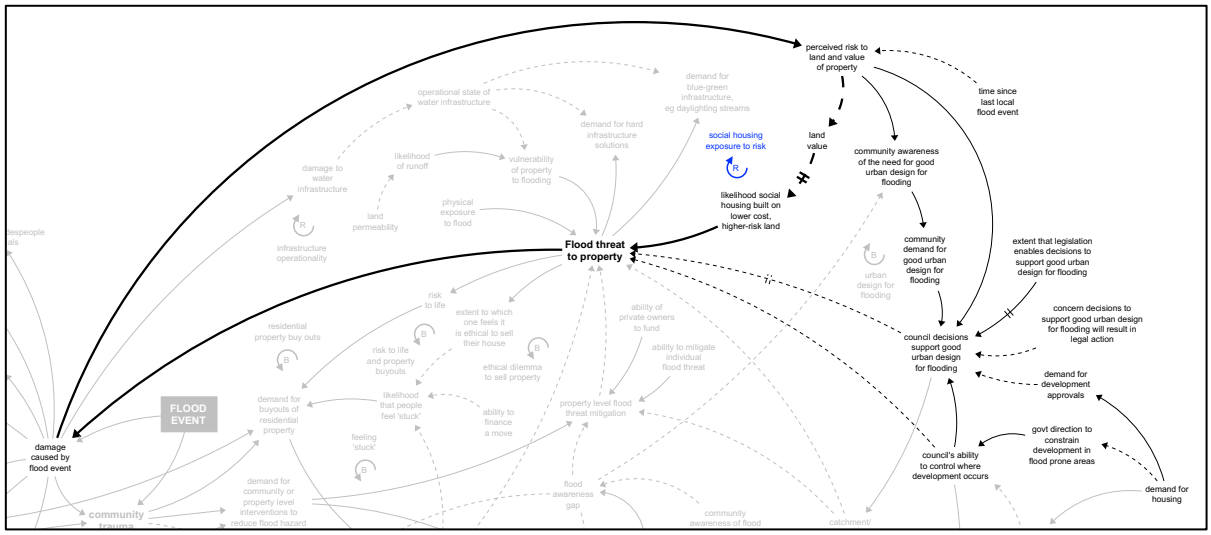

Figure 5-3: Social housing exposure to risk loop.

There is a reinforcing relationship between *social housing being built on lower cost, higher-risk land* and the damage arising from floods (Figure 5-3). The greater the *likelihood of social housing being built on higher-risk land* (because it costs less), the higher the *flood threat to properties* and the higher the *damage from a flood event*. The higher the *damage from a flood event*, the greater the *perceived flood risk to land* and the lower its value. In turn, the lower the *land value*, the greater the likelihood that social housing is built on such land. Over time, this reinforcing relationship may mean that an increasing proportion of social housing and its occupants might be expected to be at risk.

This reinforcing loop can of course be mitigated by *good urban planning and design*. This is enabled by the *community's awareness of the need for good urban design* and their demand for it, as well as the extent that legislation allows council to enable it, therefore preventing social housing from being built in high-risk areas. Council's ability to prevent social housing being built in at-risk areas may come into tension with demand for development approvals and the extent that government direction on housing encourages development in flood-prone areas. Overall housing demand is a constant pressure behind these factors.

5.1.3 Urban design for flooding

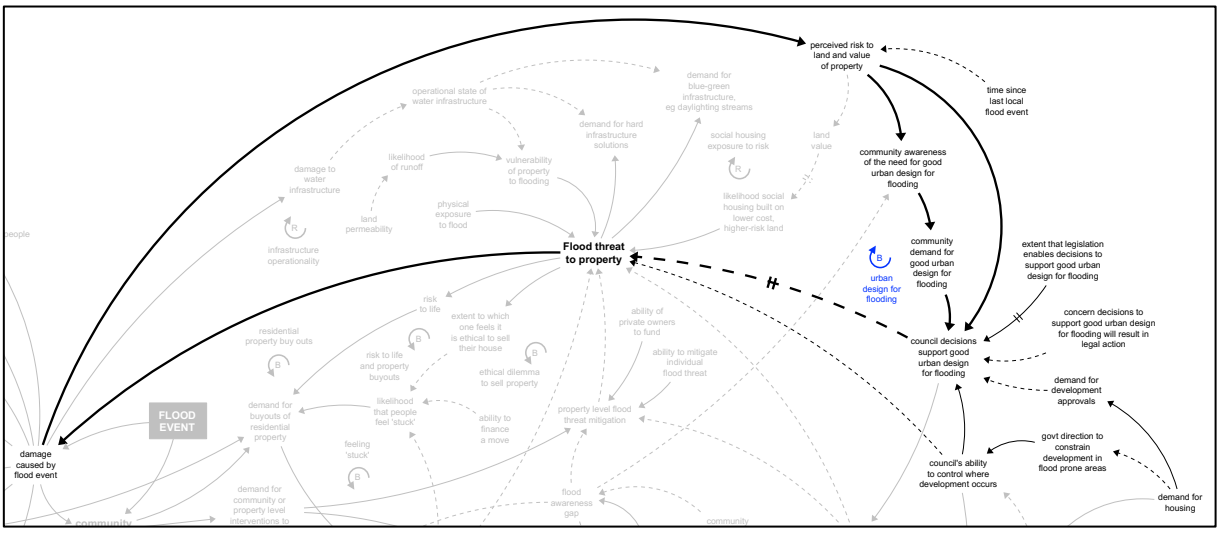

Figure 5-4: Urban design for flooding loop.

There is a balancing relationship between *council decisions to support good urban design for flooding* and the level of flood threat to property (Figure 5-4). The more council decisions support good urban flood design, the lower the *flood threat to property*, the lower the *flood damage*, and the lower the *perceived risk to land and property values*. The lower the *risk to land and property values*, the lower *community awareness is of the need for good urban design*, and the lower the *community demand* for it. Without demand, this may lead to reduced council decisions to support good urban design. Over time, this could then increase flood threats to property and flood damage during an event. In this way, time is an important influence on this loop, with perceptions that an area is at risk of flooding tending to decline over time if the period between flood events is sufficient for people to recover their sense of safety in place.

If, over time, *flood threat to property* and *flood damage* increases, *community awareness* of, and *demand for, good urban design* is likely to also increase. This is then likely to increase council decisions to support good urban design.

This balancing relationship means that the extent to which council decisions to support urban design for flooding are taken might be expected to seesaw over time, in response to flood threats to property.

Other influences on council's decision to support good urban design include the extent to which *legislation enables council* to make those decisions, as well as any concern council may have that legal action will be taken against them if they implement such designs. Closely related is the extent to which *council have the ability to control where new development occurs*. This is influenced by the level of *demand for new housing*, and whether *central government directs local government* to constrain development in flood-prone areas and/or increase densification in urban areas (where such densification is undertaken in ways that do not align with good urban design to accommodate water).

5.1.4 Pushback against density in urban areas

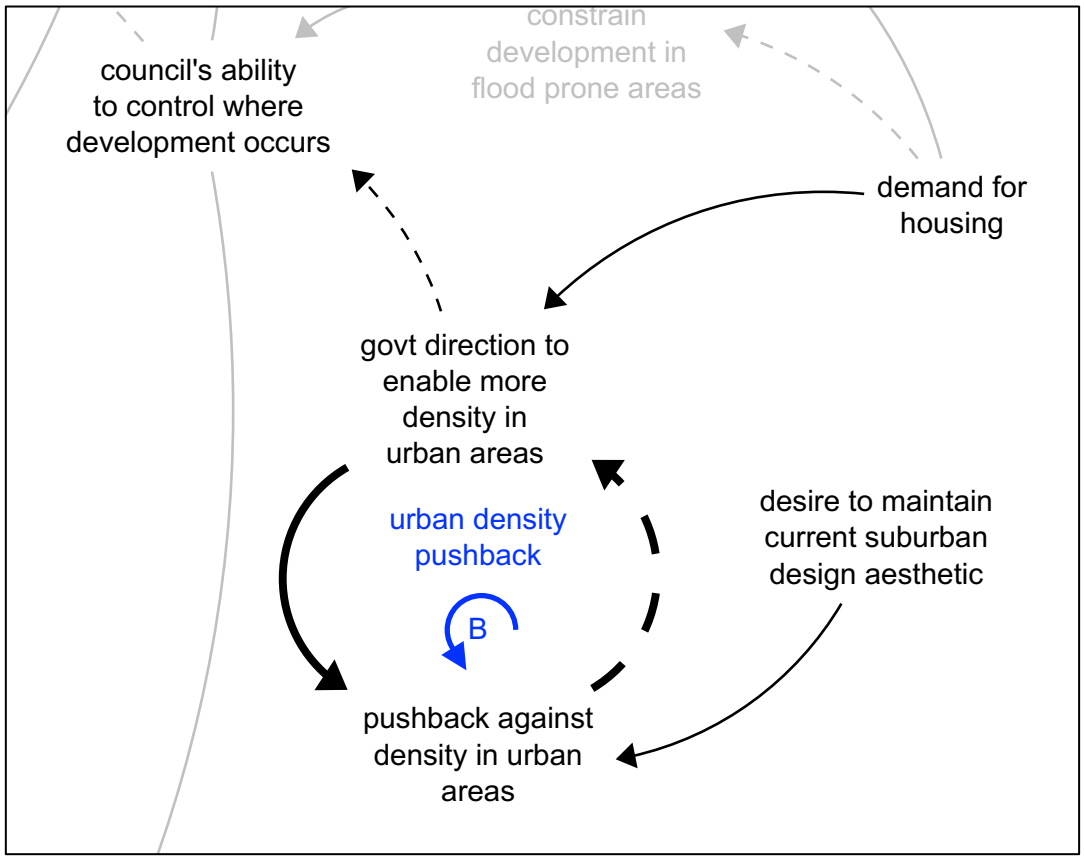

Figure 5-5: Urban density pushback loop.

Urban densification was a source of tension for some in Auckland. Some residents felt that allowing such developments was contributing to flood risks in the area and they blamed council:

> *... Probably the main emotion is being extremely angry with the council. Because we wouldn't have been flooded if it wasn't for them approving the consent [for a development next door]. And we complained because it was non-notified consent, of course, so we would never have known. And so we got hold of the consent information before the place was built and raised concerns about the overland flow path, and the engineer had approved it as being ... Not going to have any effect on flooding. And so we dealt with the consents team, who did what they could because of course the problem is the consent had been approved. And so they managed to get a channel dug through the driveway, which of course blocked within about 20 minutes in the flood. But at least they tried ...*

At the same time, some agency staff felt that national pressure to develop areas was a problem and there was a need for a change in direction:

> *... one of the hopes coming out of the January-February floods this year is [about] the approach to central government around the changes to building in [the Built Environment Act] ... where central government is telling local government, thou shalt densify and thou shalt build in these areas...*

In view of the pressures to develop, a balancing relationship is found between the *central government's direction to enable greater housing density* in urban areas, and the *pushback against density* (Figure 5-5). The stronger the *direction from government to enable greater urban*

density, the greater the *pushback* from those who oppose densification, especially when there is a *desire to maintain the current design aesthetic* of suburban areas. The greater the public *pushback*, this may lower the direction from government to densify, which would in turn lower the pushback. However, the lower the pushback, the more that central government is likely to push for densification if demand for housing remains strong. Over time, this balancing relationship means that central government's direction to enable greater urban density and pushback against densification might be expected to oscillate ('seesaw') over time.

5.1.5 Catchment cross-property level flood threat mitigation

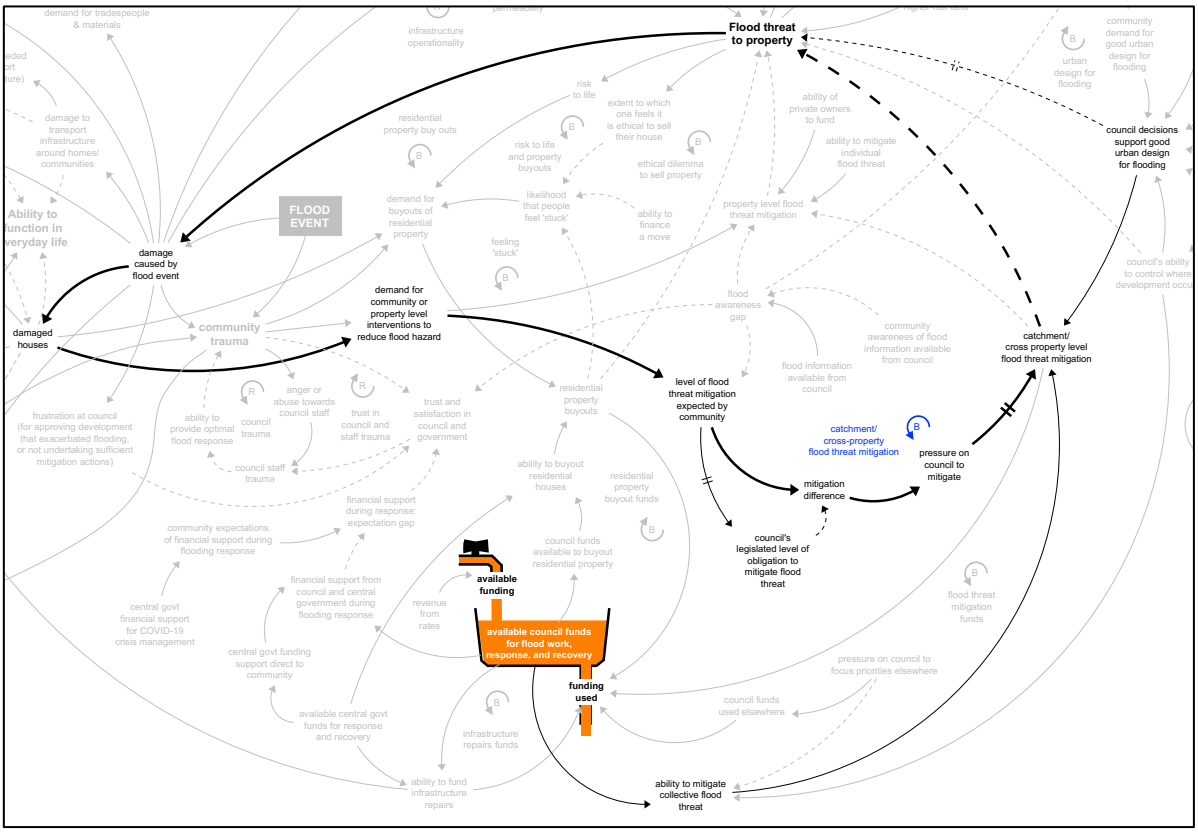

Figure 5-6: Catchment/ cross-property flood threat mitigation loop.

