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NIWA: Future Coasts Aotearoa

Causal diagrams to help understand wellbeing in Te Puuaha | The Lower Waikato River – A Community perspective

December 2023

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Disclaimer

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Acknowledgements

The support and involvement of community members from Te Puuaha | The Lower Waikato River, particularly around Port Waikato and Aka Aka, is gratefully acknowledged.

Those that agreed to be involved in the workshops generously gave their time and knowledge to contribute to the development of the causal diagram described in this report. Without their contributions this would not have been possible. Those participants who were able to attend most or all workshops are co-authors of this report, and are listed in the authorship alphabetically.

The causal diagram articulated in this report remains the property of the community of Te Puuaha | The Lower Waikato.

Glossary

Figure 1. Glossary of words used in this report

Word	Interpretation
Government	A central government ministry, department or agency. Usually tasked with the provision of some kind of service at a local level. For example, health services, transport, or education.
Council	The Waikato Regional Council or Waikato District Council. These are the two levels of council that have statutory responsibility for certain things within the geographic area of the Te Puuaha | The Lower Waikato River

Executive summary

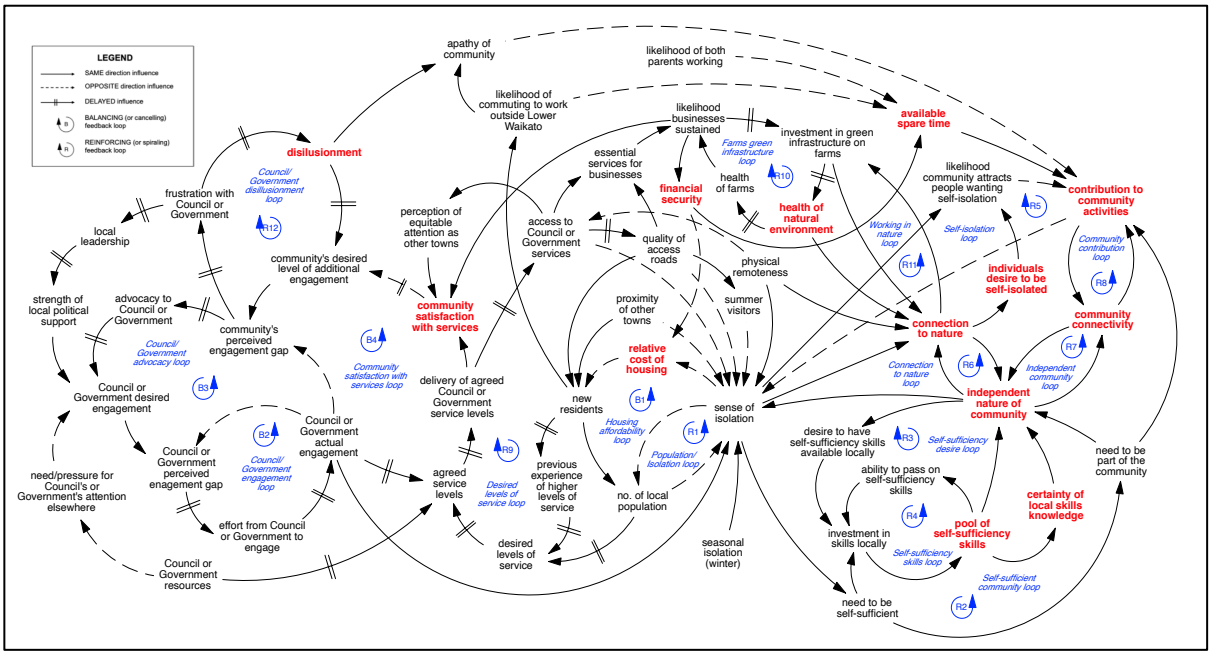
The Future Coasts Aotearoa project is Endeavour funded research that seeks to understand the impacts of climate change on low-lying riverine environments in Aotearoa New Zealand.

This report summarises causal diagrams developed by a community group in a tangata whenua-led case study in Te Puuaha | The Lower Waikato River.

Causal diagrams are a qualitative tool of the discipline of System Dynamics (Sterman, 2000). They help us understand the how the interconnections of various interacting causal factors influence a behaviour(s) that we are trying to understand. Once these interconnections are articulated we can better understand the 'system' as a larger whole, allowing us to identify areas of leverage where action could be expected to influence things in a desirable direction.

The various parts of the causal diagram described in this report highlight that the lower Waikato/ Te Puuaha has a historic sense of isolation and communities tend to be highly self-sufficient, or live there as they desire self-isolation. Communities have a strong connection to nature, strong community connectivity, and have historically experienced relatively affordable costs of housing. Businesses (mostly farming) in the area tend to have strong connections with nature and are heavily reliant on the environment being healthy. The various communities desire relatively equitable levels of engagement with, and services from, councils or government as other areas of the Waikato experience. Yet there are a range of interconnected influences on both communities and council/government expectations that may mean these are often difficult to balance.

Community group causal diagram



A range of generalisable insights can be drawn from the diagram. These were both observed by either/both the group of the facilitator:

- The situation is complex! Yet the chaos that appears in the diagram is a reasonable representation of the various influences and tensions that exist within the communities of the lower Waikato/Te Puuaha.
- It is noted that the diagram is partial. It represents the views of those that participated in the workshop and by its nature seeks to summarise a lot of complexity so that how things interconnect can be represented.
- A key element of the identity of the lower Waikato/Te Puuaha is its relative isolation. This is strongly linked with the independent nature of the community and the sense of self-sufficiency

that it has traditionally experienced. Most of these loops are *reinforcing loops*, meaning that these factors spiral together and trend in a similar direction, whatever that is (e.g. either up or down).

- A range of influences, many of which have been sought by the communities of the lower Waikato – such as improved services, have been slowly decreasing its relative isolation. This has and will continue to have an impact on the nature of the community, likely reducing its independent nature and self-sufficiency (in the much longer term). In effect, the very things that have traditionally made the lower Waikato attractive (especially low relative house prices), are likely to cause attract more people to the area over the longer term. This is likely to evolve the nature of the communities.
- A connection to nature is important for all communities in the lower Waikato/Te Puuaha. This includes those involved with farming.
- Around one third of the diagram is devoted to the relationships between the communities of the lower Waikato/Te Puuaha and Councils or Government. Most of these loops are *balancing loops*, meaning that these factors influence each other until they tend to come back into balance with each other.
- Both the communities of the lower Waikato/Te Puuaha and the Councils or Government have their own expectations around what services they expect to provide/receive. It is important to note that these are driven by different experiences and are not simply two sides of a single interaction. That is, Council or Governments expectations can be met while the communities may not.
- The communities have a sole relationship with the Councils or Government which influences their expectations. Yet the Councils of Government have many other relationships with other communities that will influence their expectations with the lower Waikato/Te Puuaha communities.
- A sustained gap between communities perceived level of engagement and service from Councils or Government (has and) will likely, over time, lead to disillusionment with Councils or Government; advocacy by the communities to Councils or Government; or a growth in local leadership and potentially political involvement/support for improved engagement from Councils or Government.

This report and the diagram it contains are the property of the communities of the lower Waikato. It is provided so that it can be one of a number of tools available to communities, relevant councils or government ministries/agencies/departments, or any interested party, to use to help understand some of the interconnected dynamics of the lower Waikato/Te Puuaha communities.

There are two ways of drawing insights from the diagram. These may be characterised as:

- Exploring the flow on effects of impacts of climate change; and/or
- Understanding the influences that support the characteristics that enable the communities to thrive, and exploring how to better support that in a likely climate changed future.

It is hoped that this diagram is one useful tool for helping the communities of the lower Waikato/Te Puuaha work towards continued thriving in a climate changed future.

1 Introduction

The Future Coasts Aotearoa project is Endeavour funded research that seeks to understand the impacts of climate change on low-lying riverine environments in Aotearoa New Zealand.

This report summarises causal diagrams developed by a community group in a tangata whenua-led case study in Te Puuaha | The Lower Waikato River.

Another causal diagram was also developed by group made up of tangata whenua whaanau participants. That causal diagram is described in another technical report (van Schravendijk-Goodman, Mahuta & Connolly (2023)).

The development of both causal diagrams were based around understanding what participants valued and made them thrive, and the factors that enabled that which may be exposed to climate change risk.

1.1 A report for multiple audiences

This report is intended for multiple audiences. The primary audience is the Future Coasts Aotearoa project. Yet it also intended for both Paakeha and Maaori decision makers and communities - inclusive of whaanau, hapuu, iwi, as a useful tool for understanding many related qualitative factors that are woven into the challenges of responding to climate change. We have kept the lay reader in mind when writing this report and hope that such an audience finds it useful.

1.2 Acknowledging the contribution of community members

This work was done with and for the various communities of the lower Waikato river/Te Puuaha. It would not have been possible without the generous contribution of time from community members that care deeply about their local communities.

The insights in this document, while generated with professional support in the use of systems thinking and causal diagrams, is considered the intellectual property of the people of the lower Waikato river/To Puuaha.

Thank you to those community members who gave their time to be involved in workshop, discuss issues on the telephone, and provide comments on this final report.

1.3 Structure of this report

This report is structured as follows:

- What are causal diagrams? (section 2);
- How to read a causal diagram (section 3);
- Description of the causal diagram developed with the community group (section 4);
- Using the causal diagram to explore impacts and insights (section 5)

The bulk of the report is contained in sections 4 and 5.

2 What are causal diagrams?

The world that we live in is a highly interconnected place of causality and effect. The work of policy development often seeks to respond to undesirable behaviour or patterns being experienced in our natural environment and therefore seeks to influence these causes, to alter or improve the desired behaviour.

'Systems Thinking' is a name often applied to a range of approaches to thinking about issues holistically. One of these approaches is academic discipline of 'System Dynamics'. System Dynamics originated from the Sloan School of Management at the Massachusetts Institute of Technology, Cambridge, Massachusetts in the late 1960's.

Systems thinking, as described by the discipline of System Dynamics, is a conceptual framework and set of tools that have been developed to help make these patterns of interconnectedness clearer (Senge, 2006)[1]. They help us understand the structure of a set of various interacting causal factors that influence a behaviour that we are trying to understand. Once these interconnections are articulated in a causal diagram (or causal loop diagram in technical jargon), we can better understand which parts of a system are having the most influence on the behaviour, allowing us to identify (usually a combination of) areas of leverage where action could be expected to influence this.

Where the term causal diagram has been used in this report, it refers to the qualitative tool of that name (causal loop diagram or causal loop map) articulated by the discipline of System Dynamics (Sterman, 2000). The term causal diagram is used throughout this report for ease of reference.

[1] For a detailed introduction to the concepts of Systems Thinking, the reader is referred to The Fifth Discipline – the art and practice of the learning organisation (2nd ed) by Peter Senge (2006) as an accessible introduction.

3 How to read a causal diagram

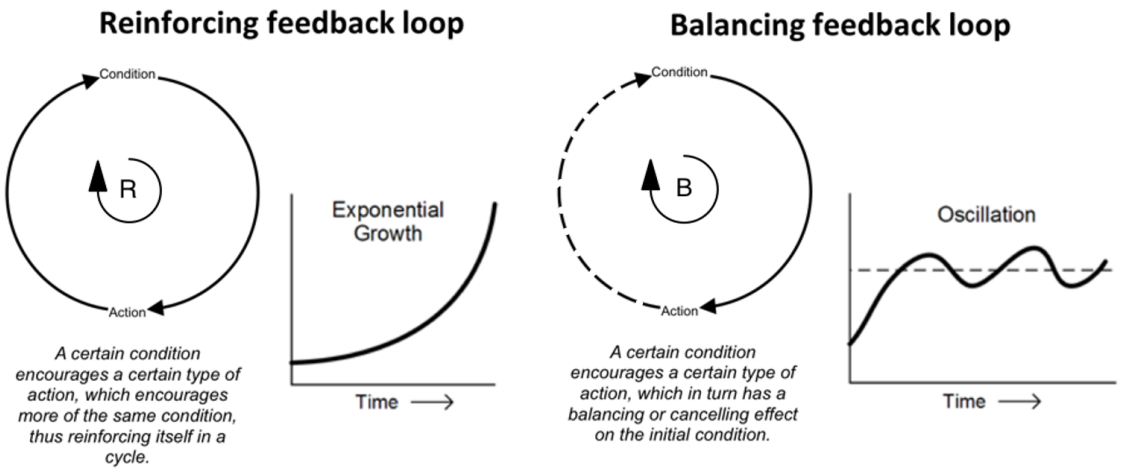
At the core of causal diagrams is the desire to visually articulate the relationships between variables that best explain some kind of behaviour or trend over. This visual articulation of relationship is known as 'causal structure'.

