Te Taitokerau Climate Adaptation Strategy

Appendix Two
Technical report
Climate risk overview

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Climate risk overview

Climate risks

Climate change effects

Driven by increased concentrations of greenhouse gases in the atmosphere and oceans, climate change **effects** first manifest in the physical environment as hazards and stressors, such as increased mean temperatures, longer periods without rain, higher intensity rainfall events and sea level rise. Effects of climate change already detected in New Zealand include increases in mean temperature, marine heatwaves, sea level rise and more extreme weather events. These have consequences for people, property, taonga, the natural environment and eventually our entire society.

Scientific evidence for climate change and its impacts continues to accumulate and increase in certainty. The release of the Intergovernmental Panel on Climate Change Sixth Assessment Report IPCC AR6 report documents widespread scientific consensus that climate change impacts will continue to increase into the foreseeable future, with the level of change depending on the rate at which greenhouse gases continue to be released into the atmosphere globally. A certain amount of further warming of the planet is almost certain to occur regardless of global emissions reductions efforts, and is likely to bring widespread disruption to Northland's climate and weather.

Climate change impacts and implications

Climate change effects on physical systems result in consequences for the environment and people. Te Taitokerau is likely to experience physical **impacts** from climate change such as increases in coastal inundation and erosion, more regular river flooding and sedimentation, extended periodic dry periods, increased fire danger weather, and alterations to seasonal weather conditions such as frosts and spring rainfall decline. These will increasingly create **implications** for our region, by disrupting our water, land and ecosystems, our people, culture and economy, and will fundamentally influence the way local government provides services to the community.

We have heard from **Māori** that climate change impacts have the potential to create an existential threat to their cultural taonga and values.[1] We have heard from **hapū** that their ability to successfully adapt is intimately connected with how local government decision making over current and future environmental management takes place and whether Maori are partners in that decision making.[2] Some hapū have expressed that climate change could exacerbate inequities already faced by Maori.[3]

Sea level rise, storm events and flood risk combined with historic patterns of occupation and existing patterns of land ownership mean in some places, traditional uses of the land will come under increased pressure. In other places, whakapapa and whanaungatanga, close social ties and cultural networks will help Māori communities develop adaptation responses and improve resilience.

Our **ecosystems** are vulnerable and currently degraded. Being at the northern tip of an island nation means many of our indigenous taonga species and habitats will naturally move southwards to cooler regions, leaving voids that are likely to be filled by invasive exotic species. Our marine habitats are ranked as being among the best in the world, and the impact of warmer waters may threaten taonga like the Poor Knights reef ecosystems. Coastal ecosystems and habitats for endemic species are likely to experience increased disturbances from heatwaves and flood events as well.

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[1] Ngā Hapū o Te Wahapū o Te Hokianga nui a Kupe (Ngāti Wharara & Te Pouka) (2008); Te Aupōuri (DRAFT) (2018); Te Roroa (last reviewed 2011)

[2] Climate Change Adaptation Workshop – Maori and Climate Risk, February 2020.

[3] Patuharakeke Hapu Environmental Management Plan, 2014. Page 37.

Northland **communities** are particularly exposed to climate change. Many of our settlements, town centres and roads sit on coastal floodplains, exposed to sea level rise and increased flooding. Some communities, already isolated, will face further pressure from frequent river and coastal flooding. Droughts, already a significant issue for Northland, are projected to become more frequent and severe. Negative human health impacts due to climate change will also affect our communities. Council infrastructure that supports community well-being and connectivity, such as roading assets and three waters infrastructure which provides drinking water and manages stormwater and wastewater may be at risk.

Our **economy** relies on primary-industry exports that are susceptible to drought, floods, pests and diseases. Water supply systems are vulnerable to prolonged droughts, which are predicted to become more common and more extreme with climate change.