There is a balancing relationship between the extent of *catchment/ cross property-level threat mitigation* work and the extent of *flood threats to property* (Figure 5-6). The greater the *flood threat to property*, the greater the *damage to houses*, and the higher the *demand for community-level interventions* to reduce flood hazards. The higher the *demand for interventions*, the greater the *pressure on council to mitigate* threats and the higher the level of *catchment/cross property-level mitigation* work. However, in lowering the flood threat to properties, over time this leads to lower demand for community-level interventions to reduce future flood hazards. The lower the demand, the lower the *pressure on council* to mitigate threats, and the lower the level of *catchment/ cross property-level mitigation* actions being taken. Over time, this leads to a higher flood threat to properties, particularly if the frequency or severity of flooding also continues to rise, balancing the loop.

This balancing relationship means that the level of catchment/ cross-property level flood mitigation might be expected to seesaw with flood threats over time. Direct influences on this loop include whether council decides, or is legally able, to implement urban design that reduces

flood risk, as well as whether council has sufficient funding available to pay for catchment/ cross property-level flood mitigation work.

5.1.6 Flood threat mitigation funds

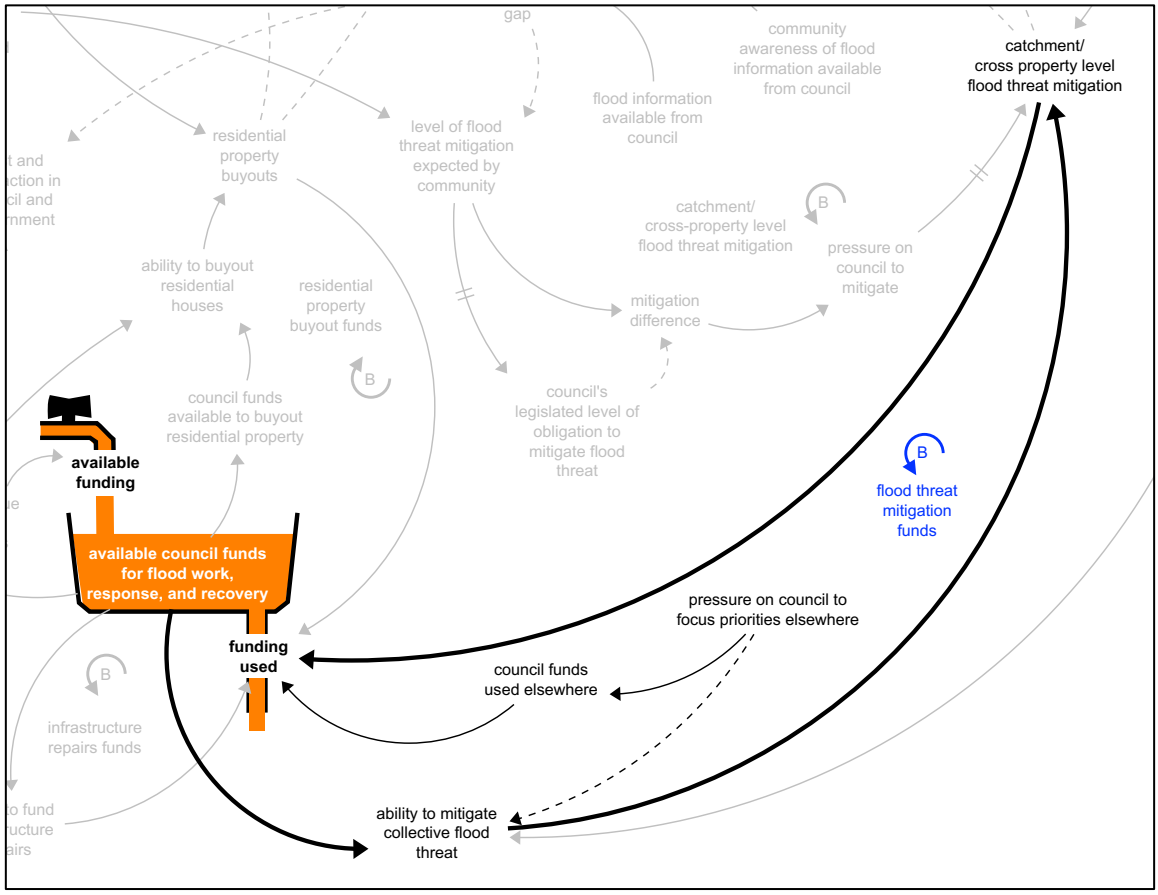

Figure 5-7: Flood threat mitigation funds loop.

There is a balancing relationship between the level of *council funds available for flood work, response and recovery*, and the extent of *catchment/ cross property-level threat mitigation* taken (Figure 5-7). The greater the amount of *council funds* available for flood work, the greater the organisation's ability to mitigate collective flood threats and the greater the level of *catchment/ cross property-level flood threat mitigation*. However, the greater the level of mitigation conducted, the greater the drain on council funds and the lower the amount of funds subsequently available. The lower the level of funds available, the lower council's ability to mitigate future flood threats and the lower the level of additional *catchment/ cross property-level flood threat mitigation*. This balancing relationship means that the level of catchment/ cross property-level mitigation and the level of council funding might be expected to oscillate over time.

An important additional influence on council's *ability to mitigate collective flood threat* is whether there is pressure for their *priorities to be elsewhere*, for example political or planning pressure to deal with other infrastructural needs. This can lower the amount of funds, resources, and capacity to undertake collective flood threat mitigation works.

5.2 Property level flood threat mitigation

The grouping includes five feedback loops, all of which are balancing. The grouping captures how experience of flooding and the level of flood threat to property influence actions taken by individual households to mitigate future flood threat.

This grouping acknowledges that people's ability to take individual actions to reduce flood risk to their property is in part influenced by their ability to afford to take such action, as well as their housing tenure status. For example, those renting are likely to depend on landlords taking measures directly, or on approval from their landlords to take measures which alter their property in some way.

The property level flood threat mitigation grouping also demonstrates the relationship between flood threat to property and residential property buyouts over time. This includes whether homeowners have the ability to sell their flood-prone homes without government intervention to buy their property.

Aspects of this grouping tie in closely with the *catchment/ cross-property level flood threat mitigation* grouping, such as the influence of catchment/ cross-property decisions about infrastructure and housing development on the degree of individual property-level flood threat.

5.2.1 Property-level mitigations

This balancing loop captures how the level of *flood threat to one's property* and the number of actions taken at the property-level to reduce future risk influence one another (Figure 5-8). The higher the *flood threat to a property*, the greater the level of *damage* caused by a flood. This in turn increases *demand for property-level interventions to reduce future flood risk*. When people undertake interventions on their properties (e.g., installing private pumps, creating gaps in their fences to allow water to travel through), this reduces future *flood threat*, providing the interventions are effective. However, in lowering the flood threat to properties, over time this leads to less property-level interventions to reduce future flood risk. Over time, this can lead to a higher flood threat to properties, particularly if the frequency or severity of flooding continues to rise, balancing the loop.

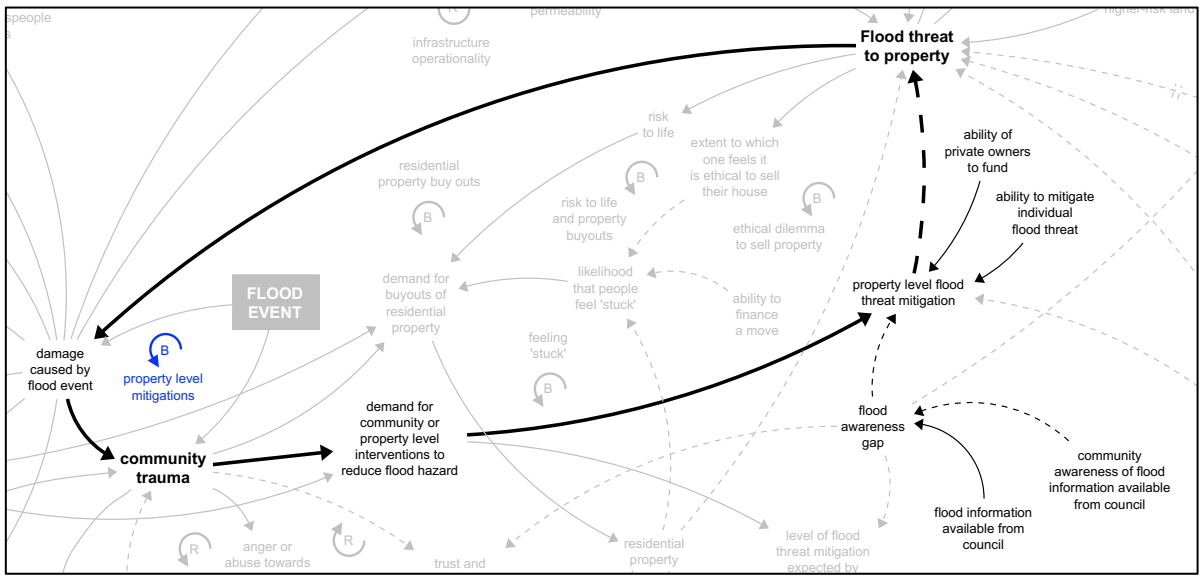

Figure 5-8: Property-level mitigations loop.

5.2.2 Residential property buyouts

An important outcome of flooding in Auckland was demand from property owners in flood-prone areas for buyouts. Demand for buyouts can arise from experiences of trauma, continued risk to life from future flood events, and residents feeling 'stuck' – that is, unable to move from their property despite wanting to, whether due to an inability to sell, other personal circumstances that keep them tied to the area, or because they feel it would be unethical to sell their at-risk property to another person.

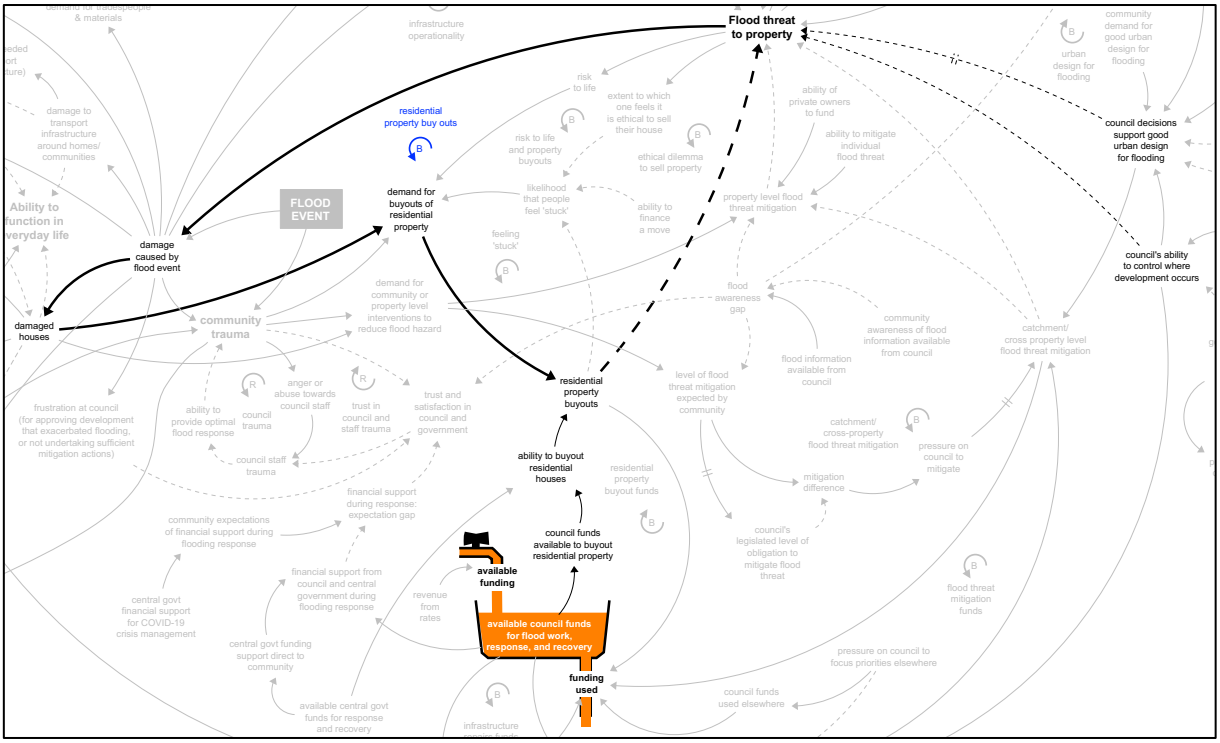

Figure 5-9: Flood threat and buyout loop.

There is a balancing relationship in Auckland between *flood threats to property* and *residential buyouts* (Figure 5-9). The greater the *flood threat* and damage to occupied houses, the greater the demand for *buyouts*. The more buyouts conducted to meet this demand, the lower the *flood threat* to occupied residential properties. In turn, the lower the flood threat to occupied residential properties, the lower the *damage from flood events* and the lower the demand for buyouts.

This balancing loop only works one way – it works to reduce the amount of damage to flood-threatened properties over time, through the process of those properties being bought-out. Because the number of houses at risk is reduced, future flood threat to property and damage from flood events is also reduced. *Flood threat to properties* will only increase again if houses are allowed to be rebuilt on flood-prone land that has previously been bought-out.

This loop is constrained by the level of council funds available to buy out residential property. It is also affected by other factors such as council's *ability to control where development occurs* and *council decisions that support good urban design for flooding*. Both contribute to limiting future residential property development in high-risk areas where buyouts have occurred.