This section outlines important fundamental elements of causal structure. These are: feedback loops; how they are correctly annotated; and the use of the 'goal/gap' structure (as this can explain how different loops dominant at different times).

3.1 Feedback loops – the basic building blocks of a causal diagram

Causal diagrams are especially interested in systems where loops of causality are identified – these are called feedback loops. There are two types of feedback loops, reinforcing and balancing (Senge, 2006).

Figure 2. The two types of feedback loops



Adapted from Senge (2006) & Ford (2010)

In a **reinforcing feedback loop**, the direction of influence provided by one factor to another will transfer around the loop and influence back on the originating factor in the **same** direction. This has the effect of reinforcing the direction of the original influence, and any change will build on itself and amplify. **Reinforcing loops tend to drive growth or decline**.

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.

In a **balancing feedback loop**, the direction of influence provided by one factor to another will transfer around the loop through that one factor (or series of factors) and influence back on the originating factor in the **opposite** direction. This has the effect of balancing out the direction of the original influence. **Balancing loops tend to create control, restraint or resistance**.

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.

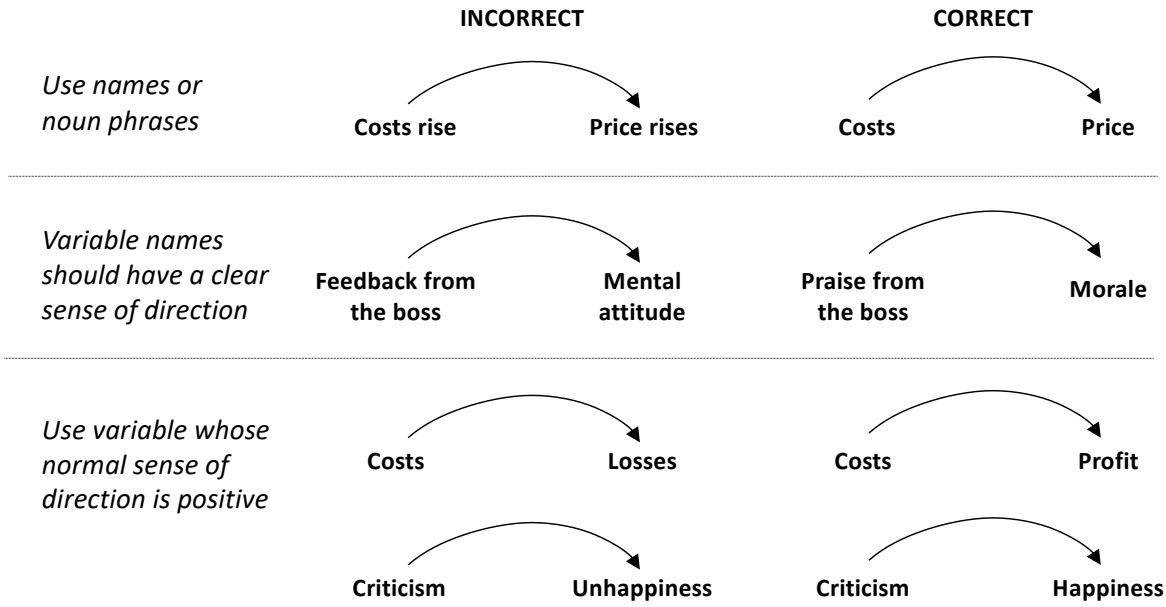
Feedback loops can be made up of more than two variables and can be linked together to form a causal diagram. How these interact in a wider network of loops provides insight into the influences that may be causing a behaviour is trying to understood.

3.2 Labelling variables

An important concept within causal loop maps is the concept of accumulation (or decumulation) –where does stuff build-up (or decrease) in the interconnected influences? The simple analogy of a bathtub is often used to describe this.

In causal diagrams, this concept of accumulation is captured by describing variables in such a way that their name implies they can increase or decrease. This means that they should be described as nouns; have a clear sense of direction; and/or have a normal sense of direction that is positive. Examples to demonstrate this are shown in Figure 3.

Figure 3. Labelling variables



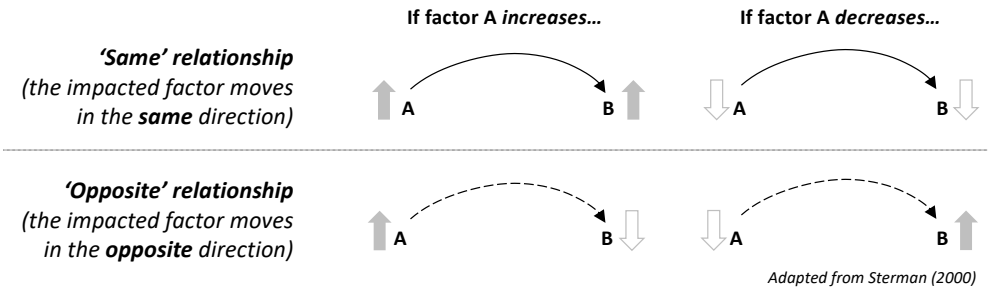
Adapted from Sterman (2000)

3.3 Annotating loops

Variables within causal loop maps are connected (and made into feedback loops) by arrows, which indicate that one factor has a causal relationship with the next. These arrows are annotated **solid or dashed lines**, which indicates they work in the **'same' or 'opposite' direction**. These terms correspond to the direction of change that any change in the first variable will have on the second variable.

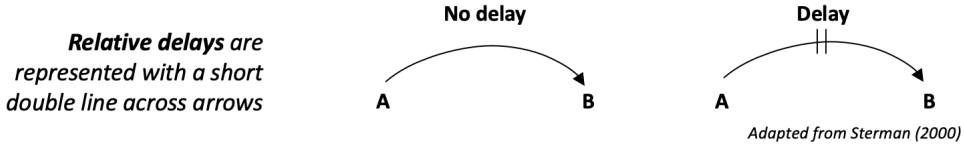
For example, if a directional change in one variable leads to a directional change in the next variable in the *same direction*, it is a *same relationship*. Likewise, if the second variable changes in the *opposite direction*, it is an *opposite relationship*. See Figure 4 for a visual description.

Figure 4. **How arrows are labelled in system maps**



If there is a notable delay in this influence presenting in the second variable, when compared to the other influences described in the causal loop map, this is annotated as a *double line crossing the arrow*. An example of this is shown in Figure 5.

Figure 5. **How delays are annotated on arrows**



3.4 Goals and gaps – driving individual loop dominance.

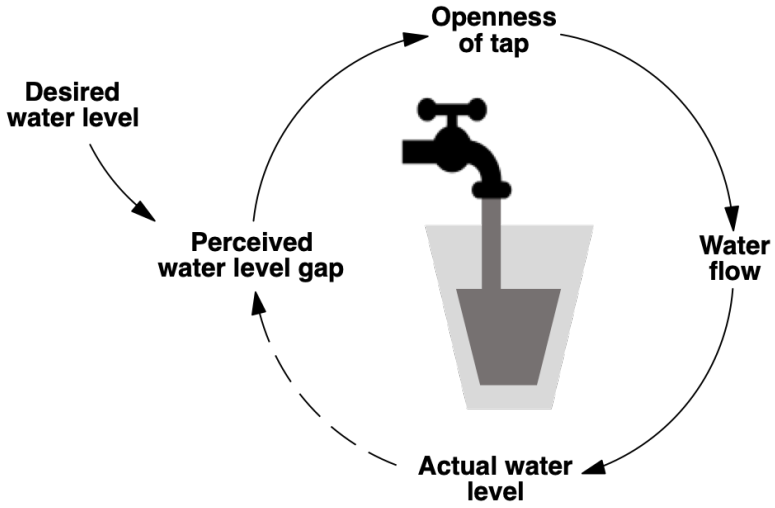
Realising that multiple loops are operating together to generate the behaviour you are trying to understand is the first useful insight of causal loop mapping. A further useful insight is understanding that not all loops operate at the same strength all the time. Different loops can dominate at different times. For example, the behaviour generated by your causal diagram might be dominated by a period of growth, but when some kind of 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 the *'goal/gap' structure*. This is a node that combines both a *desired or aspirational level* of something (a 'goal'), with an actual level of something. This *difference between these variables* is the 'gap' between the desired/aspirational and actual levels.

The higher the desired level and the lower the actual level, **the greater the 'gap' or difference**. This usually leads to continued or stronger activity to increase the actual level, or to reduce the desired level – effectively any activity that seeks to narrow the gap/difference between desired and actual.

The lower the desired level and the higher the actual, **the lower the 'gap'**. This usually leads to a decreased activity to increase the actual level, as it is near its goal.

Figure 6. **Example of a 'goal/gap' structure in a system map – pouring a glass of water**



Adapted from Senge (2006)

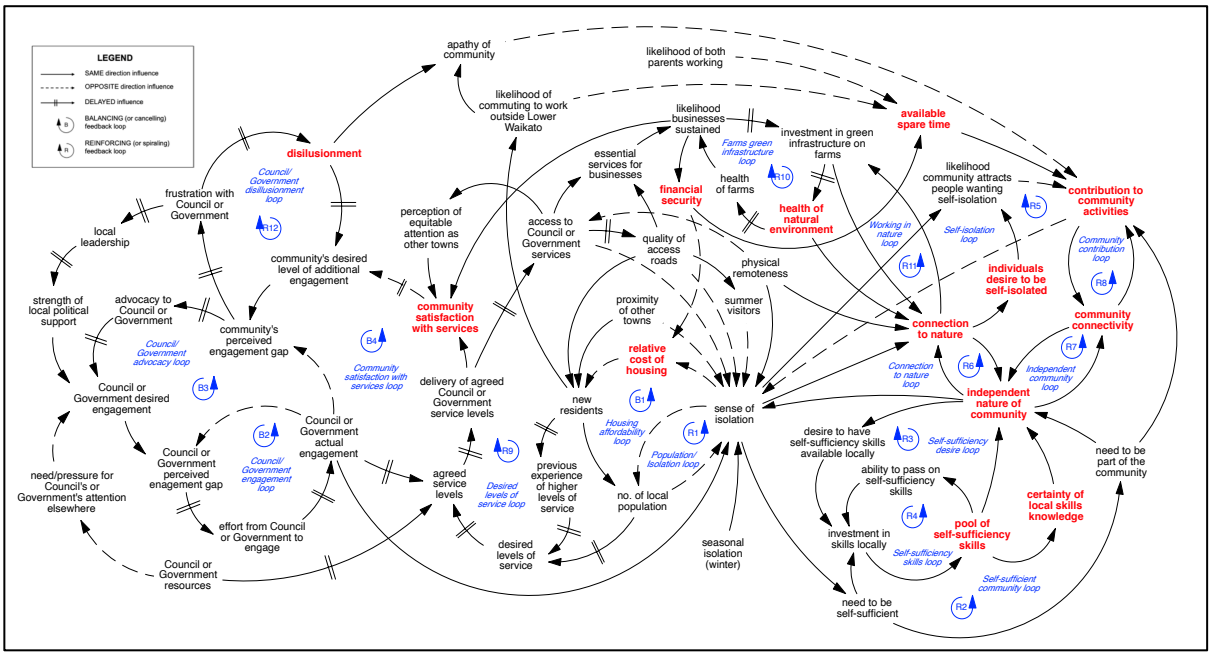
An example is shown in Figure 6 which shows the simple conceptual example of filling a glass of water. Initially, while the gap/difference between the desired and actual water level is high, the tap will be opened more. As the desired level of water is approached the gap/difference reduces, so the tap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

The 'goal/gap' mechanism can be seen in the causal diagram described in this report, where it plays an important role.

4 Description of the community group causal diagram

This section describes the causal diagram drawn by the community group. This is shown in its entirety at the beginning then explained piece by piece in the following subsections.