Table 1. Climate change projections for Northland[4]

CLIMATE CHANGE PROJECTIONS AND EFFECTS *(based on* ***high emissions scenario RCP8.5)***	
Temperature increase	***Average temperature will rise*** • 0.7 to 1.1°C by 2040 • Up to 3.1°C hotter by 2090 ***More very hot days (greater than 25°C)*** • 30 more 25°C+ days per year by 2090 (+120%) • Worst case 74 more hot days by 2090 (+260%)
Changing seasons	***Seasonal change in temperature*** • Greatest temperature increase in northern part of Te Taitokerau in summer and autumn • Worst case scenario warming is uniform across region although winters in southwest experience more warming ***Fewer frosts per year*** • reduction in number of days with frost to 1 day in 10 years
Rainfall decline	***Seasonal Change in Rainfall patterns.*** • No clear signal for change in total rainfall • Up to 20% less rainfall for eastern parts in spring • 10% increase in summer and autumn ***Longer dry periods*** • More intense and frequent drought (increase in frequency by up to 10% by 2090) • Increase in drought risk greatest on east and west coasts and southern inland areas
Extreme rainfall and storms	***Extreme rainfall*** • No clear signal for change in total rainfall • more frequent and more extreme rainfall events ***Cyclones*** • Increase in severity (and possibly frequency) of ex-tropical cyclones reaching Northland - likely to bring heavier downpours coinciding with storm surge and damaging winds ***Wind*** • Regular wind speeds are likely to increase by up to 10% by 2100
Changes to sea level and coastal hazards	***Permanent Sea level rise:*** • 0.6m by 2080 and up to 1.5m by 2130 • Expansion of areas inundated by high tides ***Saltwater intrusion*** • saline intrusion into coastal aquifers • expansion of salt-water wedge further upstream in rivers and tidal floodplains ***More frequent storm surge*** • more frequent and intense coastal flooding • Increase in coastal erosion events
Marine effects	***Ocean chemistry*** • Increasing acidification of the ocean ***Ocean heating*** • Gradual increase in sea temperature. • More intense and frequent marine heatwaves

[4] NIWA (2017) https://www.nrc.govt.nz/media/i3qnkklo/northland-region-climate-change-projections-and-implications-summary-report_niwa.pdf; also see NIWA (2016) https://www.nrc.govt.nz/media/lr3e1fxc/northlandregionclimatechangeprojectionsandimplicationself16102niwa.pdf

Different perspectives on climate risk

Climate change impacts and implications are complex and can be challenging to communicate. Depending on one's perspective or objectives, different approaches for engaging with climate risks bring different types of meaning or insight. Three approaches are presented below, each appropriate for different purposes.

The overview presented above adopts a **value domain** approach, as was used in the National Climate Change Risk Assessment (REF MfE 2020). This approach groups societal values into five domains (natural environment, built environment, human, economy and governance domains). Value domains can be a practical way to create high-level summaries of climate change impacts from multiple hazards, but tend to compartmentalise and separate social values, and has shortcomings from a risk management perspective (due to the grouping of disparate hazards and stressors) and does not reflect Māori values.

Māori perspectives see the world in a very different light to Pākehā, and climate impacts on Māori are felt on a Wairua (spiritual) level. Te Ao Māori, a Māori worldview, is often underpinned by the interconnectedness to the natural world through whakapapa to Ranginui and Papatuanuku and multi-generational perspectives based on responsibility to their tūpūna and generations yet to be born. Māori perspectives are also defined by relationships, and in terms of working with councils on addressing the consequences of climate change, are underpinned by legacy issues relating to colonisation, loss of land and the at times fractured relationships with the crown and councils (some hapū in Northland do not recognise the authority of the crown or councils).

The 'Impacts on Māori' section in Part 2 of the strategy explores these issues further.

Using **systems diagrams** is a way to conceptualise climate risks that can help show the connectivity between different climate impacts and 'value domains'. Local government is tasked with managing a large range of activities that will potentially require adaptation to climate impacts, requiring an understanding of how climate risks will propagate across value domains and hazards. Systems diagrams can illustrate cascading and accumulating interactions of risks, showing some of the complexity driven by feedback loops that needs to be considered when making risk management decisions. Systems diagrams were used to collate the rich textual data collected in a series of workshops with council staff and hapū representatives (p8) in February 2021.