5.2.3 Risk to life and property buyouts

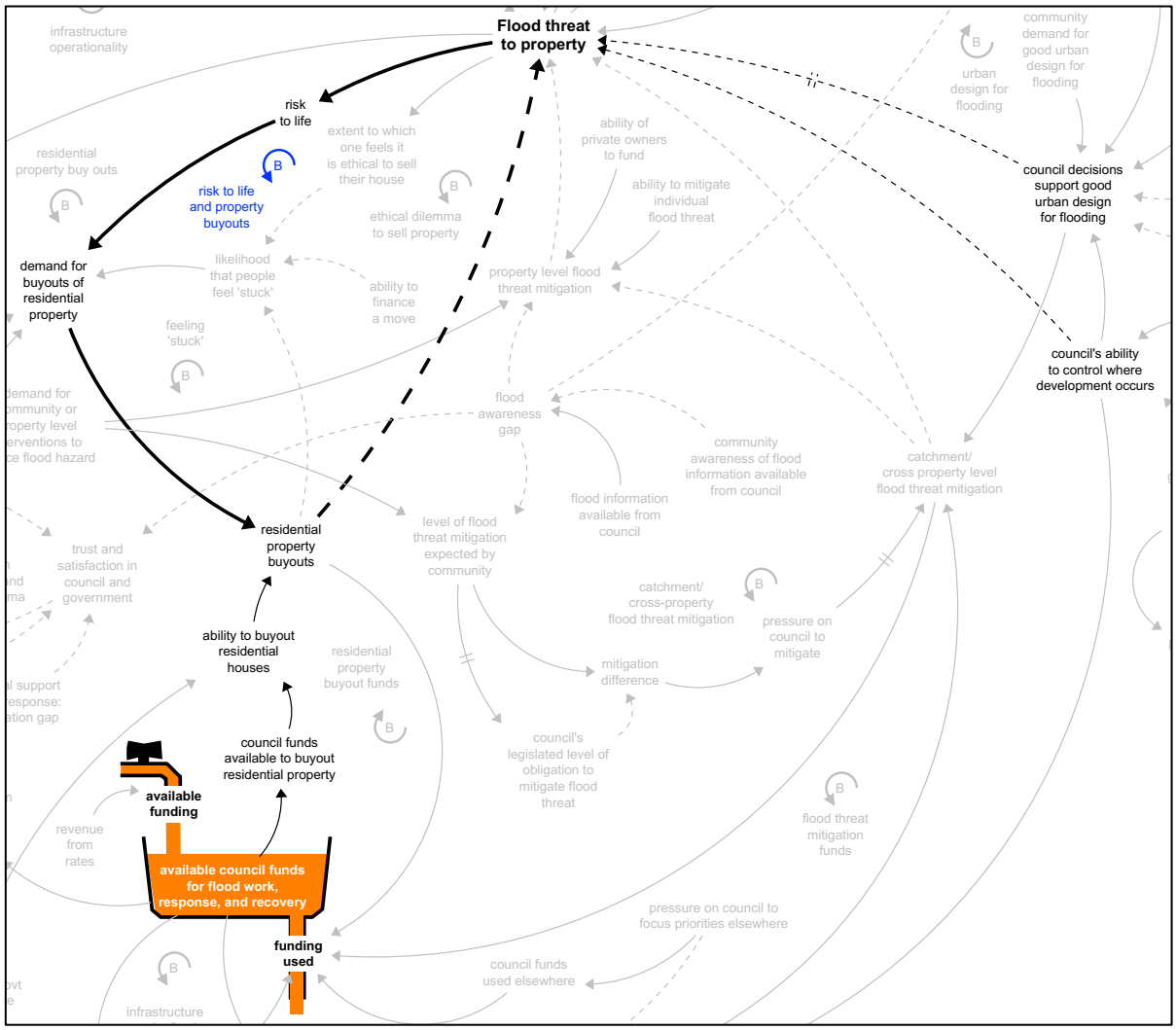

Figure 5-10: Risk to life and property buyouts loop.

Similar to the balancing loop on flood threat – buyout, there is another balancing loop focusing on life safety. There is a balancing relationship between *risk to life* and *residential property buyouts* (Figure 5-10). The greater the *risk to life* from flooding, the greater the *demand for buyouts* resulting in buyouts, and the lower the number of occupied properties where there is a flood threat. The lower the *flood threat*, the lower the *risk to life* and the lower the *demand for additional buyouts*.

This balancing loop only works one way – it works to reduce the risk to life from flood-threatened properties over time, through the process of properties being bought-out. Because the number of houses at risk is reduced, future flood threat to property and life is also reduced. *Flood threat to properties* (and therefore *risk to life*) will only increase again if houses are allowed to be rebuilt on flood-prone land that had previously been bought-out. As above, the availability of funds and factors such as whether council can, or chooses to, allow development in high-risk areas will affect the flood threat to property, and therefore risk to life.

5.2.4 Feeling ‘stuck’

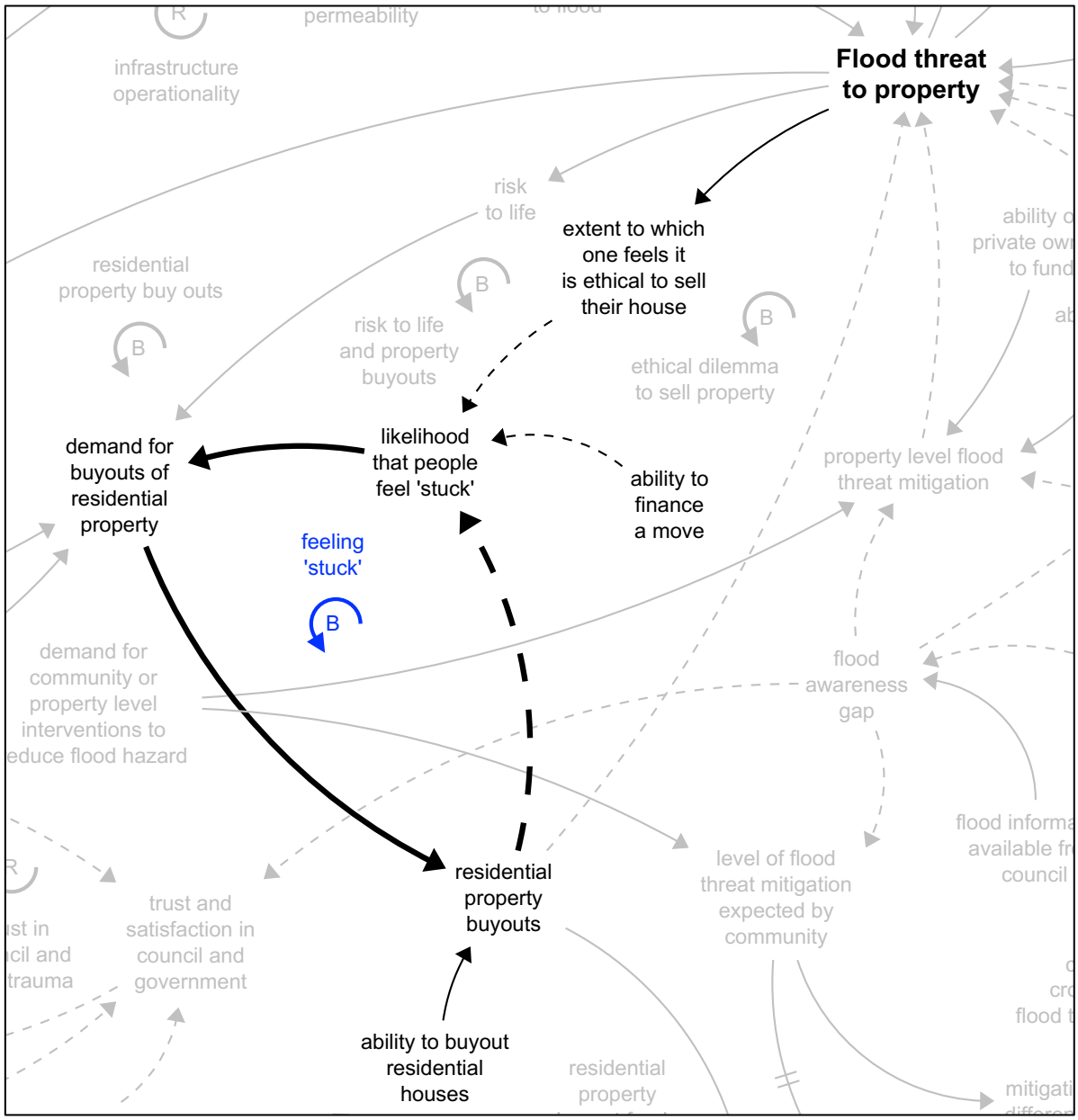

Figure 5-11: Feeling stuck loop.

There is a balancing relationship between the *buyout of residential properties* and the *likelihood that people feel ‘stuck’* or unable to move from their flood-affected property (Figure 5-11). The degree to which people feel stuck in place is influenced by numerous factors, including whether they have existing obligations in the area, whether they believe their properties are marketable, and whether they feel it would be *ethical to sell their flood-prone property* to someone else. The greater the *likelihood that people felt stuck in a place*, the greater the *demand for buyouts*. The more buyouts that occur as a result of this demand, the less people who feel stuck in place, lowering the demand for buyouts.

As with the two previously described loops, this balancing loop only works one way – it works to reduce the number of people that feel stuck by buying-out their at-risk properties. The more residential property buyouts that are completed, the less people there are who feel ‘stuck’. The

number of people feeling ‘stuck’ and demand for buyouts would only increase again if houses were allowed to be rebuilt on flood-prone land that had previously been bought-out.

5.2.5 Ethical dilemma about selling property

Participants in Auckland explicitly expressed concern about selling their homes when they are located in a flood zone. The prospect of selling up and moving on can generate complex sentiments among residents. Some homeowners wished to move but felt conflicted about the idea of potentially duping buyers who are not aware of the flood risk.

> *... Um, crossing our fingers that we get bought out because I cannot see any other way forward for us with that property. Like, I couldn't live there. I couldn't pass it on to someone else to live there knowing that risk is there. And I would hope the council could not stomach that either.*

There is a balancing relationship between the extent to which owners face an *ethical dilemma about selling their at-risk properties* and the *likelihood that they feel ‘stuck’* (Figure 5-12). The higher the *flood risk to occupied properties*, the less ethical some residents feel it would be to sell their properties, and the more ‘stuck’ they feel. The more stuck they feel, the greater their *demand for residential buyouts*, the more buyouts that could be expected, and the lower the *flood threat* to occupied houses.

This balancing influence only works one way – when there is a flood threat to the property. Once this threat has been eliminated (through a property buyout) there is no longer an owner who has an ethical dilemma. As per previous loops relating to this factor, the residential property buyout factor assumes that once a property is bought out by the government, it is no longer used and occupied for residential purposes.

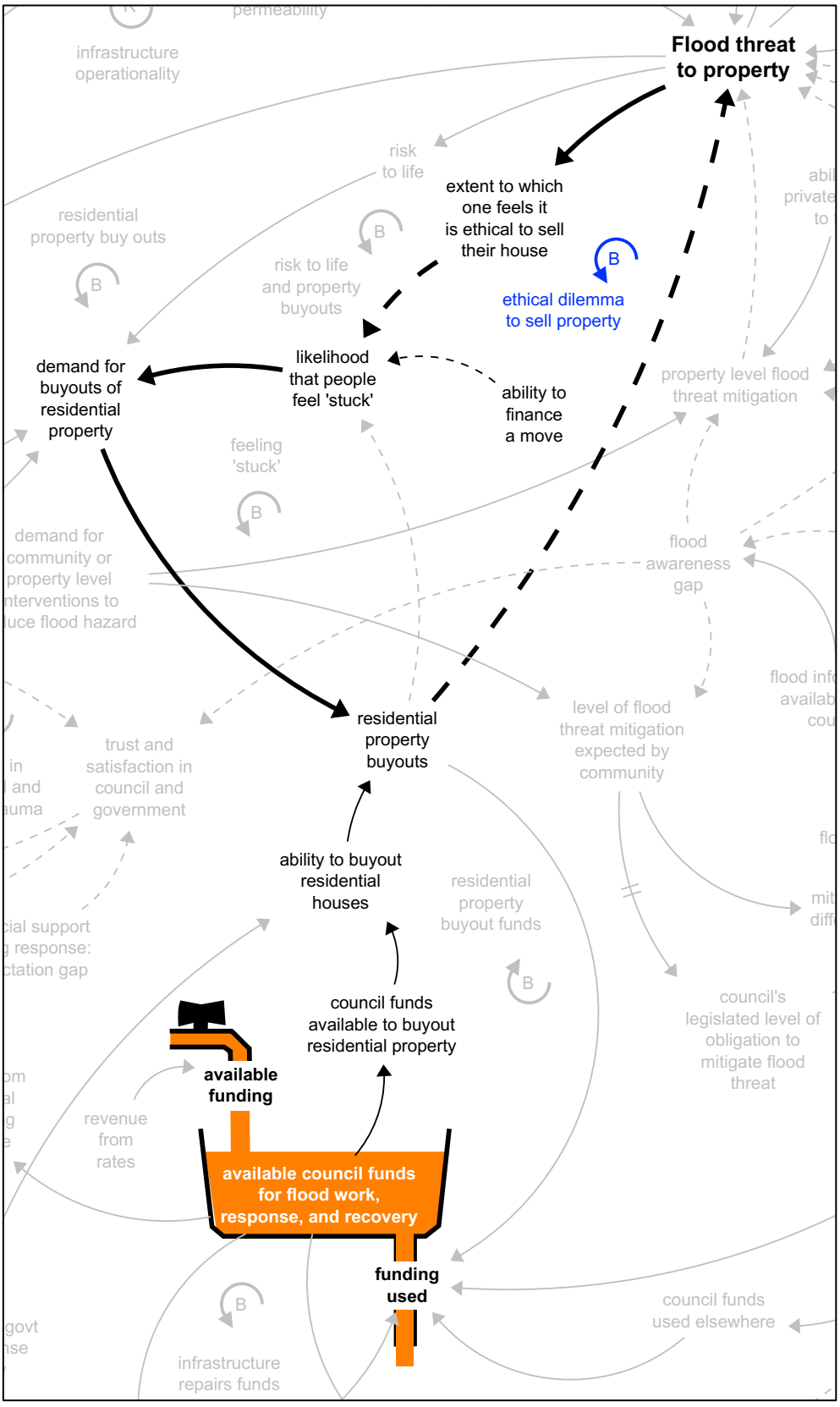

Figure 5-12: Ethical dilemma about selling property loop.