Figure 7. Complete community group causal diagram



It is noted that the order in which the pieces of the diagram are described in no way suggest that those factors or loops described earlier than others are more important or influential. As the diagram is made up of loops, they can be described by starting in any place. The sequence in which they are described has been chosen as this is a good way to tell their story.

Numbering of feedback loops is also used simply to differentiate loops. These numbers do not indicate any greater priority or influence.

Where feedback loops have been identified and labelled for ease of identification, these have been marked with blue names and labels. A ‘B’ in a loop indicates a balancing loop, and an ‘R’ indicates a reinforcing loop.

This work is also highly interested in the factors that contribute to the community’s overall wellbeing. Therefore, factors that have been identified as being an important part of the community’s wider wellbeing have been **bolded and highlighted in red**.

4.1 An area with a sense of isolation

For most participants one of the defining features of the Lower Waikato area was its remoteness and sense of isolation. This had historically been a key feature of the character of the place and the community. Therefore, it featured strongly in the discussions and is represented in the causal diagram as the factor ‘sense of isolation’, a factor which captures both the qualitative and quantitative elements that contribute to the Lower Waikato feeling like an isolated place.

Several factors were identified as contributing to this sense of isolation. These are shown in the diagrams below.

Firstly, there is the ‘physical remoteness’ – The Lower Waikato and especially Port Waikato are a long way away from most places. Secondly there is the ‘seasonal isolation (winter)’ – which recognises the fact that The Lower Waikato is more isolated in the winter as it tends to be primarily a summer

destination. These are both shown as having *same* influences on the 'sense of isolation'. That is, the greater either of these factors, the greater the sense of isolation (see 0).

Secondly there is a 'population-isolation' loop. This is where the 'sense of isolation' has an *opposite* influence on the number of people in the local population (shown by the factor 'no. of local population') – in other words the higher the sense of isolation the lower the population. At the same time, the level of the population also has an opposite influence on the 'sense of isolation' – the lower the population the higher the sense of isolation. These circular influences form a *reinforcing loop* (**R1**) meaning that these can spiral with each other. For example, if the isolation is high the population tends to be low, further reinforcing the sense of isolation. This can also work the opposite way – if the sense of isolation is reduced then the population will increase, further reducing the sense of isolation and increasing population further over time.

Figure 8. **Physical and seasonal remoteness**

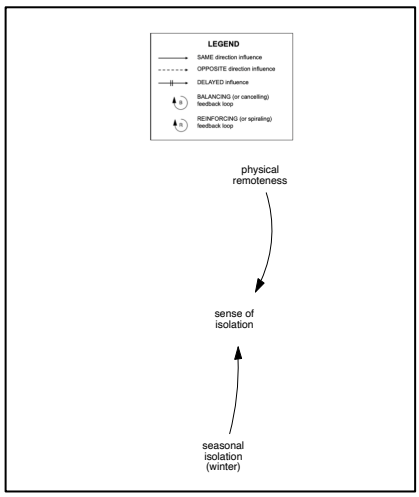
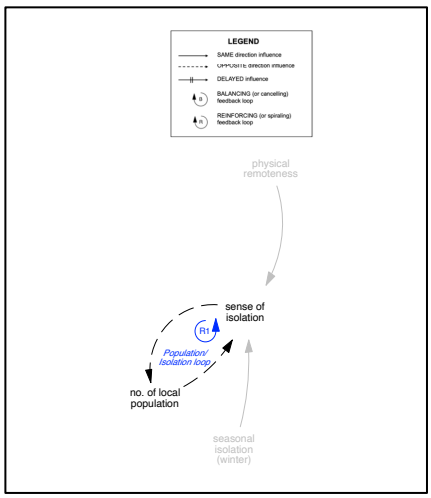


Figure 9. **Population-isolation loop**

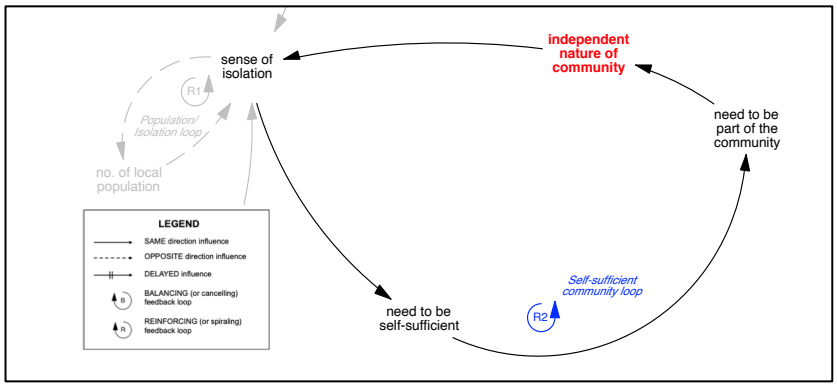


4.2 A self-sufficient community

The traditional self-sufficiency and independent nature of the communities in the Lower Waikato was also a strong feature of the discussions with the group. Historically this was seen as a product of the isolated nature of the community and so therefore has been linked to that in the causal diagram.

This is primarily described as a *reinforcing loop* (**R2**) where a high 'sense of isolation' has meant that there was a high 'need to be self-sufficient' which in turn has strengthened the 'need to be part of community', which strengthens the 'independent nature of the community' which, in turn, further *reinforces* the 'sense of isolation' due to the community being so independent (see Figure 10).

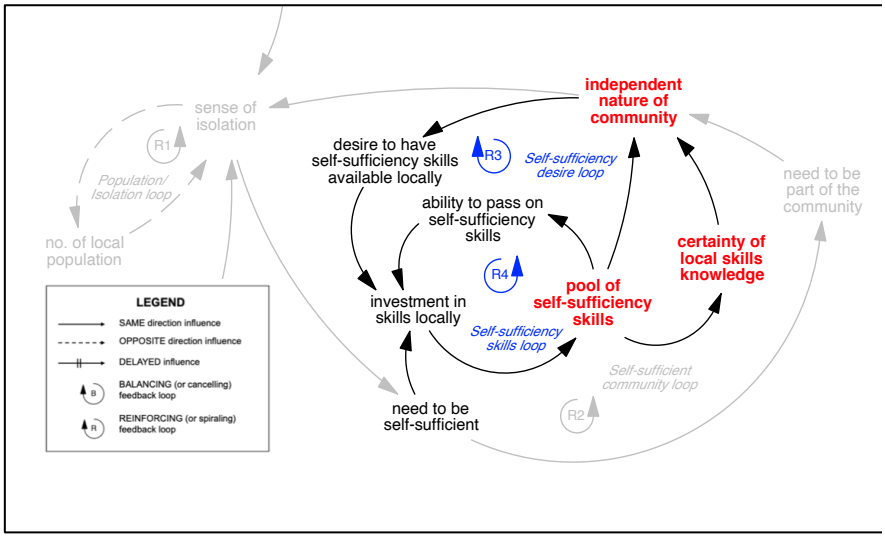
Figure 10. The self-sufficient community loop



As noted at the start of this section, as the 'independent nature of community' is an important factor contributing to the community's sense of wellbeing, this has been bolded and highlighted red.

Multiple other factors are also connected to this loop. Firstly, two other important factors contributing to the community's wellbeing are identified – The 'pool of self-sufficiency skills' available to the community and having 'certainty of local skills knowledge'. That is, the skills required to be independent and self-sufficient are available locally and people have certainty that these are there and available if needed. Both these factors are important components of wellbeing so are bolded and highlighted red. Both directly influence the 'independent nature of community' and the 'pool of self-sufficiency skills' also directly influences the 'certainty of local skills knowledge' (see Figure 1).

Figure 11. Desiring and sustaining a pool of self-sufficiency skills



The 'independent nature of community' has a *same* influence on the 'desire to have self-sufficiency skills available locally', which then has a *same* influence on 'investment in skills locally' which, in turn, has a *same* influence on the 'pool of self-sufficiency skills' which influences back on the 'independent nature of the community'.

These factors operate in a *reinforcing loop* (**R3**) called the *self-sufficiency desire loop* where, if one or any factors are strong or strengthening, they are all strong or strengthening. Or vice versa in the case of weak or weakening factors.

The 'need to be self-sufficient' also influences the 'investment in skills locally'.

Another feedback loop operates within this where the 'pool of self-sufficiency skills' has a *same* influence on the 'ability to pass on self-sufficiency skills' which then has a *same* influence on 'investment in skills locally' which then flows through the *same* influence to 'pool of self-sufficiency skills' already described. This completes another reinforcing loop (**R4**) called *self-sufficiency skills loop*. These also spiral with each other: if any or all factors are strong, then so are the others in this loop; if any or all factors in the loop decline then so too will the others.

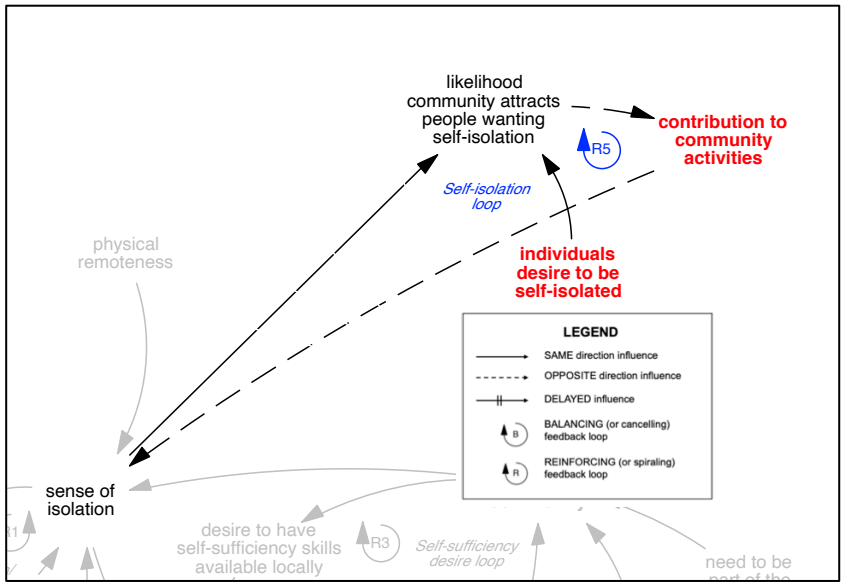
4.3 A community for those wanting to self-isolate

Another important feature of the community that was highlighted in discussions was the fact that some members of the community lived there because they were deliberately seeking a place to live an isolated existence and *not* be part of a community. It was noted that there was a sizeable portion of community members who were quite happy keeping to themselves and not actively looking to interact with other community members.

This is captured in the causal diagram with the *self-isolation feedback loop* (**R5**). Here both the 'sense of isolation' and an 'individuals desire to be self-isolated' have a *same* influence on the 'likelihood community attracts people wanting self-isolation' – the great the isolation and desire to isolate, the more people seeking that the community attracts.

In turn this has an *opposite* influence on the extent that people make a 'contribution to community activities' – the *more* the community attracts people wanting self-isolation the *less* they will contribute to community activities. This then has an opposite influence on the sense of isolation – the *less* people make a 'contribution to community activities' the *more* this reinforces a 'sense of isolation'.

Figure 12. Individuals wanting to self-isolate

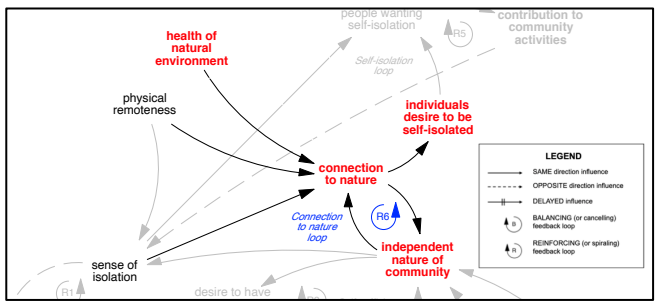


4.4 Connection to nature

Coupled with the remoteness of the area is its proximity to nature. The connection to nature was identified as an important element of the identity and attraction of the lower Waikato communities. The factor 'connection to nature' is therefore shown as a red factor, as it is an important contributing factor to wellbeing. Also, it influences both the 'independent nature of community' as well as 'individuals desire to self-isolate'. The factors 'connection to nature' and the 'independent nature of community' also form a feedback loop (**R6**) and reinforce each other – the greater the independent nature of the community the greater the connection to nature, and vice versa.