As our understanding of the complexities of climate change develop, our conceptual models of climate impacts will need to evolve and improve. We need to remember that climate risks accumulate over time, achieving critical thresholds beyond which current approaches to risk management will no longer work. Climate risks can also be non-linear in their onset or consequences, or have surprising interactions with other risks, increasing uncertainty and making time-bound projections of impacts extremely challenging.

In addition, adaptation responses themselves can carry risks, and developing plans and policy requires nuanced foresight to anticipate unintended consequences. Uncertainty in the form of knowledge gaps also limits our ability to accurately describe and respond to climate risks.

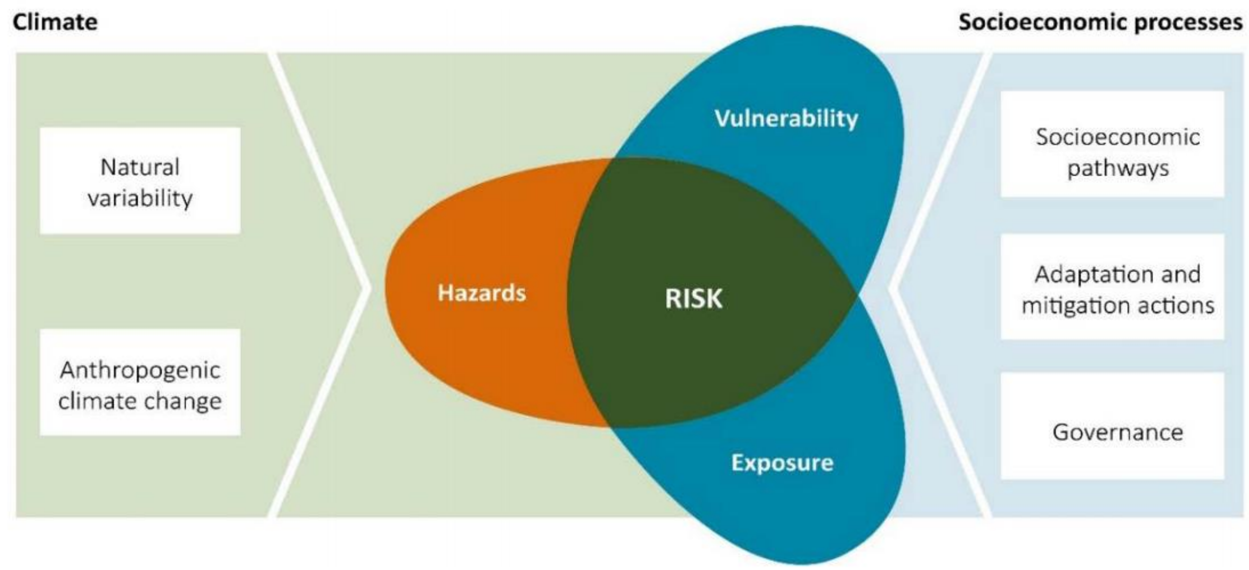
Managing climate risks

Risk management

Effective adaptation means good risk management, requiring planning which draws on the knowledges from our past that we have available to us, responds to the changing portfolio of risks facing our region and works with the needs of both current and future generations. Different approaches to managing climate change risks need to consider the three factors contributing to risk: a) hazard, b) exposure and c) vulnerability (see Fig 1). These might include a) consequences of a hazard or stressor, and if the risk is due to a slow-onset stressor (e.g. tidal inundation), or an episodic hazard event (e.g. flood); b) how likely and widespread the exposure is; and c) the vulnerability of the community or ecosystem being impacted.

A key challenge of managing climate change risks is that risks are constantly changing, creating uncertainties in our ability to project accurate timeframes, for instance the rate of sea level rise, the frequency and severity of drought, or the spread of novel environmental pests. This requires councils to develop programmes that are responsive to changing risks and flexible in the type and timing of risk management responses and do not commit to a particular irreversible course of action.

Figure 1. Climate change risks as the confluence of three drivers (based on IPCC 2014)



Risk management explained

Risk avoidance approaches are used where exposure to potential climate risks can be circumvented. This could be where exposure to risks has not yet occurred, such as rules restricting new development and infrastructure in high-risk hazard zones, or preventing the establishment of new invasive pest species.