5.3 Council and Government funds

The *council and government funds* grouping displays the influences on the availability of council and central government funds to pay for flood mitigation, recovery and response work. Two feedback loops are included, both of which are balancing. They centre around the ability of council and government to fund property buyouts and to pay for infrastructure repairs. The grouping connects into the *community trauma* and *disruption to everyday life* groupings. It also influences, and is influenced by, the *property-level* and *catchment/ cross-property level flood threat mitigation* groupings.

While not captured in either of the two loops, the council and government funds grouping also considers how the availability of council and central government funds to pay for flood mitigation, recovery and response work can impact on community expectations of financial assistance during a flood event. When communities have previously experienced a high level of financial support during an emergency (e.g., during the COVID-19 response), this can raise their expectations for support in future events. Where there is a gap between community expectations and the amount of financial support provided, this can reduce community trust and satisfaction with council and/or central government.

5.3.1 Residential property buyout funds

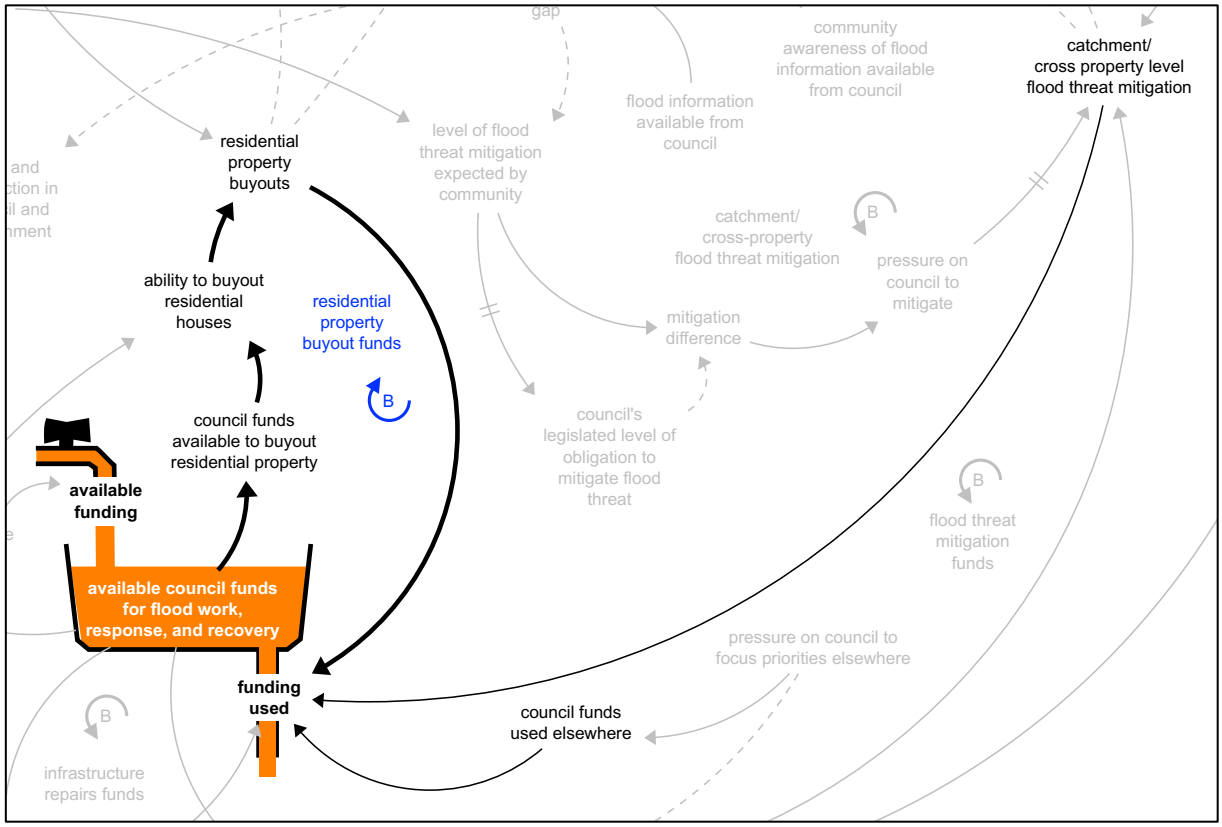

Figure 5-13: Residential property buyout funds loop.

There is a balancing relationship between the level of *funding available to council for flood work, response and recovery*, and *residential property buyouts* (Figure 5-13). The higher the *level of council funds available*, the greater council's *ability to buyout at-risk residential houses*. However, paying for these buyouts drains council funds. The greater the drain on *council funds*,

the lower the amount available for future buyouts, unless additional funding is made available for this specific purpose. This balancing relationship means that the amount of council funds available for buyouts and the level of buyouts supported can be expected to oscillate over time.

The ability of council to pay for property buyouts also depends on how much council funds are spent on *other priorities*, including infrastructure repairs and *catchment/ cross-property level flood threat mitigation* work.

5.3.2 Infrastructure repair funds

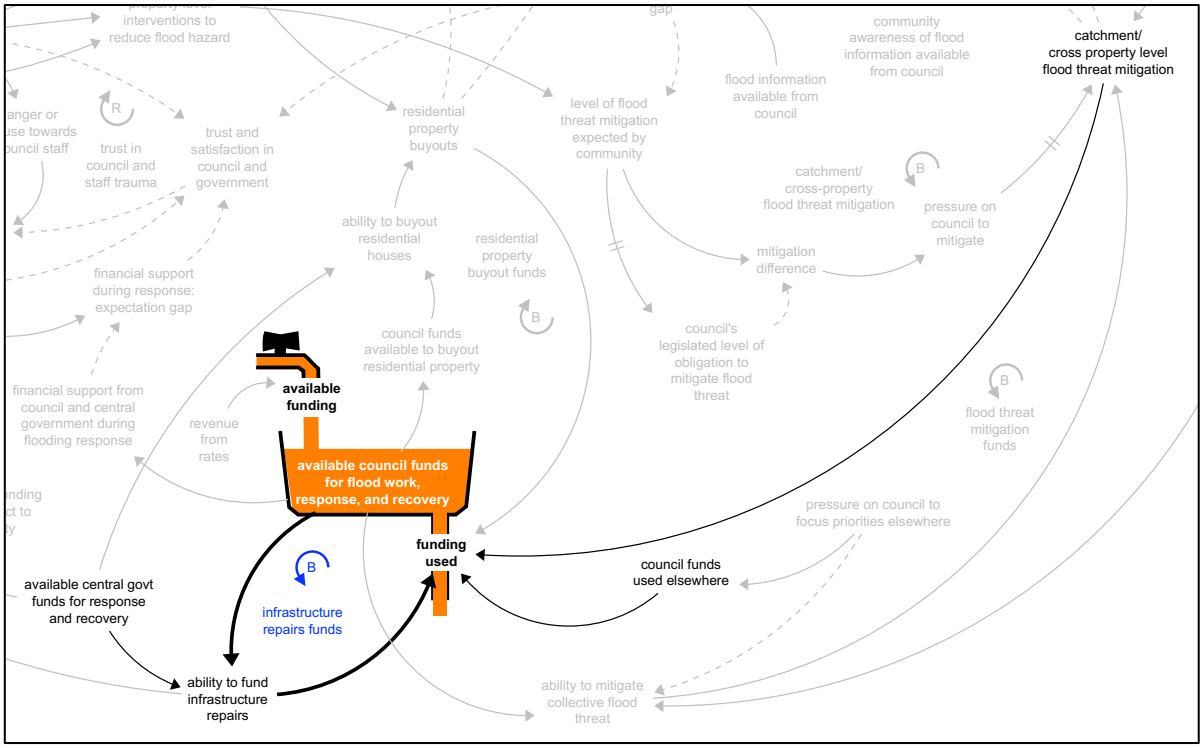

Figure 5-14: Infrastructure repair funds loop.

There is a balancing relationship between the level of *funding available to council for flood work, response and recovery*, and the extent of council funds used for *infrastructure repairs* (Figure 5-14). The higher the level of council funds available, the greater the amount used for infrastructure repairs. This drains council funds, reducing the amount available to spend on future repairs. Over time, new funds are required to give council the *ability to pay for future infrastructure repairs*. This balancing relationship means that the amount of council funds available and the amount spent on infrastructure repairs might be expected to oscillate over time. As with the *residential property buyout funds loop*, the amount of money available for infrastructure repairs depends on competing priorities for council funds.

5.4 Community trauma

Community trauma, while occupying a small space in the diagram, is an important and powerful factor that influences throughout the rest of the diagram from a wellbeing perspective of flood impacts. Not all causes or outcomes of flood-related trauma are shown in the diagram, for the sake of brevity. However, we note that trauma (which we take to include stress and anxiety) from experiencing flooding either directly or indirectly has a path of influence to or from a large number of factors within the diagram.

In Auckland, trauma and stress arose from experience of flooding itself, as well as the emotional pain arising from knock-on effects such as displacement. Financial stress arose as residents dealt with repairs, having to make both rent and mortgage payments while in alternative accommodation, and other costs associated with displacement. The emotional toll of the floods often lingered, especially with repeat events escalating levels of family and financial stress. Accordingly, repeated flooding events in August 2021, March 2022, January 2023, February 2023 and May 2023 are reported to have resulted in a widespread "sense of collective trauma" across the Auckland region (Tan 2023).

5.4.1 Council trauma

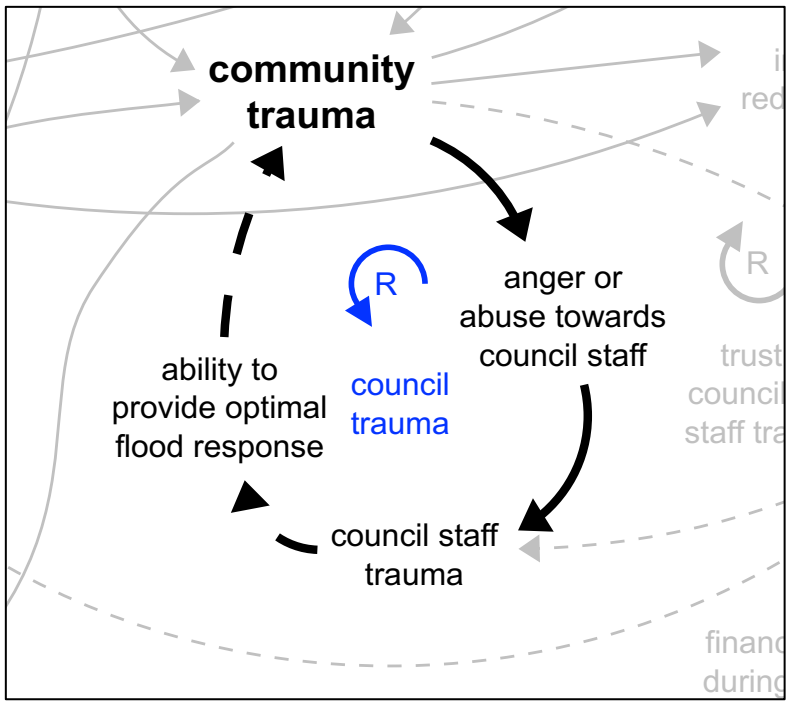

Figure 5-15: Council trauma loop.

The trauma that the general public experiences influences the level of trauma amongst council staff and vice versa, forming a reinforcing relationship between the two (Figure 5-15). The greater the level of *community trauma*, the greater the level of trauma experienced by council staff, especially when community trauma translates into *anger and abuse directed towards staff*. When council staff are subject to these negative experiences, it can significantly affect their wellbeing and, in turn, their *ability to provide an optimal response* during and following a flood event. 'Optimal' here refers to what staff considered to be the best possible response for the community. When they are not able to provide an optimal response, this can increase community trauma. Over time, this might be expected to result in deteriorating mental wellbeing for both communities and council staff.

5.4.2 Trust in council and staff trauma

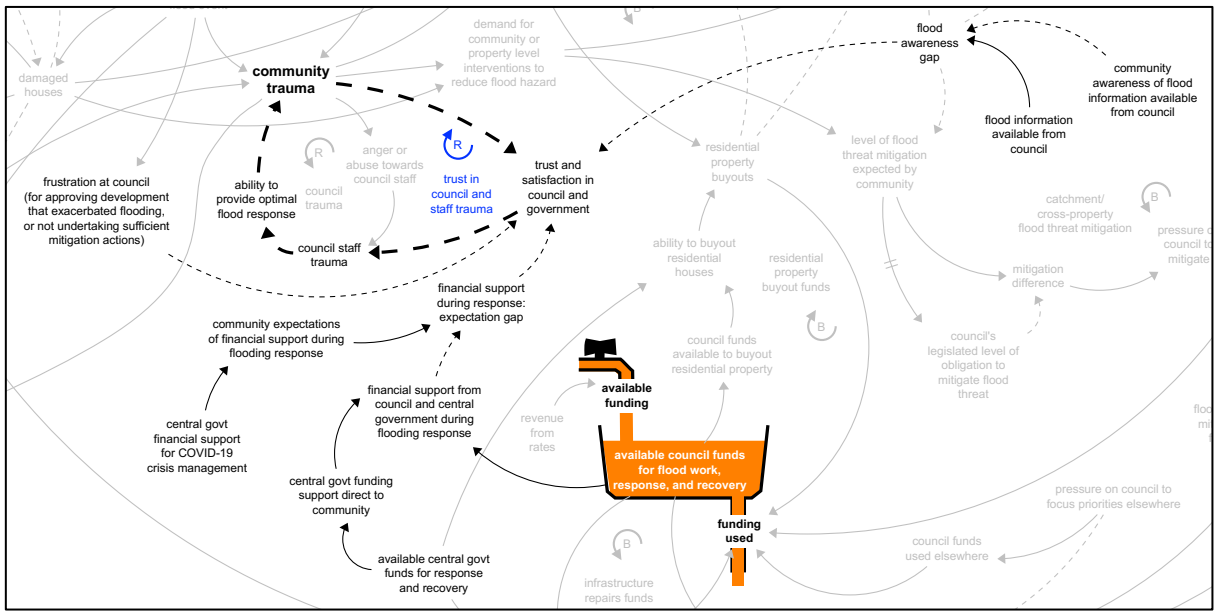

Figure 5-16: Trust in council and staff trauma loop.