The factors that influence the 'connection to nature' are the 'sense of isolation', 'physical remoteness' and the 'health of natural environment'. This last factor is also shown in red as it is an important factor in wellbeing. All of these are *same* relationships – the greater or stronger any one of them, the greater or stronger the connection to nature. And vice versa.

Figure 13. Connection to nature loop



4.5 Community connectivity

It is important to recognise that (at least) two different types of pressures on community connectivity were identified by the group – the need for a strong independent community and the desire of some to remain self-isolated. Both contribute to the wider wellbeing of different types of people. The feedback loops describing these two different types of desires for the community interact in the feedback loops described below and contribute to 'community connectivity' – a factor used to describe the sense that the community is connected within itself enabling people to meet any necessary needs they may have from within the community. This is also an important factor of the wider wellbeing of the community and so has been bolded and highlighted red.

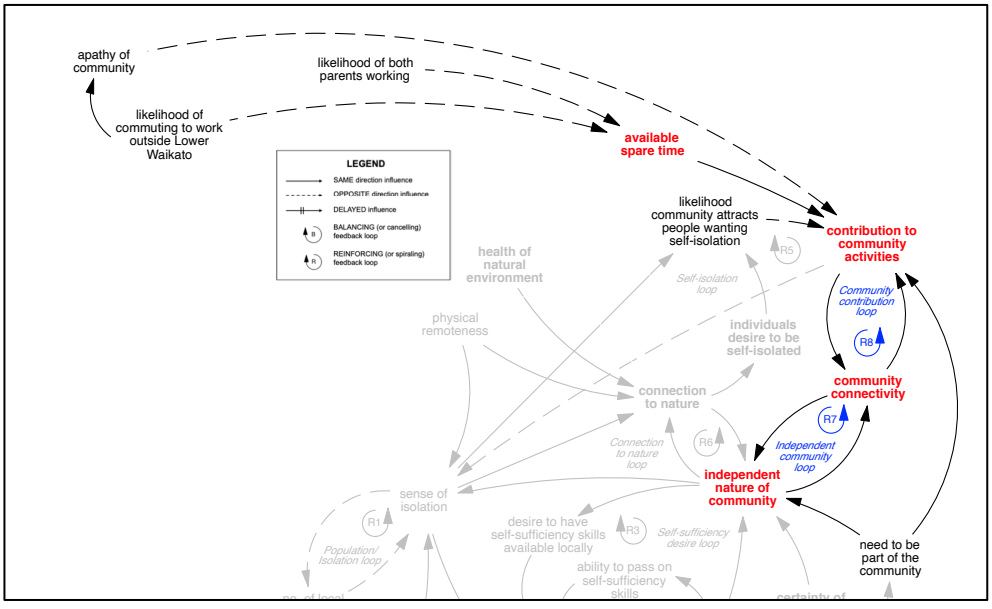
Firstly the 'independent nature of community' forms a *reinforcing feedback loop* (**R7**) with 'community connectivity', this is called the *independent community feedback loop*. The independent nature of the community drives a need for the community to have good internal cohesion and have strong internal connectivity.

At the same time there is another *reinforcing feedback loop* (**R8**) formed between people's 'contribution to community activities' and 'community connectivity' – the more people contribute to community activities the strong the community connectivity is, and vice versa.

It is important to note that there are multiple and competing influences on people's 'contribution to community activities'.

The 'need to be part of the community' has already been described as an influence on the 'independent nature of community' (section 4.2). It also has a *same* influence on people's 'contribution to community activities' – the greater the need to be part of a community the greater that people prioritise contributing their time to community activities. The 'likelihood community attracts people wanting self-isolation' has also already been described (section 4.3), and the more this occurs the less the people make a 'contribute to community activities'.

Figure 14. Community connectivity – community contribution and independence loops



In addition, two new factors are described. Firstly, the amount of 'available spare time' that community members have has a same influence on their 'contribution to community activities' – if they have available time, they are more likely to contribute and vice versa. Available time is considered an important element of a community's wider wellbeing and so have been bolded and highlighted in red. This is in turn influenced by the 'likelihood of both parents working' (where families that have two parents or caregivers) and people's 'likelihood of commuting to work outside Lower Waikato'. Both of these

have *opposite* influences on 'available spare time' – the greater the likelihood of both parents working or people working further away from the Lower Waikato, the lesser the chance of them contributing to community activities.

Secondly, a factor called 'apathy of community' also has an *opposite* influence on people's 'contribution to community activities. The *more* the apathy in a community (the *less* it takes an active interest in itself), the *less* people will make a 'contribution to community activities'. The 'likelihood of commuting to work outside Lower Waikato' also has a *same* influence on the 'apathy of community' – the more people have to travel far to work outside the area, the more detached they may become from and the less they may care (or have time to care) about the local community.

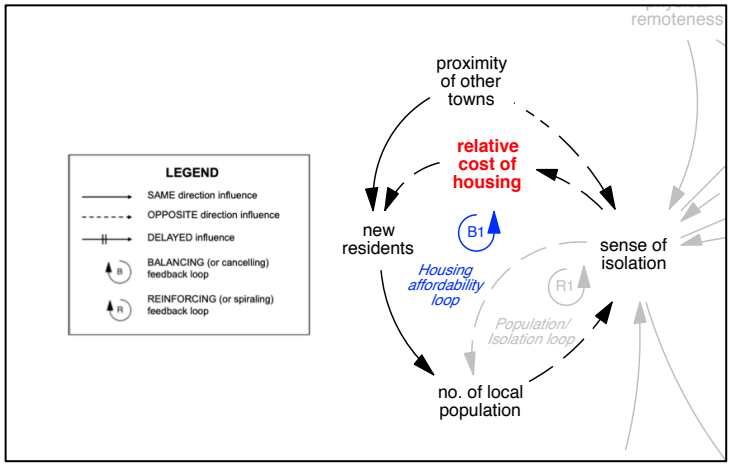
4.6 Residents and the relative cost of housing

The 'relative cost of housing' was described by participants as an attractive feature of the Lower Waikato and an important element of the community's wider wellbeing (hence it is shown as bolded and in red). This is represented in the diagram as a factor itself and sits in an important *balancing feedback loop* (**B1**) with factors representing the number of 'new residents', the total local population ('no. of local population') and the 'sense of isolation'. The *higher* the 'sense of isolation' the *lower* the 'relative cost of housing', in turn this means that this can attract *more* 'new residents' which *increases* the local population, in turn *reducing* the 'sense of isolation' in the Lower Waikato (because more people have moved there).

This suggests that over time the very feature that helps make the Lower Waikato attractive to those that live there will attract more people and likely reduce the sense of isolation that made it attractive in the first place.

The 'proximity to other towns' also influences several of these factors. For example, the *greater* the proximity to other towns then a) the *greater* the 'new residents' and the b) *lesser* the 'sense of isolation'.

Figure 15. Residents and the relative cost of housing



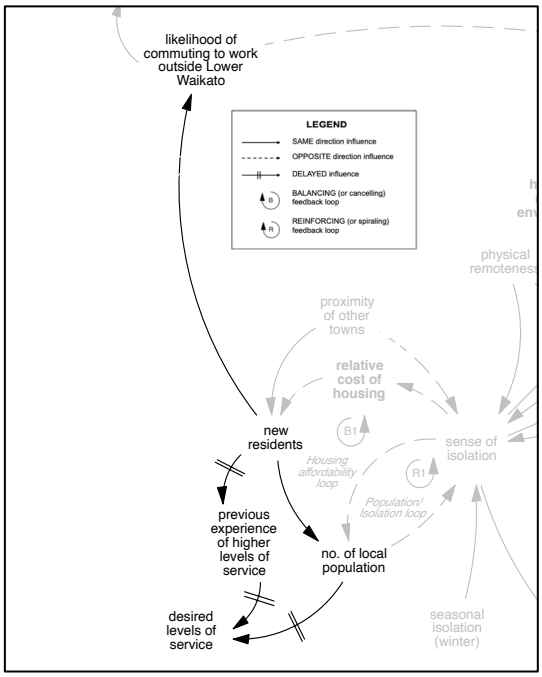
4.7 Council and Agency levels of service

The importance of the services and infrastructure provided through Councils and Government (that is, Crown Ministries, Departments and Agencies) was highlighted by community group members. While this was not the only set of factors that contributed to the wider wellbeing of the community, it was noted that it was an important one. In part this seem to be partly in response to a perception that Councils or Government had neglected the community in the past, or that they had least not provided as much attention as they should or could have. Several sub-parts of the causal diagram are described in this the following figures.

To begin, a factor capturing the 'desired levels of service' is described. Levels of service is a term intended to capture the provision of infrastructure or services to a community from a Council or Government. The term 'desired' indicated the level of this service that the community would *like* to receive – it does not indicate the actual level received as will be described in subsequent figures. This

'desired levels of service' is contributed to by the total number of residents, as well as the number of 'new residents', who influence an intermediary factor that describes these new resident's 'previous experience of higher levels of service'.

Figure 16. Desired levels of service

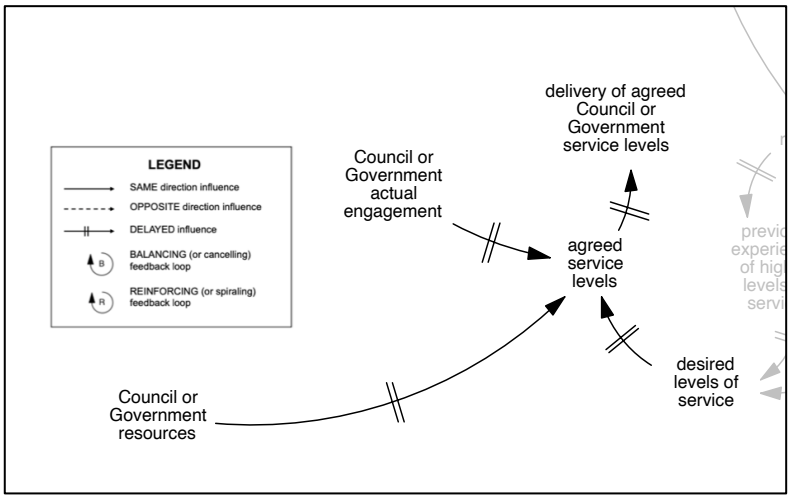


In other words, when people move to the Lower Waikato from more populated areas or areas with higher levels of service, those experiences can unconsciously inform the levels of service that they expect in the Lower Waikato. For example, the regularity of rubbish collection, or the extent of concrete footpaths and street lighting. These influences all have relative delays, as they take time to present and change expectations.

At the same time, the number of new residents (which has been increasing in recent years) has a *same* influence on the 'likelihood of community to work outside Lower Waikato'. That is, while increased numbers of people may move to Lower Waikato, they are still likely to have to commute outside the area to their places of work as those work places tend not to be located in the Lower Waikato.

A community's 'desired levels of service' is only one factor that contributes to the actual agreed and delivered levels of service. Others include the level of 'Council or Government resources' to provide such services, as well as the level of 'Council or Government actual engagement' – in other words, the extent that Councils or Government engage with their communities and the resources they have to support them.

Figure 17. Agreed and delivered levels of service



These three factors are shown as having *same* and *delayed* influences on 'agreed levels of service', this relative delay indicates that these things are a process and take time to determine. The 'agreed levels of service' then have a *same* and *delayed* influence on the 'delivery of agreed Council or Government service levels. These are shown as separate factors as simply agreeing service levels does not make them happen – there is a delay between when they are agreed and when they are delivered.

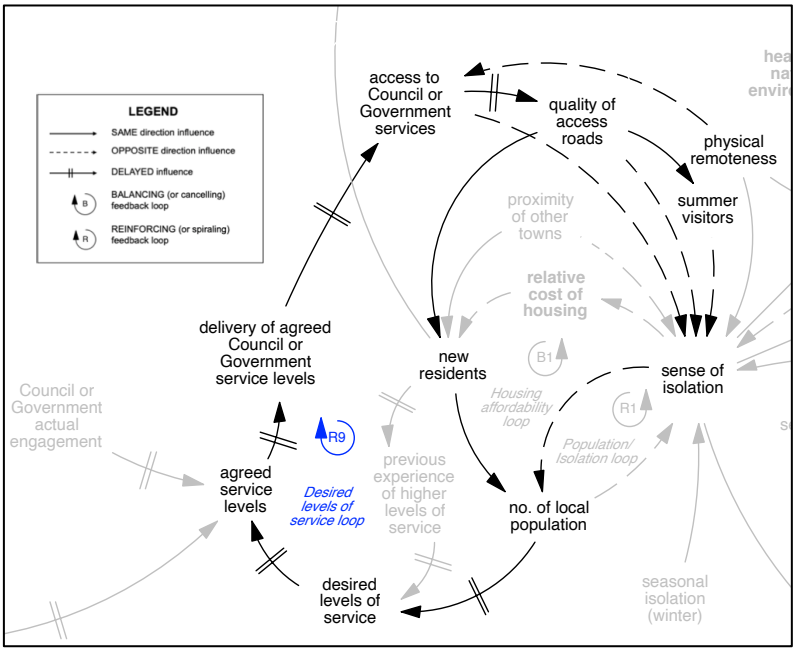
The delivery of these services means they are then accessible for the community which links back around via several pathways to form a *reinforcing feedback loop* (**R9**) with the 'desired levels of service'. This has labelled the *Desired levels of service loop*. Once people have greater 'access to Council or Government services' this has a *delayed same* influence on the 'quality of access roads' to the Lower

Waikato. In turn this will *reduce* the sense of isolation either directly, or by *increasing* the number of 'summer visitors' which in turn *decreases* the 'sense of isolation'.

Over time this will *increase* the population and in turn increase the 'desired levels of service'. A secondary pathway for this loop to operate is for the 'quality of access roads' to have a *same* influence on 'new residents', which in turn also increases the population.

The important thing to recognise with this loop is that is has multiple delays, so is slow moving, but spirals on itself – if service levels are met or increased this, in the longer run, increases population and desired service levels. This could also work in the opposite direction.

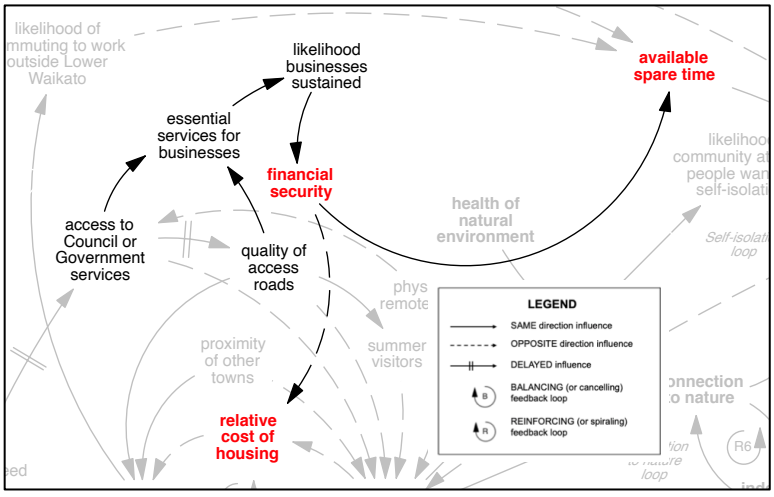
Figure 18. Desired levels of service loop



4.8 Businesses, farming and working with nature

Council and government services not only support local residents but also local businesses and farms. The factor 'essential services for businesses' is intended as a broad proxy for the many services that council and government provide (e.g. transport, energy, flood protection). The 'access to Council or Government services' influences this, as does the 'quality of access roads' already noted earlier.

Figure 19. Services support businesses

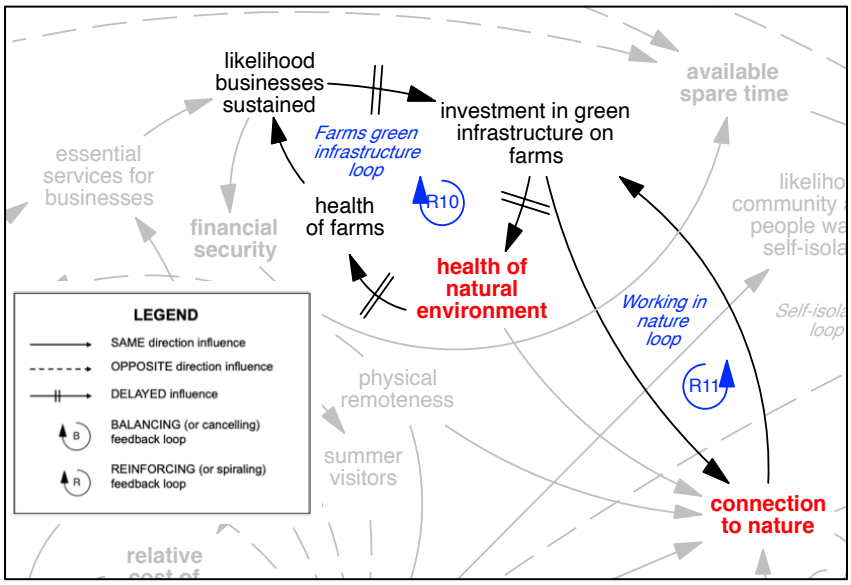


These essential services influence the 'likelihood businesses [are] sustained' which is an important influence on 'financial security'. This is shown in red as it is an important contributor to wellbeing. 'Financial security' then influences two other factors: firstly, it has an *opposite* relationship on the 'relative cost of housing' – the *greater* people's financial security the *lesser* the relative cost of housing; and secondly it has a *same* relationship on 'available spare time' – the *greater* people's financial security the less financial strain they are under and pressure to work more, and therefore the *greater* their likelihood of having time available for non-work activities.

It is noted that financial security also has a wider reaching impact on wellbeing across the communities of the lower Waikato. These have not been shown on the diagram as they did not always directly feature the discussion of the community culture (e.g. desire for isolation or community connectivity).

It was noted that farming was a particularly important business in the lower Waikato. While this is supported by the council and government services noted above, Figure 1 also highlights the important relationship between a healthy environment and healthy farms, as well as the benefits of working in nature.

Figure 20. **Green infrastructure on farms and working in nature loops**



This highlights that another important factor influencing the 'likelihood businesses [are] sustained' is the 'health of farms'. This represents health in an environmental sense – the health of the soil, water, flora and fauna which form the foundation for farming practice. These are all *same* relationships – the *better* the 'health of natural environment', the *better* the 'health of farms', the *greater* the 'likelihood [farming] businesses sustained'.

These influences then flow on circularly forming a reinforcing feedback loop: The *more likely* businesses are sustained, the *greater* the 'investment in green infrastructure on farms', the *greater* the 'health of natural environment'. 'Investment in green infrastructure on farms' is used here as a factor to note the investment in plantings such as riparian margins and that help support healthy flora and fauna on farms. This has been labelled the *Farms green infrastructure loop* (**R10**).

A reinforcing *Working in nature loop* (**R11**) has also been identified. Here, 'investment in green infrastructure on farms' has a *same* relationship with 'connection to nature' which in turn has a *same* relationship with 'investment in green infrastructure'. In other works, working in and with nature builds a greater connection with nature, which in turn builds a greater appreciation of the importance and a desire to work in and with nature.

It is noted that there are significant delays in these loops. This is because flora and fauna take time to grow and so their impacts take time to manifest. This is also the same for working in nature – it takes time for people to build an appreciation for nature over time and for their efforts to manifest in further commitments to doing more.

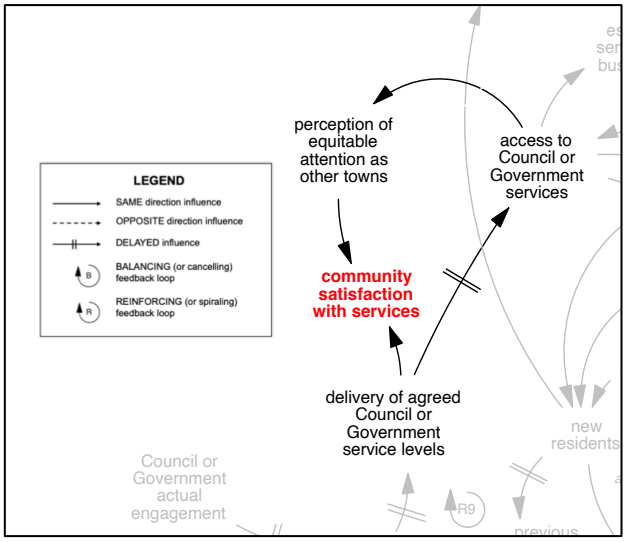
4.9 Community satisfaction and the dynamic between Community and Councils/Government

Because the infrastructure and services provided by Councils and Government are viewed as important by the community, their satisfaction with these and the dynamics of the relationship the community has with different Councils and Government is important. Consequently a significant portion of the causal diagram has been dedicated to understanding some of the causal relationships that underpin these dynamics.

Firstly, the 'delivery of agreed Council or Government service levels' has a *same* relationship with 'community satisfaction with services' – if the services are delivered the community is happy. This node is an important part of the community's wider wellbeing, so has been bolded and highlighted in red.

When a community has 'access to Council or Government services' this has a *same* influence on their perception whether they are treated as equitably as other towns (represented by the factor 'Perception of equitable attention as other towns'). This higher this factor, the higher the 'community satisfaction with services'.

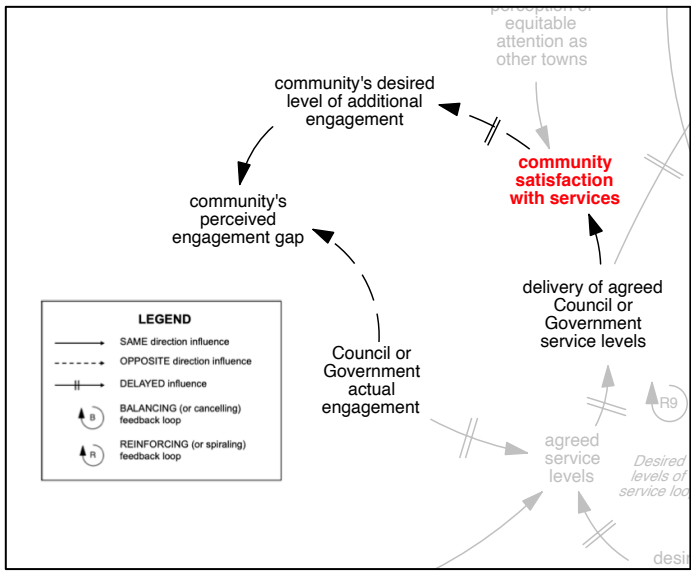
Figure 21. Community satisfaction



The higher the 'community satisfaction with services' the lower the 'community's desired level of additional engagement' from Councils or Government. That is: if they are satisfied with the services they generally won't seek additional engagement from providers, as they are getting what they need; if they are *not* getting their desired level of service, they will desire a higher level of engagement from Councils or Government to remedy this. This factor is the communities *desire* that forms half of the 'community's perceived engagement gap' and has a *same* influence – the *greater* the desire the *greater* the gap between that and the provided reality (for a description of how the *goal/gap* structure works, see section 3.4). The *reality* side of the goal/gap structure is provided by the factor that represents the 'Council or Government actual engagement', which has an opposite influence on the 'community's perceived engagement gap' – the *greater* the actual engagement, the *lesser* the gap between that and the desired level ('community's perceived engagement gap').

This perceived engagement gap will vary over time depending on how aligned those two factors are. The greater the gap, the great its influence on other factors described below.

Figure 22. Community engagement gap



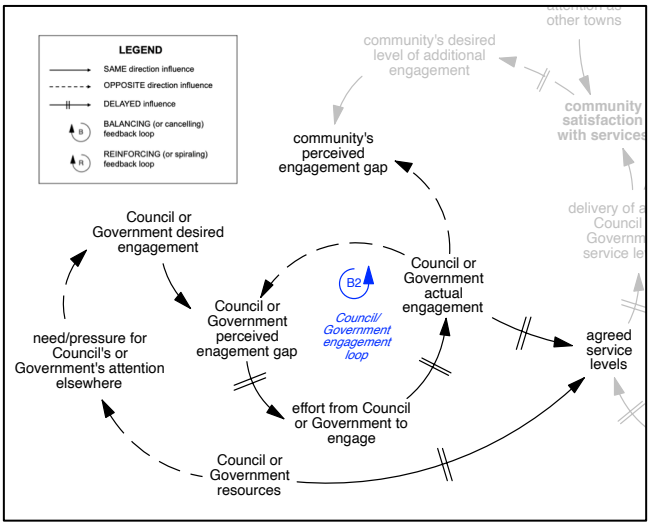
The influences on the Council/Government desired and actual levels of engagement are different to those on the community's. The influences on the Councils/Government are also driven by a goal/gap structure and are described in Figure 23.