There is a reinforcing relationship between *community trauma* and the level of community trust in council and government (Figure 5-16). The higher the level of *community trauma*, the lower the level of *trust and satisfaction in council and government*, and the higher the level of *council staff trauma*. The higher the level of *council staff trauma*, the lower their *ability to provide an optimal flood response*, and the higher the level of *community trauma* – continuing the cycle. Over time, high levels of community trauma might be expected to result in deteriorating relationships with council and government agency staff.

> *... If you're really heavily impacted, in terms of category, you're angry at authorities ... There's the ongoing frustration of having to deal with bureaucracy ... for a lot of people who have not had great experiences prior to having to deal with the system, their experiences with dealing with the system is exacerbated by going through this process, whether it's around reimbursement money, financial support, mental welfare support, connecting to the right services. And if you haven't gone through the system, and there's a lot of people in this sort of situation, and it's the first time that you're a victim and you ask for help and you're just encountering barrier after barrier after barrier, it's just ... it's a tipping point for many people.*

Trust and satisfaction in council and government is also influenced by a range of other factors. These range from how *aware* communities are of the likelihood of flood; the existing level of frustration with council for allow development that exacerbates flooding; and the level of *financial support that comes from central government or council*. The financial support expectations form a goal/gap relationship. There is a level of expectation from the community of the funds for recovery, which is in part influenced by the established precedent of financial support during COVID-19. These are in tension with the actual amount of funds available from council or government.

5.5 Dislocation

Dislocation arising from floods was a major concern for Aucklanders and is an important influence in the diagram, despite the grouping only including one reinforcing loop. *Displacement* of residents from their homes occurred at a large scale and for a sustained period in Auckland, with a shortage of suitable accommodation putting severe pressure on an already stressed local housing market. Participants described many flow-on effects from this displacement, and we have characterised these more generally as *dislocation*. Dislocation included impacts such as having to temporarily relocate to areas far away from their places of work and education. For some, this meant an increase in transport costs to be able to access these places, and for others it meant that children did not attend school or had to transfer schools. Having to move into alternative accommodation also split some families or resulted in overcrowding for others, which was a source of stress for many.

5.5.1 Residents displaced from their homes

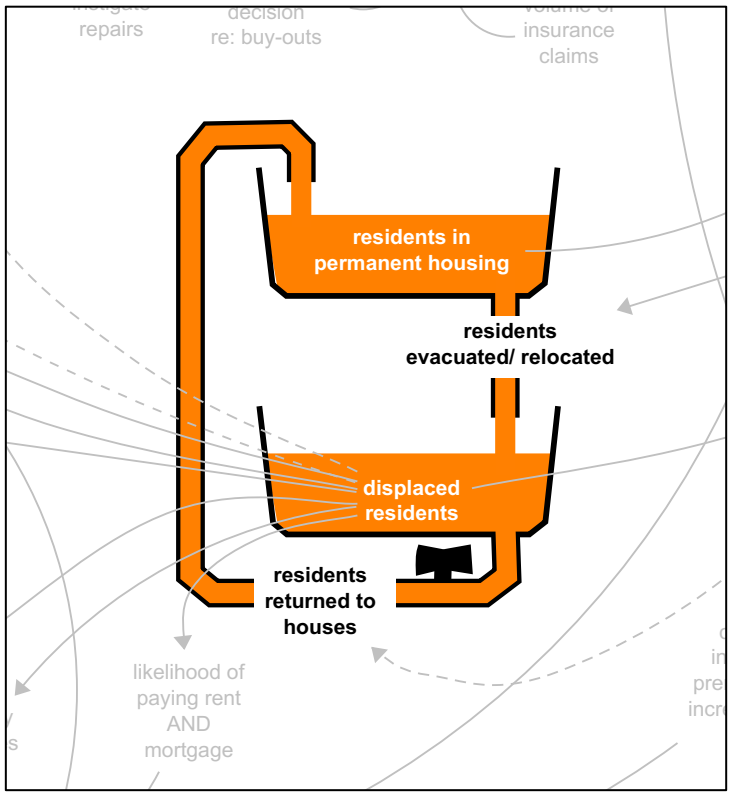

Figure 5-17: Residents displaced from their homes.

In Auckland, residents being displaced from their homes was a major source of disruption and stress (Figure 5-17). Displacement is effectively an 'either/or' situation, where people are either living in their homes, or they have been displaced from them. Using the bathtub analogy, the displacement of residents from their homes has been captured in the causal diagram using two linked bathtubs: the upper bathtub in the diagram is *residents in permanent housing* – this captures people living in their homes under normal everyday circumstances. The lower bathtub in the diagram is *displaced residents* – this captures people who have been displaced from their homes due to the impacts of flood events.

People move from being *residents in permanent housing* to being *displaced residents* when they are evacuated or relocated due to their houses being damaged (the more damaged houses, the more people are displaced). This reduces the number of people in the first (in permanent housing) bathtub and increases the number of people in the second. It is the number, and experiences, of people in this second (displaced) bathtub that has an influence on many of the variables relating to the other ways dislocation presents in people's lives. For example, family stress or fragmentation; being further from the places and people you need to connect to in your life; children needing to attend different schools. This is evident from the number of influence arrows that flow from this bathtub.

One of the obvious objectives of recovery efforts is to return people to permanent homes (whether these are the same homes or different homes). This is represented by the flow of people *from* displaced residents *back to* residents in permanent housing. This is shown as a flow with a tap – from the bottom of the *displaced residents* bathtub back to the *residents in permanent housing* bathtub. This flow is also driven by the volume of damaged houses – in this case the *fewer* damaged houses there are, the *more* people there are returned to permanent housing.

It is important to note that while this may be viewed as a circular flow of people between these two living situations, it is not a circular feedback loop of influence like the others described in this report. Yet we have taken time to represent it in detail given the centrality of people's living situations to their wellbeing and lived experiences.

5.5.2 Community belonging

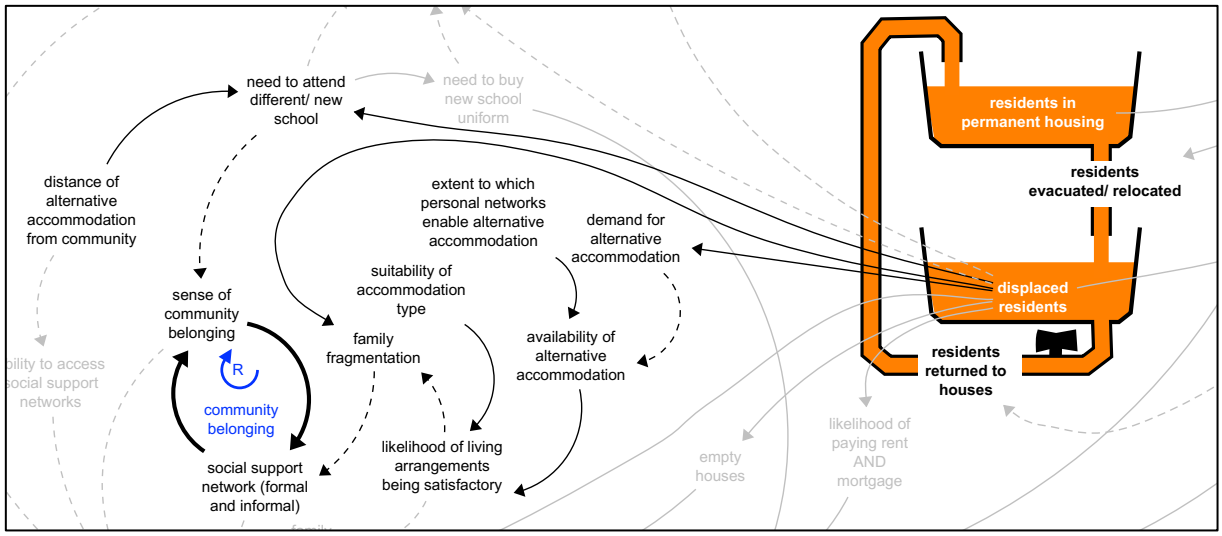

Figure 5-18: Community belonging loop.

In Auckland, the importance of community was emphasised. There is a reinforcing relationship between the *sense of community belonging* that people have, and the *social support networks* that they have access to following a flood (Figure 5-18). The greater the *social support networks* that people have and can draw on during times of stress, the greater their *sense of belonging* to their community. In turn, the more that people feel a *sense of community belonging*, the greater the *network of support* people have to draw on as they recover from a flood.

In Auckland, this *sense of community* played out in terms of community assistance following floods. Despite negative flood experiences, participants reflected on the ways in which communities rallied together, and how *social networks* and a *sense of community belonging* supported positive wellbeing during stressful periods:

> *... in terms of the community and, you know, that kind of social fabric and how it flexed and moved in those first 24, 48 hours, I mean, just phenomenal. People just stood up. I know people who opened their homes to complete strangers because they had children [who needed] to go to the bathroom. BP stores opened up just so people could use the bathroom and get some food. You know, there's just so many ... There's lots of good stories and we need to tell more of them.*

Conversely, when people were dislocated from their community and family, this lowered their ability to draw on these important sources of social support.

People's *sense of community belonging* and the quality of their *social support networks* were also influenced by the extent that people were *displaced* after the floods. This disrupted people's usual living arrangements, fragmented families and required children to attend different schools, which in turn put pressure on the strength of the community belonging loop.

5.5.3 Learning environment quality

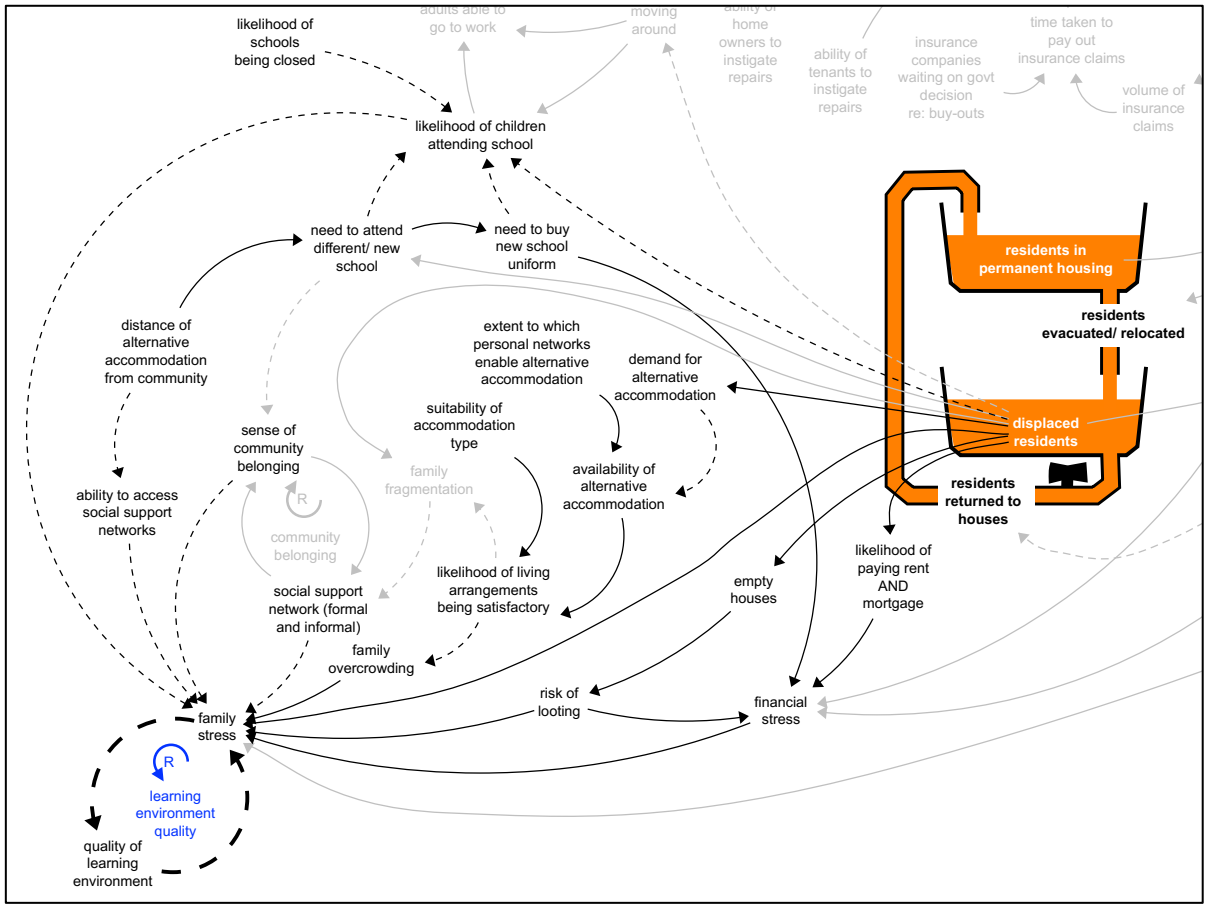

Figure 5-19: Learning quality and family stress loop.

There is a reinforcing relationship between *family stress* and the *quality of the learning environment* for students (Figure 5-19). The greater the amount of *family stress* at home, the

lower the *quality of students' learning environments*. This in turn can increase *family stress*. Over time, this might be expected to result in a downward spiral in learning. *Family stress* is increased by numerous factors, including trauma associated with experiencing a flood event, *financial stresses* associated with flood damage or dislocation, having to live in overcrowded *alternative accommodation*, and *reduced ability to access support networks* following dislocation.

The reverse situation might also apply, with lower *family stress* resulting in higher *quality learning environments*. In this case, the higher the *quality of the learning environment*, the lower the *family stress* and, in turn, the greater the quality of the learning environment for students. Over time, this might be expected to result in increasingly robust learning environments and calmer families.