Here, the size of the 'Council or Government perceived engagement gap' is determined by the 'Council or Government desired engagement' (a *same* influence – the greater the *desired engagement* the *greater* the gap); and the 'Council or Government actual engagement' (an *opposite* influence – the greater the *actual engagement* the *lesser* the gap).

The size of this gap determines the level of influence that is passed on to the 'effort from Council or Government to engage'. If there is a gap between where Council thinks it needs to be and where it is it will put in more effort; if there is not a gap (or a low one) it will not (or put in a low effort).

This level of effort in turn has a *delayed same* influence on the 'Council or Government actual engagement', completing this important *balancing feedback loop* (**B2**). This level of actual engagement goes on to have important influences on both the 'agreed service levels' and the 'community's perceived engagement gap', as already described.

Figure 23. Council or Government perceived engagement gap

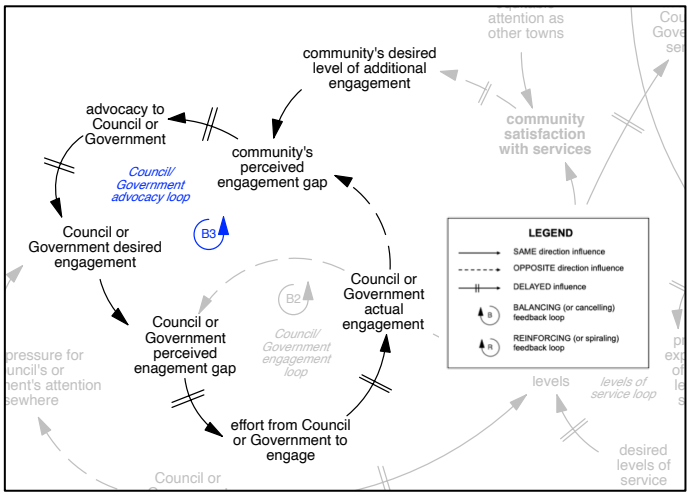


There are important other influences on the 'Council or Government desired engagement' also. These are the 'Need/pressure for Council's or 's attention elsewhere' – or in other words, this recognises that Councils and Government serve multiple communities and there will often be pressures for their attention and their resources elsewhere. This is an *opposite* influence – the greater the pressure elsewhere the less they will prioritise engagement with this community. In turn, this factor is also influenced by the actual level of 'Council or Government resources' – Councils and Government have limited resources and the *less* they have the *more* pressure there will be for the Council or Government's attention to be elsewhere.

Having described the different pressures on both a community's and Council's perceived need for engagement, Figure 24 now describes a balancing feedback loop that highlights the ability of a 'community's perceived engagement gap' to drive action.

Here, a 'community's perceived engagement gap' remains high, then over time (delay) this will have a *same* influence on their 'advocacy to Council or Government' which, over time, can may increase the 'Council or Government desired engagement'.

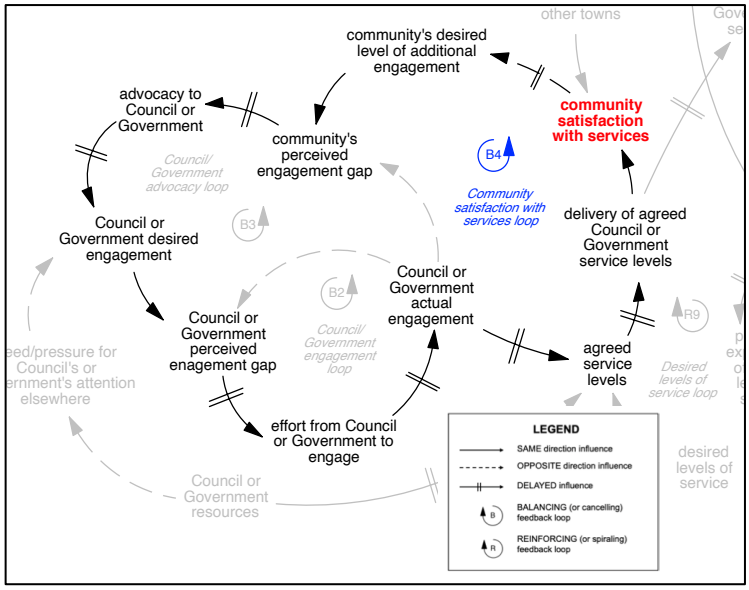
Figure 24. Advocacy loop



This will of course be dependent on the other pressures on Councils/Government, as already discussed. But this highlights an advocacy pathway which, if influential, will increase the level of Council or Government engagement with a community and bring the *actual* engagement in line with the *desired* engagement.

Part of the above balancing feedback loop also forms part of another larger balancing loop which has been labelled the *Community satisfaction with services loop*. This is described in Figure 1 below.

Figure 25. Community satisfaction with services loop

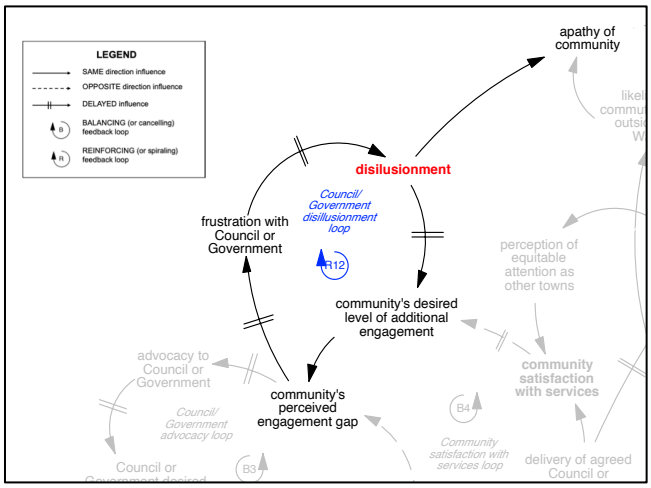


Here, a 'community's perceived engagement gap' drive advocacy and an increase in the council or government's desired level of engagement, and eventually (there are delays throughout) their actual level of engagement. Council or governments' increased engagement may, over time (delays throughout), lead to improved agreed service levels, delivery of services, and eventually an increase in 'community satisfaction with services'. This brings the delivery of services in line with a community's expectations, thus the loop into *balance*.

Having said that, given the other pressures on councils and governments as noted earlier, that loop achieving balance is not guaranteed, meaning that a 'community's perceived engagement gap' may remain high for a while. If this is the case disillusionment can occur, which is described in Figure 26.

Here a sustained 'community's perceived engagement gap' has a delayed *same* influence on 'frustration with Council or Government', which has a delayed *same* influence on 'disillusionment' – a factor to represent the level of disillusionment that a community has with Councils and Government.

Figure 26. Disillusionment loop

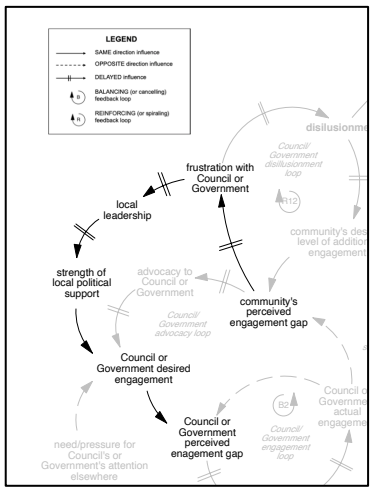


This factor then has a delayed *same* influence on a 'community's desired level of additional engagement' – that is, the more disillusioned they are the more they want a higher level of engagement. This then further increases the 'community's perceived engagement gap'. This is a reinforcing loop and has been labelled the *Council/Government disillusionment loop*.

Such frustration with Council or Government can prompt 'local leadership' to rise (see Figure 27). This is factor to describe the extent to which locals may become involved in politics. Over time this has a delayed *same* relationship with the 'strength of local political support' which in turn has a *same* influence on the level of 'Council or Government desired engagement'.

These causal factors are not a loop themselves but this chain of causality can influence into the feedback loops described earlier in this section.

Figure 27. Local leadership



5 Using the causal diagram to explore impacts and influence

5.1 How to use the diagram for insights

The causal diagram can be used in several ways to help understand impacts and influence on and between factors that have been identified as important.

The diagram can be used as a high level of way of exploring how impacts or changes might be characterised. For example, might changes that community members are most concerned about be characterised as changes in their ability to contribute to their community? Of for the physical infrastructure to provide its required level of service? It is of course possible that some impacts might also influence multiple factors, so the diagram can be used to reflect on the definition of both what the impacts are and what they may impact on.

Similarly, the diagram can be used to identify important feedback loops that may be impacted, not just individual factors. For example, discussion and use of the causal diagram may highlight that the self-sufficiency loops are being most influenced by a particular impact, or perhaps the loop relating to the desired levels of and provision of levels of service. These insights can be used to help understand and direct effort into the feedback loops that may be most affect, or considered most useful to strengthen.

Exploring how influences flow downstream from a factor, or those influences that are upstream of a factor and flowing to it, is also a useful way of using the diagram. This can help with discussion and insights into what impact any action being discussed might enable. Or similarly, what actions might be required in other factors 'upstream' of the factor where change is desired.

Insights with the causal diagram remain qualitative. Yet these can be coupled with discussion and knowledge within the community to generate useful insights and understandings.

Most importantly, it is noted that the diagram and the factors in it have been described at a medium level of aggregation. They are also unlikely to account for all factors relating to wellbeing in the Lower Waikato communities. Yet the fact that these were identified in the workshops with community members indicates their likely relative importance.

5.2 Generalisable insights

A range of generalisable insights can be drawn from the diagram. These were both observed by either/both the group of the facilitator:

- The situation is complex! Yet the chaos that appears in the diagram is a reasonable representation of the various influences and tensions that exist within the communities of the lower Waikato/Te Puuaha.
- It is noted that the diagram is partial. It represents the views of those that participated in the workshop and by its nature seeks to summarise a lot of complexity so that how things interconnect can be represented.
- A key element of the identity of the lower Waikato/Te Puuaha is its relative isolation. This is strongly linked with the independent nature of the community and the sense of self-sufficiency that it has traditionally experienced. Most of these loops are *reinforcing loops*, meaning that these factors spiral together and trend in a similar direction, whatever that is (e.g. either up or down).
- A range of influences, many of which have been sought by the communities of the lower Waikato – such as improved services, have been slowly decreasing its relative isolation. This has and will continue to have an impact on the nature of the community, likely reducing its independent nature and self-sufficiency (in the much longer term). In effect, the very things that

have traditionally made the lower Waikato attractive (especially low relative house prices), are likely to cause attract more people to the area over the longer term. This is likely to evolve the nature of the communities.

- A connection to nature is important for all communities in the lower Waikato/Te Puuaha. This includes those involved with farming.
- Around one third of the diagram is devoted to the relationships between the communities of the lower Waikato/Te Puuaha and Councils or Government. Most of these loop are *balancing loops*, meaning that these factors influence each other until they tend to come back into balance with each other.
- Both the communities of the lower Waikato/Te Puuaha and the Councils or Government have their own expectations around what services they expect to provide/receive. It is important to note that these are driven by different experiences and are not simply two sides of a single interaction. That is, Council or Governments expectations can be met while the communities may not.
- The communities have a sole relationship with the Councils or Government which influences their expectations. Yet the Councils of Government have many other relationships with other communities that will influence their expectations with the lower Waikato/Te Puuaha communities.
- A sustained gap between communities perceived level of engagement and service from Councils or Government (has and) will likely, over time, lead to disillusionment with Councils or Government; advocacy by the communities to Councils or Government; or a growth in local leadership and potentially political involvement/support for improved engagement from Councils or Government.