5.6 Business operability

The *business operability* grouping illustrates the influences on local businesses' ability to operate following a flood event. It comprises one reinforcing loop. It is closely linked to the *insurance* grouping, with insurance cover being an important influence on the ability of businesses to operate.

There is a reinforcing relationship between *businesses' ability to operate* and the number of *businesses selling products and services* in the community (Figure 5-20). The more factors that increase *businesses' ability to operate*, the more *businesses selling products and services* – and the more income they generate through sales, the greater their ability to continue to operate. Over time, this might be expected to fortify business resilience. In addition to income from sales, other factors that increase businesses' operability following a flood include their staff being able to attend work, and whether any flood damage sustained can be repaired in a timely manner.

The reverse can also apply: the fewer factors there are increasing the ability of businesses to operate, the less they are able to sell their products and services to generate income – and the weaker their potential ability to operate. Over time, this might be expected to result in a downward spiral in business resilience.

5.6.1 Business operation and income

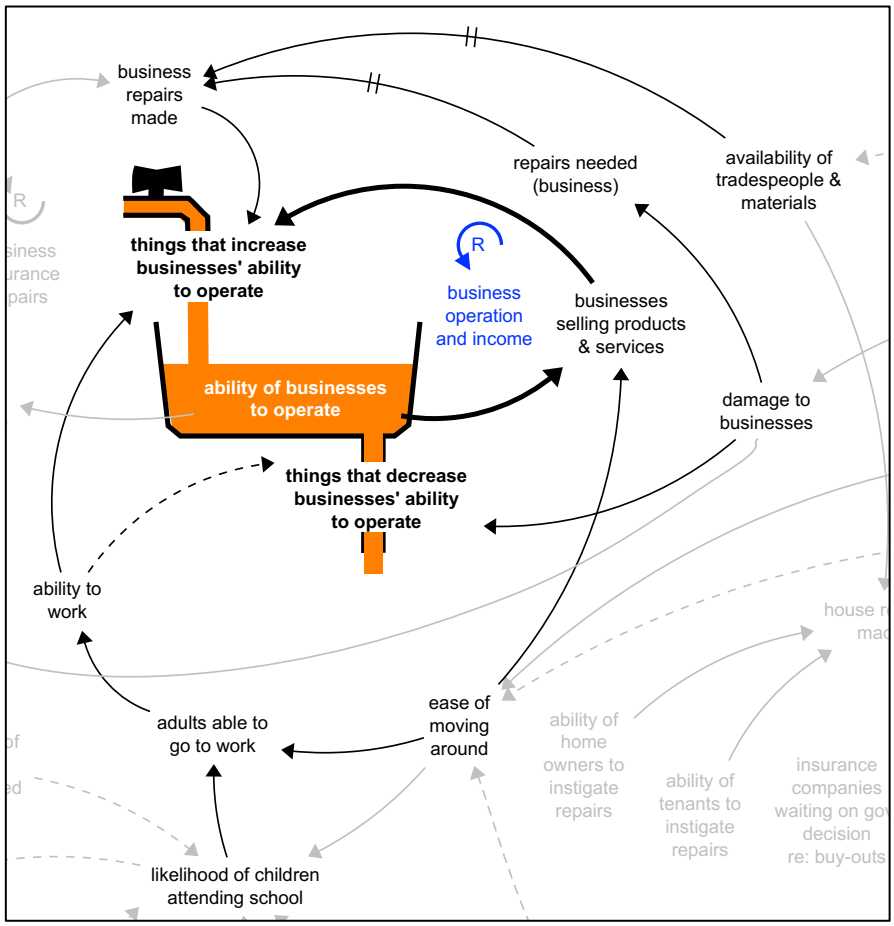

Figure 5-20: Business operation and income loop.

5.7 Insurance

The *insurance* grouping focuses on the relationship between businesses having insurance cover and their operability post-flood, as well as the influences on businesses' ability to afford insurance. It is comprised of one reinforcing loop.

There is a reinforcing relationship between *insurance cover* and the *ability of businesses in Auckland to operate* (Figure 5-21). When businesses have insurance cover, their ability to *undertake repairs* after a flood event and resume operations in a timely manner increases. Being able to operate and bring in revenue supports their ongoing ability to be able to afford to insurance against future events. Over time, this might be expected to fortify business resilience in Auckland.

5.7.1 Business insurance repairs

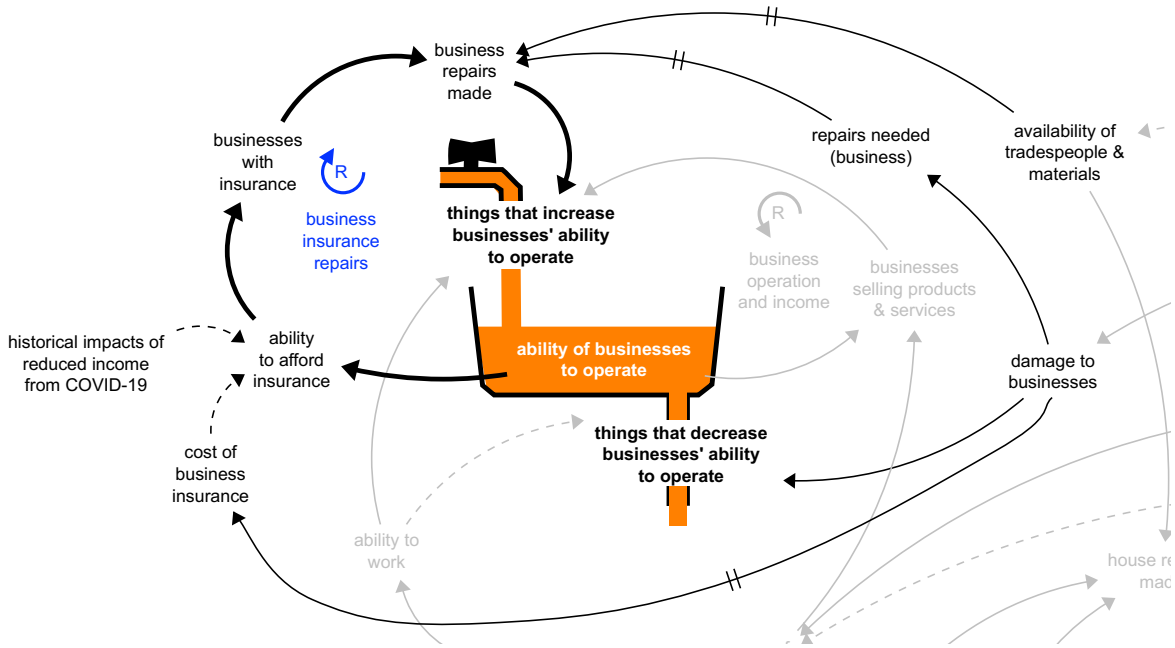

Figure 5-21: Business insurance and repairs loop.

The reverse could also apply: the lower the *ability of businesses to operate*, the less likely it is that they will be able to afford to maintain insurance and get repairs after an event – worsening their *ability to operate*. Over time, this might be expected to result in a downward spiral in business resilience. In Auckland, some businesses had dropped their insurance cover following the COVID-19 lockdowns due to financial constraints, leaving them uninsured during the 2023 flood events. Any increase in the cost of insurance (including increased excesses) is likely to result in a greater number of businesses reducing or cancelling their cover, with potentially negative implications in future flood events.

Another important influence affecting businesses' ability to operate post-flood is competition for *tradespeople and building materials* as both businesses and homeowners seek repairs in the aftermath of flooding, such as during the Anniversary weekend floods (Morrison 2023).

The *cost of business insurance* is also influenced by the amount of *damage to businesses* that occurs over time. As more and more damage occurs it is reasonable to anticipate an increase in the *cost of business insurance*. This will have flow on impacts to the ability of businesses to operate.

5.8 Disruption to everyday life

The *disruption to everyday life* grouping captures the many ways in which flooding affects people's ability to function in everyday life due to damage incurred by homes and transport infrastructure.

Damage to homes instigates the need to undertake repairs. The time in which repairs are undertaken is influenced by a number of factors, including whether occupants are *able to instigate repairs* (with tenants having little or no control over this), the *availability of tradespeople due to high demand*, and the *timeliness of insurance* companies in approving and

paying for repairs for those with cover. Damage to homes also directly influences the *dislocation* grouping and people's need or desire to relocate following a flood.

Damage to transportation systems, particularly roads, influences the ease with which people can move around, which in turn affects people's ability to get to work or school.

The *disruption to everyday life* grouping is comprised of one reinforcing balancing loop focused on house repairs.

5.8.1 House repairs

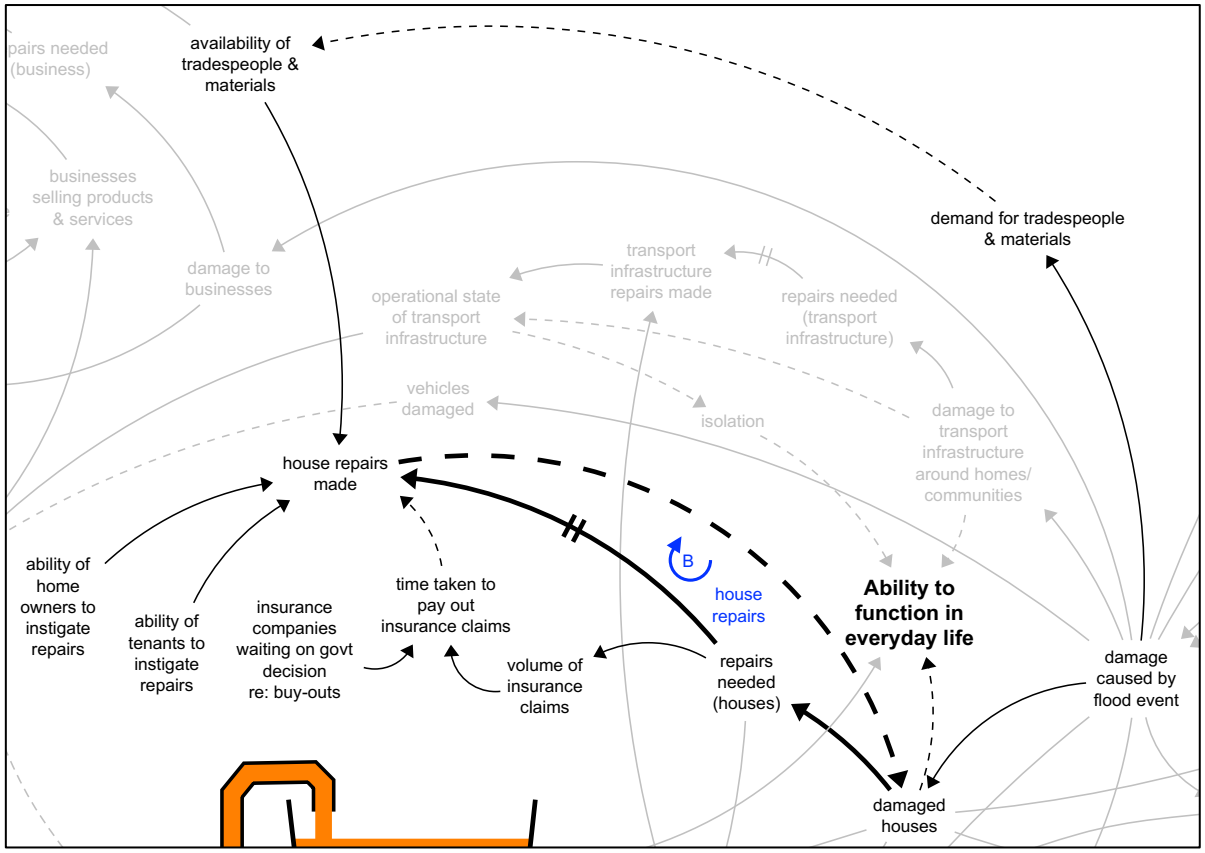

Figure 5-22: House repairs loop.

There is a simple balancing relationship between *damaged houses* and *house repairs being made* (Figure 5-22). The more damage a house sustains, the more repairs are needed and made (including those covered by insurance claims). The more house repairs made, the fewer damaged houses requiring repairs.

This balancing influence only works one way – when there are damaged houses needing repair. Once repairs have been made, there are no longer damaged houses. What is important is that the rate at which this balancing loop operates (i.e., how quickly the repairs are made) is influenced by other factors such as the time insurance companies take to pay for repairs, the availability of tradespeople, and the ability of the occupier – either owner or tenant – to instigate and manage the repairs.

6 Future-focused impacts

As well as the loops developed from the data analysis, several future-focused themes were identified. These were developed from commentary on what the future might hold for Auckland communities, given changes to the climate and future flood risk. It is intended that they will be more fully explored in subsequent publications.

6.1 Land use changes

Many of the themes Auckland participants discussed centred around land use – both how current land use had contributed to flooding, and also how changes to land use could be made to reduce the risk of future flood events.

Reflecting on increasing urban densification, several participants described how in-fill development near their properties had reduced the ability of rainfall to drain away, or redirected water onto their property, contributing to their experience of flooding. As a result, they wanted to see changes to the way densification was undertaken, or limits to it. It also led to anger towards the council. For council staff, the regulatory limits on council's ability to control where development occurs was a source of frustration, as they too described the need to undertake good urban design to reduce flood risk.

Other changes in land use were proposed by participants as part of the solution for reducing flood risk. Many discussed a preference for adopting 'sponge-city' principles, such as the use of green-blue spaces to increase the ability of rainfall to drain away. They noted that bringing more natural spaces such as parks and stream banks into Auckland's urban environment could have co-benefits for wellbeing by increasing people's ability to connect to nature and providing additional spaces for recreation and social connection when not in flood. The desire for changes in land use was also exemplified by the widespread calls, and eventual actioning of, property buyouts in some of the most at-risk areas of Auckland. In this way, experience of recurrent and severe flooding led to agreement that some areas of land should no longer be used for residential purposes due to the extreme risk to life and wellbeing that could not be reasonably mitigated.

6.2 Consequences of the regulatory environments for council-community relationships

As noted previously, the regulatory environments within which council operate were identified by participating staff as being a major constraint on their ability to implement the urban design and development control they knew would be best for reducing flood risk. Some participants described how they felt there was a disconnect between what council's legal obligations were to the community, and what they believed were the moral obligations of council to protect and support their constituents who, through no fault of their own, found themselves at risk of flooding. They also described the budgetary restraints they operated within, and in particular how this limited the number of staff available to do the flood prevention, preparedness, response, and recovery work required. Some also reflected on how these limitations and community experiences or perceptions that council was not doing enough caused anger within the public, which was often directed at council staff.

Despite these constraints, council staff described doing their best to undertake measures that would reduce flood risk. This includes continuing to advocate to central government for the

regulatory changes they believe would best allow them to do the work necessary to enhance Auckland's preparedness and capacity to withstand extreme rainfall events. It also includes initiatives such as the council's recently adopted 10-year 'Making Space for Water' programme which aims to reduce flood hazards in Auckland (Auckland Council 2024b).

6.3 Cascading impacts after the emergency response

Mapping how flood impacts cascade throughout communities has highlighted that recovery takes time. In Auckland, dislocation was a major source of disruption, stress, disconnection from support networks, and financial burden that continued far beyond the immediate few weeks and months post-event. The widespread scale at which temporary and permanent dislocation occurred exacerbated the challenge, putting immense pressure on Auckland's already strained accommodation market. For those whose homes were severely damaged or eventually bought out by government and council, processes of returning home (or to new homes) were particularly drawn out due to high levels of demand for tradespeople, insurance claims, and council time and resources. From this, it was clear that support for impacted communities needs to continue long after the conclusion of the emergency response.

7 Post-interview insights

In August 2025 we shared the results of the research with a group of Auckland Council staff involved broadly in flood planning, modelling, response and recovery work. Attendees shared additional insights and longer-term reflections which we believe are valuable to acknowledge here. Insights shared with us included:

- Reflections that, even over two years following the Auckland Anniversary floods, the long tail of impacts is still being felt across Auckland communities. For example, some residents are still grappling with challenges finding permanent, appropriate housing following displacement.
- The large amount of work that had been undertaken through the Auckland Recovery Office to support and bolster community trust with council. This is an example of action that seeks to turn the potentially vicious reinforcing cycle of deteriorating community-council relationships identified in the causal diagram to one built on trust and constructive working relationships.
- How actions to reduce future flood risk can be maladaptive. For example, to acquire the land needed to increase the amount of blue-green space in the city, it may mean that some people have to move from their property – including people who have already been displaced by the floods and who now potentially face additional displacement.
- That the actions residents take to reduce flood risk on their personal properties may or may not be effective – but the critical thing affecting residents' feelings of safety, agency and perceptions of risk is when they believe their actions have reduced future risk. This may raise challenges when people believe they are safer but potentially may not be, especially as flood hazard increases over time.
- The cascading impacts of flooding on physical health. For example, Auckland Council staff noted increased incidence of substance abuse, domestic violence, health issues arising from living in flood-affected housing, and pressure on the health system occurring post-flood. These cascading health impacts are not captured in the causal diagram as they were not identified as impacts by our interviewees. Nevertheless, these impacts are important for those who experience them.
- The ongoing work being undertaken to make flood risk information more easily accessible and understandable to the general public. There was also reflection that having access to risk information on its own is not necessarily sufficient to help people truly understand the impacts they may face, especially if they have not experienced them previously.

8 Where do we go from here?

The causal diagramming exercise highlights a range of flood effects on the wellbeing of Auckland communities. Many of the experiences of flood impacts in Auckland were broadly similar to those in Little River and the Waikanae Catchment. For instance, all cases identified stress and trauma within the community, the important role of community in supporting one another, and the influence of flooding and flood risk upon community relationships with councils.

On the other hand, Auckland experienced some specific impacts that were not reported in the Little River and Waikanae Catchment case studies. These differences mostly arose due to the urban nature of Auckland, the severity of the recent flooding experienced by the communities there, and the scale of displacement that took place during the Auckland Anniversary flood. Issues raised specifically in Auckland included:

- Pushback against urban densification and the way in-fill development is undertaken, due to how this may increase flood risk
- Widespread dislocation due to flooding, including the negative effects of separation from community and support networks on people's wellbeing, as well as implications for student learning and people's ability to attend work
- Calls for residential property buyouts, driven by experiences of feeling 'stuck' in place and ethical concerns about potentially selling flood-affected properties to other private buyers.

While these impacts were uniquely discussed in the Auckland case study in this research project, they are likely to be relevant for other urban centres or other communities experiencing severe flooding across Aotearoa New Zealand.

8.1.1 High-level themes across the three case studies

Across our three case studies, including Auckland, we have learnt about the nature of flooding impacts in communities over time, and how they come about. The impacts of floods go well beyond the inundation and damage experienced during and immediately after an event. They affect trauma levels within the community, the ability to function in everyday life, how communities connect and function, the capacity of communities to adapt to flood risk, and the ability of the investment and regulatory environment to manage flood risk. We identified four mechanisms for understanding how flood impacts cascade through Aotearoa New Zealand's social and economic systems in ways that, if not addressed, can increase community vulnerability to harm (Figure 8-1).

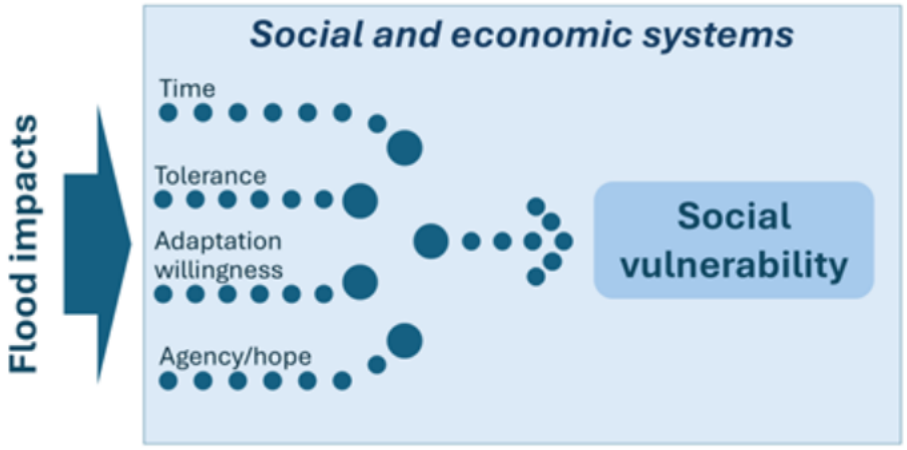

Figure 8-1: How flood impacts cascade through social and economic systems to increase social vulnerability.

Time plays an important role in understanding how impacts from flood events develop. Firstly, the full consequences of floods take time to become apparent and often they only become apparent when things are well into post-event recovery phase. Secondly, time between events matters – without sufficient time to fully recover and experience life as normal, the trauma from flooding accumulates. And thirdly, time fades memories – without knowledge of what has happened in the past, there is little motivation for change in terms of actions to reduce the risk of future flood impacts.

Tolerance to flooding varies, particularly to the cumulative impacts from repeated historical events, or the threat of repeated future flooding. Threats to life, property investments, quality of life, and personal investments in future lifestyles all challenged people's willingness to tolerate future flooding.

We found that the *willingness to take adaptation measures* to reduce future risk and trauma was affected by knowledge of past impacts. This included both personal experiences and collective memories held within the community. Greater knowledge of previous events motivates adaptive change at the personal property level and supports willingness within the community to collectively address risks. Conversely, where there is less willingness to adapt (perhaps because of few memories), people are inadvertently less able to reduce their future flood risks and will be more vulnerable to harm.

Where there is personal, collective, and council *agency* to manage and adapt to future flooding risk, people have *hope* for their future in their community. This belief in the ability to manage flood risk supports, and is motivated by, connection to place and community. Where flood risk mitigations are no longer possible or sufficient, desire to remain in place can weaken and negative implications for wellbeing can emerge.

Addressing these influences on vulnerability should happen across the 4 Rs of emergency management – Reduction of risk, Readiness and Response to events, and Recovery from events. Examples include:

- Supporting people's ability to function in everyday life over the extended recovery period
- Acknowledging and mitigating the trauma caused by flooding, no matter the scale of events
- Promoting community connections and functioning before, during and after events
- Creating and maintaining collective knowledge about flood events to increase the appetite for flood harm reduction measures, so those who do not have direct experience are also better protected in the future
- Building and maintaining collaborative working relationships between communities and their respective councils
- Supporting investment and regulations that manage and mitigate flood risks, and
- Supporting the adaptive capacity of communities.

8.1.2 What does this mean for communities in Auckland?

Although the purpose of this research was only to provide insights on the nature of cascading social impacts of flooding, information from the causal diagramming exercise could be used by Auckland communities and council to draw on themes emerging from the diagram (e.g., community relationships with council or insurance companies) to achieve better outcomes. To do this, Auckland Council and communities could ask themselves a number of questions:

- How can we ensure that the community understands flood risk and what actions can be taken, individually and collectively, to reduce future risk?
- How do we maintain and improve working relationships between community, council, and relevant government agencies, to ensure trust and collaboration to reduce future flood risk?
- What steps can be taken to ensure community expectations of help during and following a flood event are managed so they reflect reality?
- Community connections are a critical source of support during and following a flood. How do we ensure that we sustain these connections? And how do we best support the groups, marae, organisations, and community infrastructure that provide support and assistance to their communities?
- What can be done to minimise the disruption associated with evacuation and displacement? And how do we reduce displacement in the first place?
- How do we support council and agency staff wellbeing as they undertake flood response, recovery, and mitigation work?

These questions can help to frame thinking about actions and interventions to reduce future flood vulnerability in Auckland.

9 Acknowledgements

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We also wish to thank all participants who shared their stories and knowledge with us as part of this project. We are incredibly grateful for the time you took to provide us with your insights and lived experiences.

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This appendix provides a more comprehensive explanation for how to read a causal diagram.

Causal diagrams help us visualise the relationships between different related variables and how they influence each other. This visual articulation of inter-connected relationships is called the 'causal structure'. This causal structure helps us understand how the behaviour of variables in the diagram will change over time will change (or not), in response to changes (or not) in factors within the wider causal structure.

This section outlines important fundamental elements of causal structure. These are:

- The bathtub analogy.
- Feedback loops – the basic building blocks of a causal diagram.
- How feedback loops and causal diagrams are annotated.
- Goals and gaps – driving individual loop dominance.
- How influence operates differently upstream and downstream of a change in flow.

Reading this section will help the reader understand and navigate the causal diagram in this report.

Appendix A How to read a causal diagram (detailed)

The bathtub analogy

Causal diagrams often draw on the analogy of a bathtub. A metaphorical bathtub has been used in the diagram described in this report. The analogy of the bathtub (Figure A-1) represents an accumulated level or amount of something (also called a stock) that is of interest to the issue you are seeking to understand. It may even be the central feature of the issue you are seeking to better understand.

The level of the bathtub (stock) can only be increased by adding more through a metaphorical tap (also called an inflow); and it can only be decreased by removing some of what is in the bathtub through a metaphorical drain (also called an outflow).

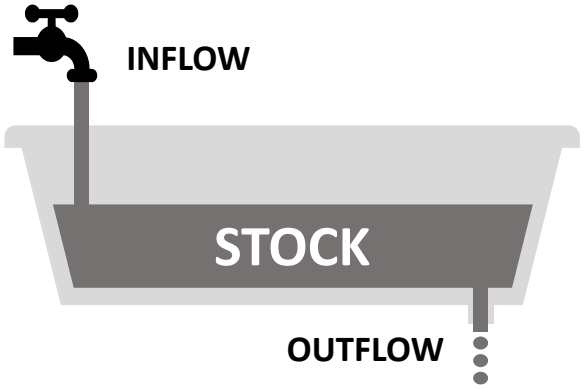


Figure A-1: The bathtub analogy.

This simple analogy can provide powerful insights. For example, an action may stop an issue being added to by reducing or stopping the inflow (the tap). This will stop the level of the bathtub increasing but will not reduce it. To demonstrate this, think of greenhouse gas emissions into the atmosphere. If all greenhouse gas emissions were to stop tomorrow, this would not cause their level in the atmosphere to reduce, it would simply stop them increasing.

Another example is an action that may increase the outflow (the drain) from the bathtub in an attempt to reduce the level of the bathtub. But if there is still a significant inflow through the tap into the bathtub, this will reduce the impact of the increased outflow from the drain. Or if the inflow was to increase more than the outflow, the level of the bathtub will still continue to rise, but at a slower rate due to the increase in the outflow (drain). Greenhouse gases are another good way of demonstrating this point. Even though there are many increased efforts to remove greenhouse gases from the atmosphere (e.g., increasing the flow from the drain (i.e., sequestering carbon) by planting trees or using direct carbon air capture technology), if the emissions (the tap) increase by more than the drain, the level of the bathtub will still increase.

Simply put, if more flows in through the tap than out the drain, the level of the bathtub increases. If more flows out than in, it decreases. It is noted that the bathtub is a metaphor – it will never overflow as it does not technically have a specific capacity. However, it may be fully exhausted (drained).

Feedback loops – the basic building blocks of a causal diagram

Causal diagrams focus on moving away from thinking of causality as linear, to circular. That is, a linear way of thinking about causality might be that A influences B, whereas a circular way of thinking about causality might be that A influences B, and then B also influences A (Figure A-2). This means the causality 'feeds back' on itself, so where this is identified it is known as feedback loops.

Figure A-2: From linear to circular causality.

There are two types of feedback loops, reinforcing and balancing (Senge 2006).

Reinforcing loops seek to spiral in the direction they are already heading (hence reinforcing). They can spiral up or spiral down, and they tend to drive growth or decline (see Figure A-3). They can also change direction and spiral the opposite way, in response to influences from outside the feedback loop (i.e., how they interact with other influences). But the influence from within the loop will always seek to continue spiralling it in the same direction that it is heading.

A simple example of a reinforcing loop is money in a bank account earning interest. Assuming no withdrawals, the more money in the bank then the more interest earned, thus resulting in even more money in the bank. This influences back on itself in the same direction and has the effect of compounding on itself.