5.3 Some illustrative examples

To demonstrate how the causal diagram may be used, a couple of illustrative examples are discussed below. Firstly, ongoing erosion of the sand banks at Port Waikato; Secondly, the failure of the stopbanks on the true right hand side of the river.

5.3.1 Example 1: Erosion of the Port

Port Waikato has been experiencing ongoing issues with erosion of the sand dunes. When looking at this as an example, we first identify any areas where that erosion would have an impact on any of the factors in the causal diagram. For this example, it is likely the two major areas directly and immediately impacted would be:

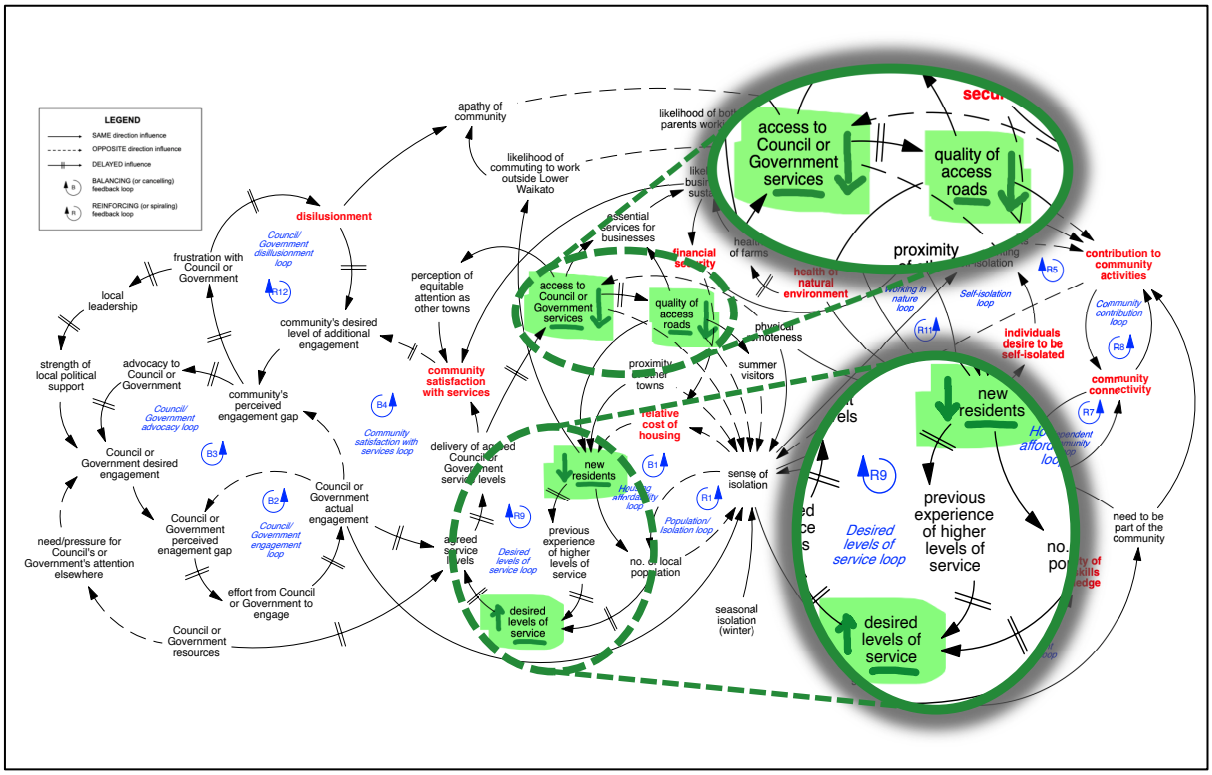
- a *decrease* in the ‘access to Council or Government services’, and
- a *decrease* in the ‘quality of access roads’ (as one immediate manifestation of the above),
- if the erosion is symptomatic of climate impacts elsewhere, then also potentially an *increase* in pressure for Council and Government’s attention elsewhere.

Depending on the severity or ongoing nature of the erosion, in the slightly longer term direct impacts may also include:

- A *possible halt* to new residents moving there due to perceived risk, flatlining population growth,
- A *possible decline* in existing residents, due to people moving away, and
- Upward pressure on the desired levels of service.

These areas are highlighted on the causal diagram with arrows indicating the direction of change (Figure 28).

Figure 28. Potential direct impacts of erosion at Port Waikato

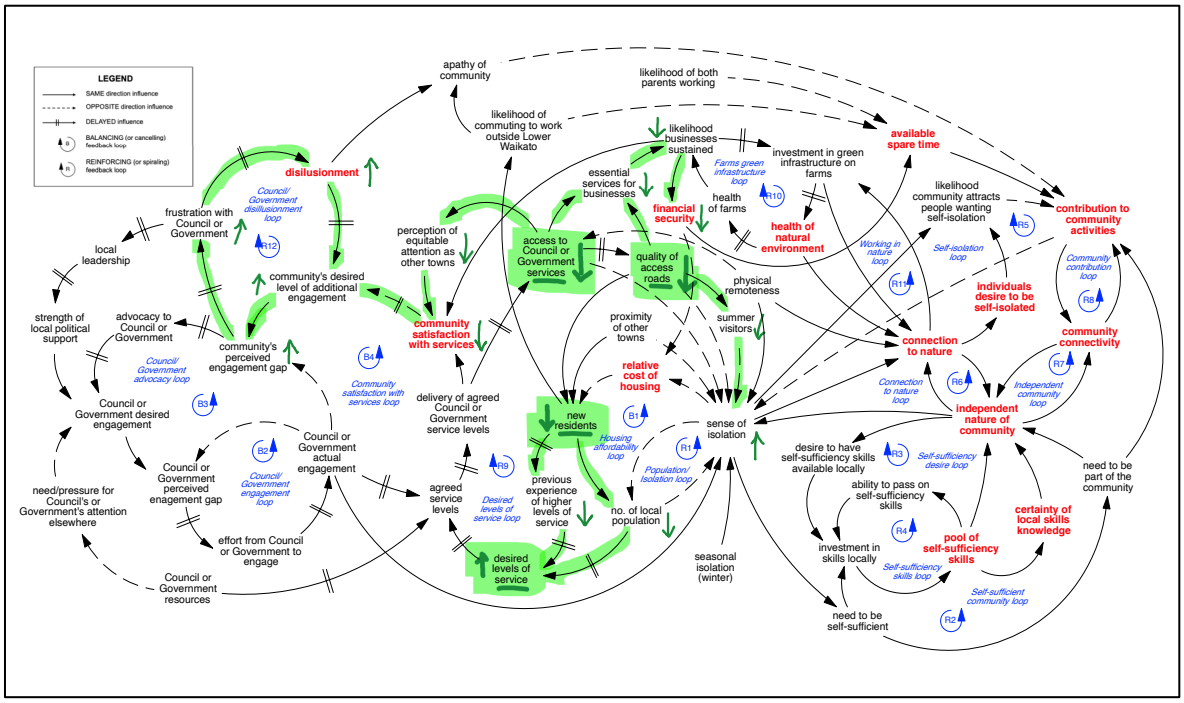


Flow on effects are highlighted in Figure 29. Arrows indicate the flow on effects from these impacts the direction of change that might be expected in the factors that are impacted. These suggests that:

- The sense of isolation of Port Waikato will be *increased*,
- Essential services for businesses and farms in the area will be *reduced*, flowing on to *reduce* financial security and, in the longer term, *reduce* the contribution that makes to housing affordability and people's spare time,
- Longer term, increased financial pressure this will *reduce* people's ability to contribute to their community, potentially reducing community connectivity, at a time when the community will need to be draw on such connectivity,
- *Reduced* access to services will *increase* the community's perception that they are not treated as equitably as other communities, thus *increasing* their dissatisfaction with Council and Government services,
- This dissatisfaction will *increase* a community's desired engagement with Councils or Government, who *may not be able to increase* their actual engagement commitments due to them being faced with an *increase* in the need/pressures for their limited resources elsewhere,
- This will likely lead to a continued *increase* in disillusionment within the community.

It is important to note that while mental health has not been articulated as a specific factor in the causal diagram, it was discussed as an important feature of some of the factors described in the causal diagram. For example, mental health impacts may manifest from *decreased* satisfaction with essential services, *increased* disillusionment, the frustration from *decreased* essential services and *decreased* financial security. These will *reduce* people's ability to contribute to community services and *reduce* community connectivity, right at a time when there will be an increased need to draw on the wealth of community connectivity and the pool of self-sufficiency skills that exist within the community.

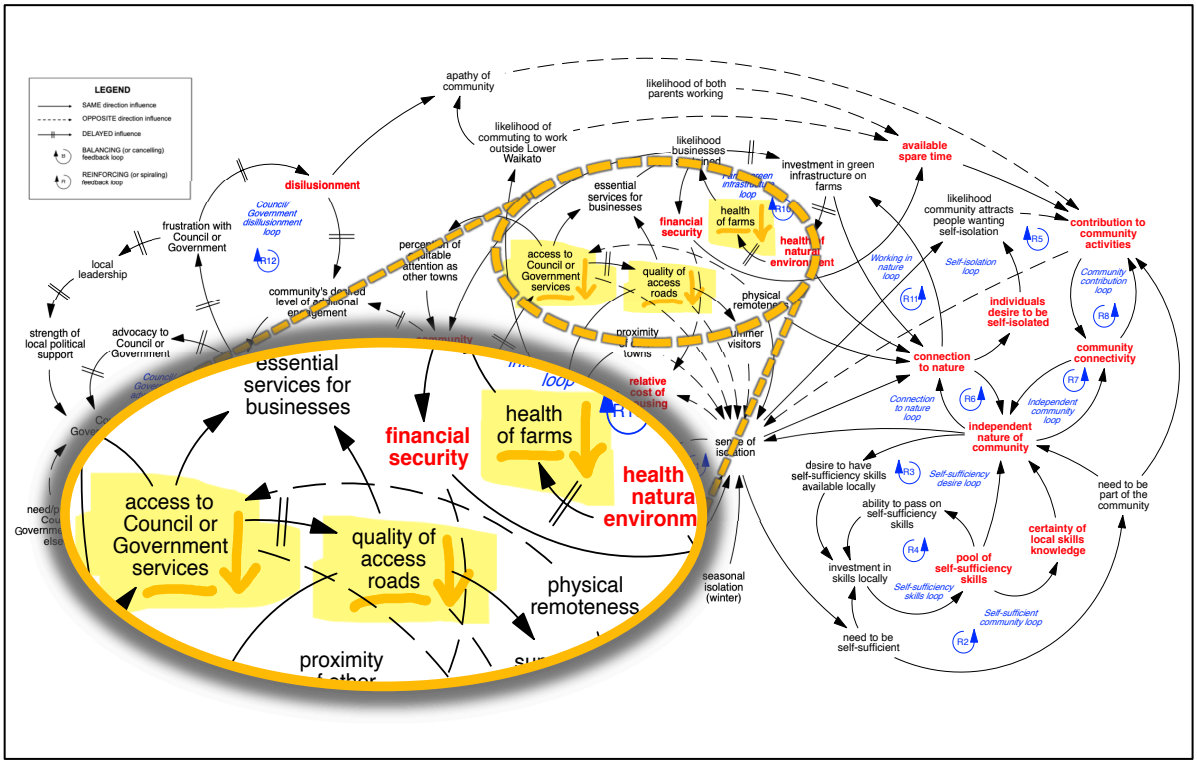
Figure 29. **Flow on effects from direct impacts of erosion at Port Waikato**



5.3.2 Flooding of the stopbanks

Another possible example is the longer-term failure of the stopbanks on the true right due to increased sea level rise. Note – this is not a deliberate retirement of the stopbanks, rather an acknowledgement that with sea level rise in the longer term, stopbanks may regularly be 'overtopped' (the river overflows into the protected areas) despite best efforts.

Figure 30. **Potential direct impacts from flooding of stopbanks on true right of river**

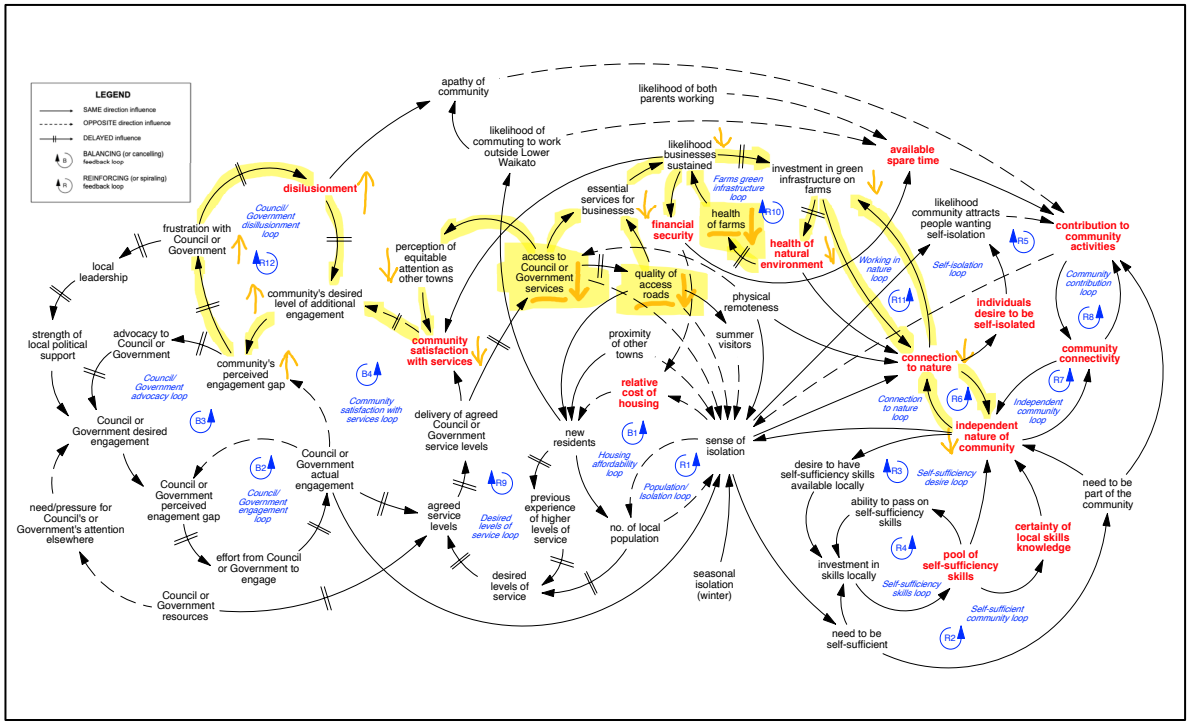


As with the previous example, firstly we identify the areas that this would directly impact on the causal diagram (Figure 30). Here this would be:

- a *decrease* in the 'access to Council or Government services', and
- a *decrease* in the 'quality of access roads' (as one immediate manifestation of the above),
- a *decrease* in the 'health of [the] natural environment' and 'health of farms' due to land being flooded.
- if the stopbank flooding is symptomatic of climate impacts elsewhere, then also potentially an *increase* in pressure for Council and Government's attention elsewhere.

The flow on impacts of these are shown with arrows in Figure 31.

Figure 31. Flow on effects from flooding of stopbanks on true right of river



These would have an impact on the factors that capture farm activity, as well as some similar flow on impacts as already noted in the Port Waikato example. These include:

- The sense of isolation of farming areas will be *increased*,
- Essential services for businesses and farms in the area will be *reduced*, flowing on to *reduce* financial security and, in the longer term, *reduce* the contribution that makes to housing affordability and people's spare time,
- A *reduced ability* to invest in green infrastructure, and possibly raising questions around whether this should be done at all if land is continually flooded.
- *Reduced* connection with nature due to reduced land to work in an environmentally sympathetic way, further *reducing* the connection with nature which may have impacts on the independent nature of the community,
- *Reduced* access to services will *increase* the community's perception that they are not treated as equitably as other communities, thus *increasing* their dissatisfaction with Council and Government services,
- This dissatisfaction will *increase* a community's desired engagement with Councils or Government, who *may not be able to increase* their actual engagement commitments due to them being faced with an *increase* in the need/pressures for their limited resources elsewhere,
- This will likely lead to a continued *increase* in disillusionment within the community.

Again, the impacts of the above on the mental health of the local communities should be considered. Dramatic and immediate *reductions* in the health of the environment, farm health and financial security may have significant impacts on mental health. So too will ongoing *reduced* satisfaction with council or government services. The need to draw on the wealth of community connectivity will come at a time when that very connectivity may not be able to be supported.

5.3.3 What insights can we take from these examples?

The examples above highlight how these causal diagrams can be used to trace flow on impacts from climate change through the various influences identified by the community.

For example, they highlight that access to council services and the quality of access roads support the connectivity of people in and with the lower Waikato/Te Puuaha. They also highlight the importance of the health of the environment for farms.

It is important to note however, that influence can be traced *backwards*, or *'upstream'*, through the diagram as well. In other words, rather than only focusing on where climate change may impact influences on a community and following influences *'downstream'* from there, the causal diagram can be used to also highlight the things that *support* the elements of the community that help make it thrive.

For example, the independent nature and self-sufficiency of the community was identified as an important feature of the communities in the lower Waikato. This will also be an important trait to be able to draw on when climate changes begin to impact the lower Waikato more directly. These community characteristics are in part driven by a strong connection to nature and the physical remoteness of the area. This raises the question, how can these characteristics of the communities be encouraged or nurtured, knowing that climate change coming, not only as a result of the physical remoteness of the area? This may generate a discussion around how the communities may organise proactively themselves with the nurturing of those characteristics in mind.

The quality of access roads and access to other Council or Government services is also noted as an important influence on may things for all communities in the lower Waikato, on both banks of the river. Yet working back *'upstream'* to these influences, from other places in the causal diagram, these influences can also be proactively reframed to help inform the conversation moving forward. At the heart of the services and roads provided by councils/government is *connectivity* of the communities to outside the lower Waikato/Te Puuaha. When discussing about how to respond, or plan ahead for a world that is climate changed, perhaps these influences could be reframed as *connectivity*. How can this be provided in ways other than roads ot the existing services currently provided, which are likely to come under increased threat of damage under climate change?

These two ways of looking at the diagram may be characterised as:

- Exploring the flow on effects of impacts of climate change; and/or
- Understanding the influences that support the characteristics that enable the communities to thrive, and exploring how to better support that in a likely climate changed future.

It is hoped that this diagram is one useful tool for helping the communities of the lower Waikato/Te Puuaha work towards continued thriving in a climate changed future.

6 References

Senge, P.M. (2006). *The fifth discipline – the art and practice of the learning organisation (2nd ed)*. London, United Kingdom: Random House.

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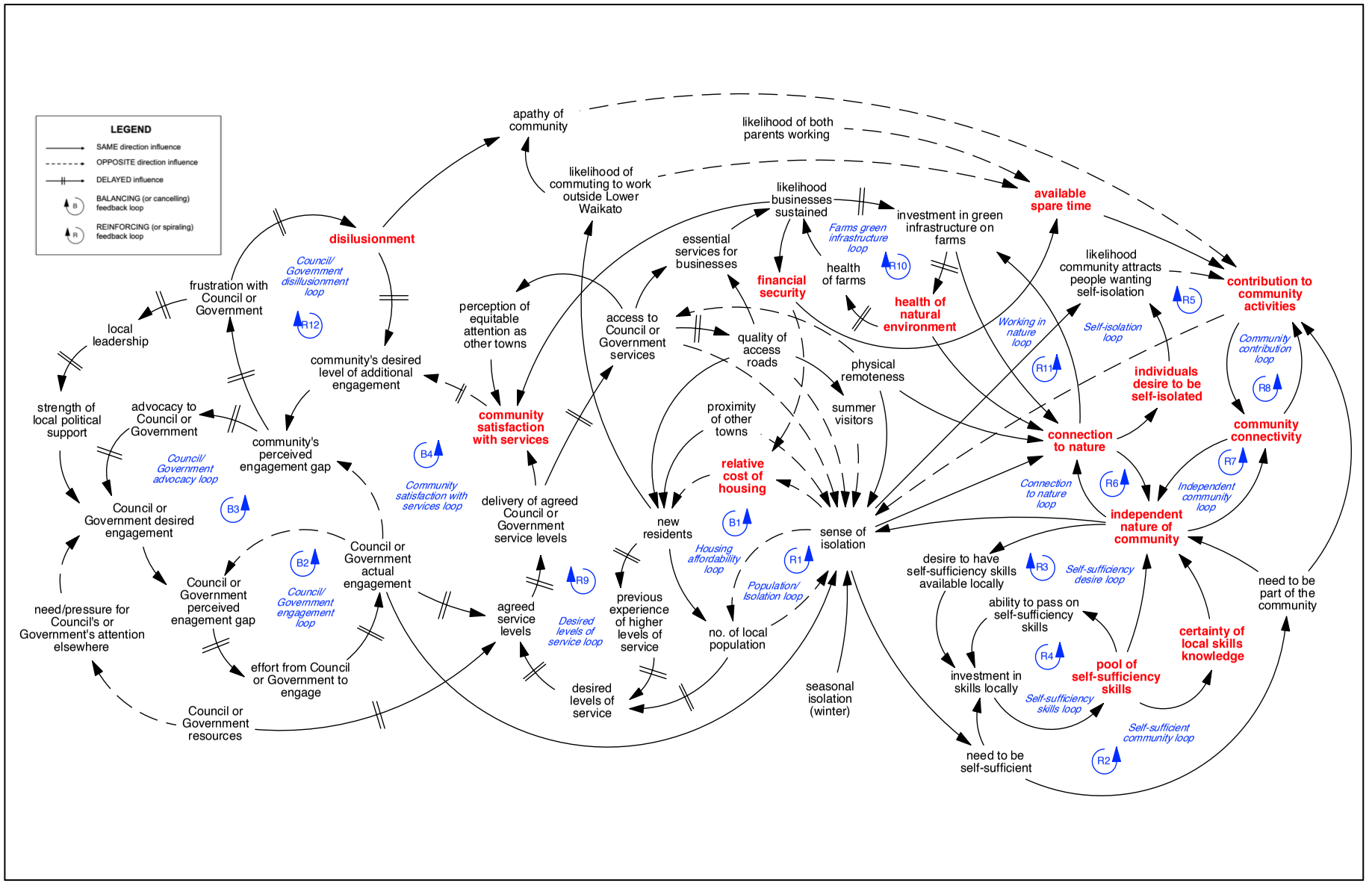
Appendix 1 Large version of causal diagram


LEGEND
SAME direction influence
OPPOSITE direction influence
DELAYED influence
BALANCING (or cancelling) feedback loop
REINFORCING (or spiraling) feedback loop
apathy of community
likelihood of both parents working
likelihood of commuting to work outside Lower Waikato
likelihood businesses sustained
investment in green infrastructure on farms
available spare time
disillusionment
Council/ Government disillusionment loop
R12
frustration with Council or Government
local leadership
essential services for businesses
financial security
health of farms
Farms green infrastructure loop
R10
health of natural environment
likelihood community attracts people wanting self-isolation
contribution to community activities
Working in nature loop
Self-isolation loop
R5
R11
perception of equitable attention as other towns
access to Council or Government services
quality of access roads
physical remoteness
individuals desire to be self-isolated
Community contribution loop
R8
community's desired level of additional engagement
community satisfaction with services
proximity of other towns
summer visitors
connection to nature
community connectivity
strength of local political support
advocacy to Council or Government
community's perceived engagement gap
B4
Community satisfaction with services loop
relative cost of housing
Connection to nature loop
R6
R7
Independent community loop
Council/ Government advocacy loop
B3
delivery of agreed Council or Government service levels
new residents
B1
sense of isolation
independent nature of community
Council or Government desired engagement
Housing affordability loop
R1
Population/ Isolation loop
desire to have self-sufficiency skills available locally
R3
Self-sufficiency desire loop
need to be part of the community
B2
Council/ Government engagement loop
Council or Government actual engagement
Council or Government perceived enagement gap
agreed service levels
R9
Desired levels of service loop
previous experience of higher levels of service
no. of local population
ability to pass on self-sufficiency skills
need/pressure for Council's or Government's attention elsewhere
effort from Council or Government to engage
desired levels of service
seasonal isolation (winter)
investment in skills locally
R4
pool of self-sufficiency skills
certainty of local skills knowledge
Self-sufficiency skills loop
Self-sufficient community loop
Council or Government resources
need to be self-sufficient
R2