Balancing loops seek to cancel or balance themselves out. They tend to create control, restraint or resistance (Figure A-3). Depending on how they interact with other loops they may not always manage to cancel themselves out or come back into balance, but this is what the influences within them will be seeking to do.

A simple example of a balancing loop is thermostat-controlled heating. Let's say that the room temperature drops so the thermostat clicks on and generates heating, this increases the room temperature, so the thermostat clicks off, stopping the heating. This has the effect of cancelling itself out.

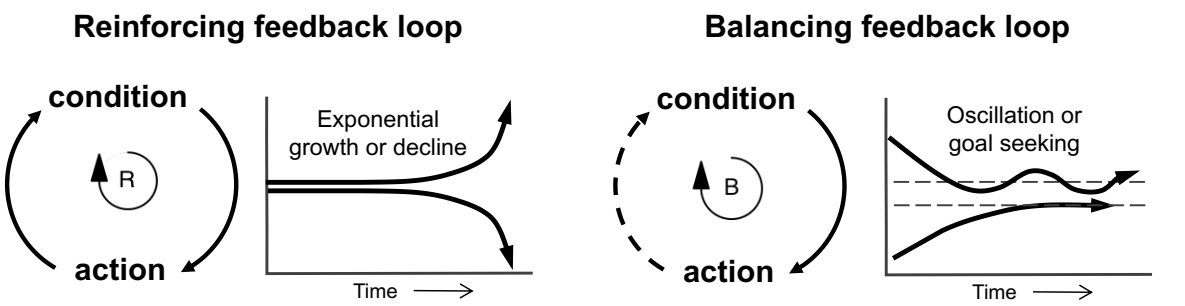


Figure A-3: The two types of feedback loops.

Feedback loops can be made up of more than two variables and can be linked together to form a causal diagram. How these interact in a wider network of loops and influences provides insight into the influences that may be causing a change in the system over time.

How feedback loops and causal diagrams are annotated

This section describes how feedback loops and causal diagrams are annotated.

Labelling variables

As noted in the bathtub analogy section, an important concept within causal diagrams is demonstrating where things build-up (accumulation) or decrease (decumulation). Not all variables need to be represented using the bathtub analogy, but all variables in a causal diagram should be labelled in such a way that they can increase or decrease. This means that they should be described as nouns; have a clear sense of direction, therefore making it obvious that it could increase or decrease; and/or have a normal sense of direction that is positive (or at least when a change in direction is included, it does not become a double negative – e.g., instead of more or less unhappiness we have more or less happiness. Examples to demonstrate this are shown in Figure A-4. In this report, when factors from the diagram are referenced in the text, they are italicised.

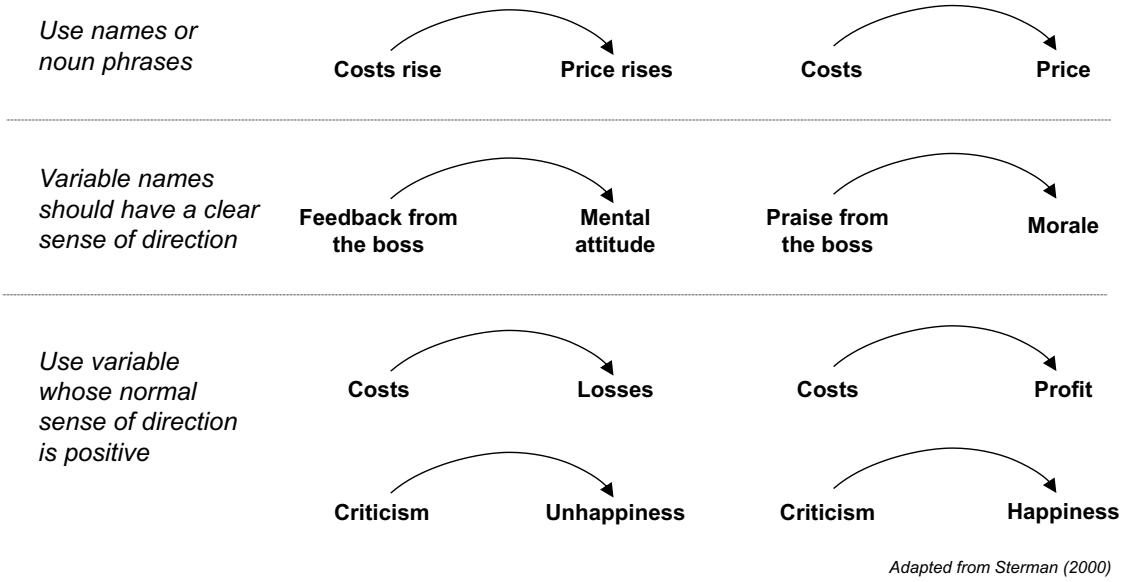


Figure A-4: Labelling variables.

Annotating loops

Variables within causal diagrams are connected (and made into feedback loops) by arrows, indicating that one factor has a causal relationship with the next. These arrows are solid or dashed lines, because they work in either the 'same' or 'opposite' direction. These terms correspond to the direction of change caused by one variable on another (Figure A-5).

For example, if change in one variable leads to change in the next variable in the same direction, it is a same relationship (solid line). Likewise, if the second variable changes in the opposite direction, it is an opposite relationship (dashed line).

Relative delays in the cause-and-effect influence between two variables, when compared to other influences outlined in the causal diagram, are annotated as a double line crossing the arrow. An example of this is shown in Figure A-5.

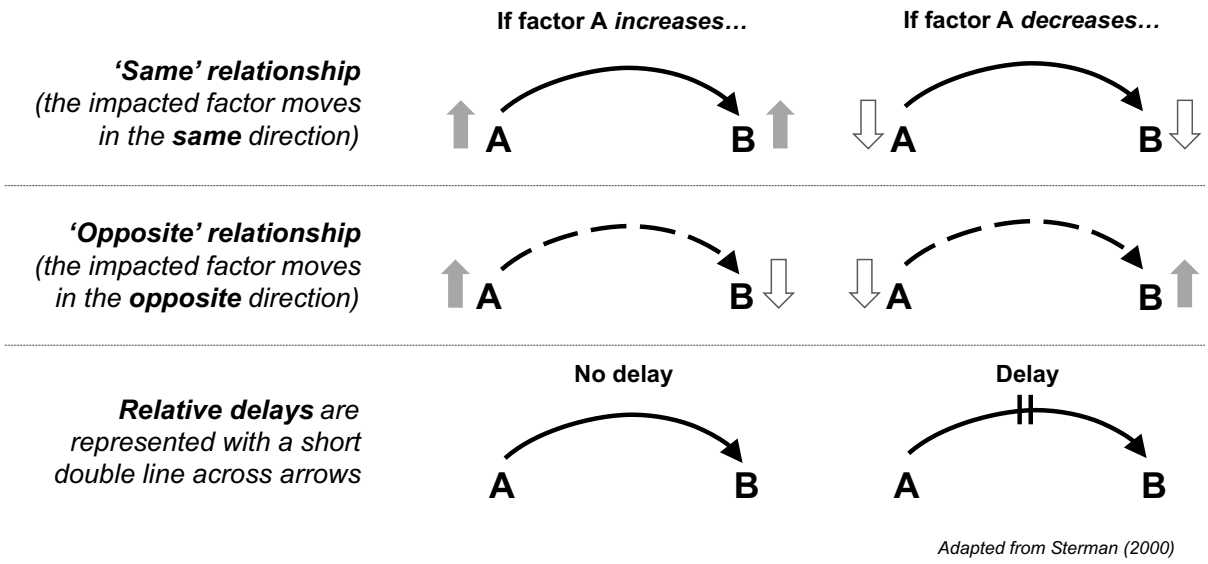


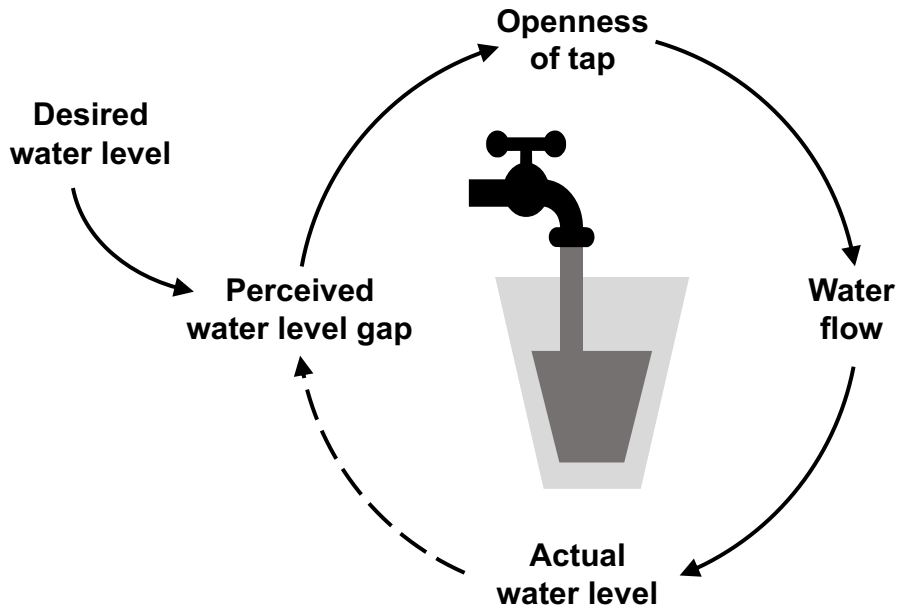
Figure A-5: How arrows and delays are labelled in causal diagrams.

Goals and gaps – driving individual loop dominance

Realising that multiple loops are operating together to generate the behaviour you are trying to understand is the first useful insight of a causal diagram. A further useful insight is understanding that not all loops operate at the same strength all the time. Different loops can dominate at different times. For example, the behaviour generated in a causal diagram might be dominated by a period of growth, but when a physical limit is approached (e.g., the available space in a pond for algae to grow) a balancing loop will start to dominate, therefore slowing the rate of growth.

One useful mechanism for gaining insight into the strength of a balancing loop is '*goal/gap' structure*. This is a feature within the causal diagram that combines both the *desired or aspirational* level for something (a 'goal'), with its *actual* level. The difference between these – aspiration versus actual - is the 'gap'. The higher the desired level and the lower the actual level, the greater the 'gap'. The result is movement towards activities/decisions that narrow the gap between desired and actual. The lower the desired level and the higher the actual level, the lower the 'gap'. This usually leads to decreases in activity because it is nearer its goal.

An example of filling a glass of water is shown in Figure A-6. Initially, while the gap/difference between the desired and actual water level is high, the tap will be opened more. As the desired level of water is approached the gap/difference reduces, so the tap is closed further, until it is fully closed when the water level reaches the desired amount.



Adapted from Senge (2006)

Figure A-6: Example of a 'goal/gap' structure in a system map – filling a glass of water. Adapted from Senge (2006).

How influence operates differently upstream and downstream of a change in flow

When a diagram is made up partly of variables and arrows of influence, as well as a visual bathtub analogy (stock and flows - as this report has), then the flows in or out of a stock themselves often form pathways of influence within feedback loops. When this occurs, the influence can be either same or opposite, depending on which way along the flow the influence is travelling.

When a flow forms part of a feedback loop and the influence is travelling *with the flow* (i.e., downstream), then that is a same influence. That is, if the flow was to increase (or decrease), then the stock to which it is flowing would also increase (or decrease), all other things being equal.

When a flow forms part of a feedback loop and the influence is travelling *against the flow* (i.e., upstream), then that is an opposite influence. That is, if the flow was to increase (or decrease), then the stock from which it is flowing would decrease (or increase), all other things being equal.

For example, imagine a stock of 'students' at a university and a stock of 'students that have graduated' from that university, joined by a flow of 'students graduating'. An *increase* in the flow of people graduating will *increase* the number of people in the 'graduated' stock – a same influence. At the same time, an *increase* in that flow will *decrease* the number of people in the 'students' stock – an opposite influence.

The flow structure and the variable/arrow influence structure are compared below in Figure A-7.

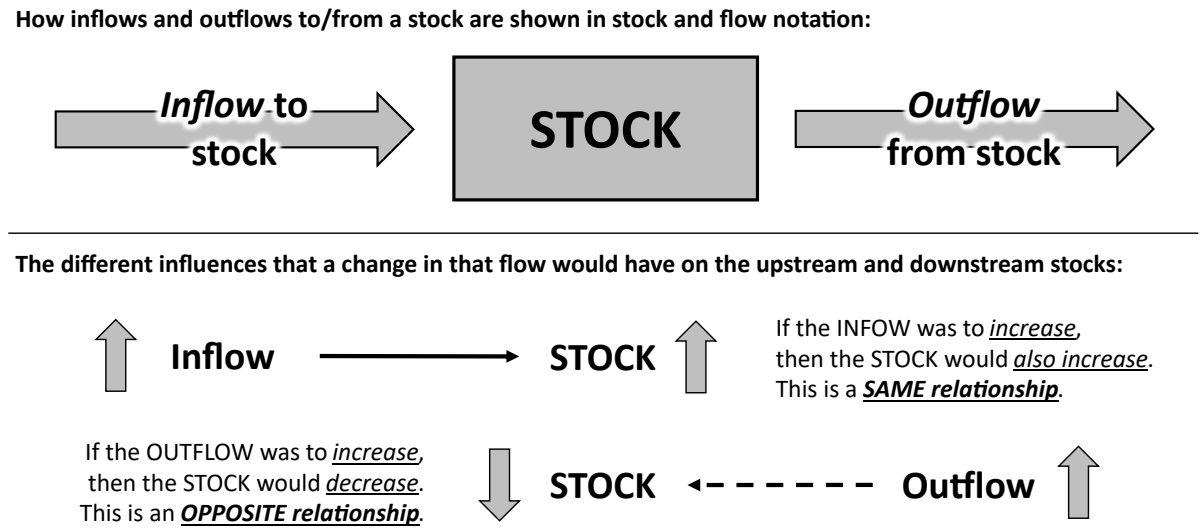


Figure A-7: How influence operates differently upstream and downstream of a change in flow.