Where exposure already exists, **risk elimination** may be possible, for example through the planned relocation of services and infrastructure, managed retreat of urban areas from coastal hazard areas, or the translocation of temperature-sensitive species to cooler climates.

However, in some instances climate risks will be unavoidable. **Risk reduction** actions can help minimise the probability or consequences of exposure to hazards or stressors. This might include interventions such as providing flood or erosion protection for properties in coastal or river hazard zones, changing to less vulnerable land uses, or by improving the reliability of local water supplies during drought.

While some interventions may not eliminate risk altogether, they may enable the current system to operate until the risks become too large to manage. **Improving** the **resilience**, or ability of communities or ecosystems to continue functioning and prepare to adapt, is another risk management approach where exposure to risk is inevitable. This might involve improving the ability of a native ecosystem to cope with drought by managing pollution or pests, or by helping develop community response plans to enable towns to recover quickly following floods.

Finally, situations exist where it is necessary to **accept risks** and adapt to change. Such approaches might include adopting different building practices (e.g. flood shutters to deal with regular flood events), acknowledging a lower ‘level of service’ will be provided by infrastructure, or by managing populations of established invasive species.

Climate impact diagrams

Climate risks are likely to interact in complex ways, creating compound effects that cascade between and across our environment, society and economy over time. A systems approach is useful to appreciate and communicate the complexity of interacting and cascading elements when trying to understand climate impacts.

Describing the web of potential risks can be difficult due to difficulties in communicating complicated related climate impacts that traverse different ways of understanding risk and value, including cultural, social, financial, economic, biological and engineering perspectives. In addition, as the number of logical steps increases, so does the degree of uncertainty involved in the assessment. of risk.

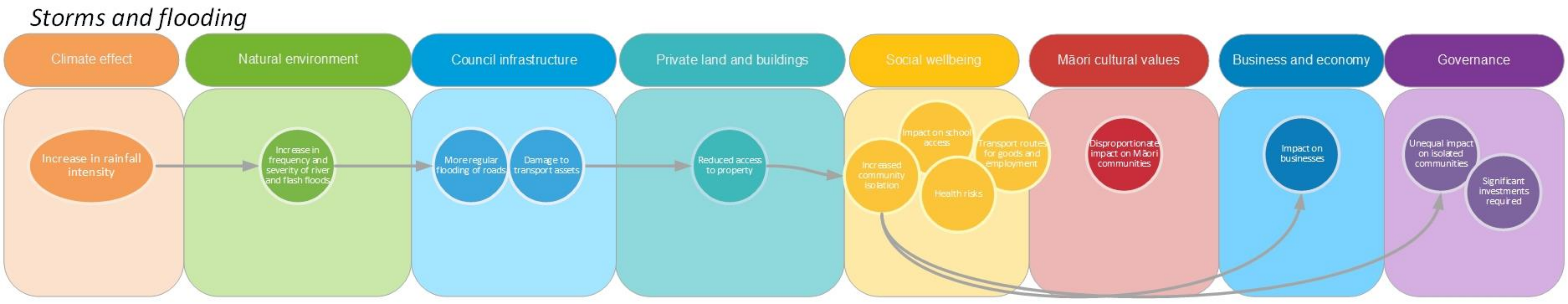
Climate impact diagrams are a type of 'systems map' that attempt to show the complex inter-relationships between the effects of climate change hazards and stressors on the things we value (value elements). Interconnecting arrows show the flow of causality between value elements, and how impacts cascade across different groups of elements. In this case we have used value domains to group 'value elements', but other groupings could be used, such as those developed with hapū or local communities.

Methodology

Perceived climate impacts on local government activities were discussed during a series of six participatory workshops held with local government staff and Tangata whenua representatives during February 2020. Workshop attendees discussed and brainstormed climate risks to local government responsibilities and Māori cultural values based on their areas of expertise. Attendees acknowledged the difficulty in separating out different hazards and elements of concern and were encouraged to use creative means to document their thoughts. A variety of methods were used in the workshops including lists, pictures and systems diagrams.

Information from the workshops was collated in tables, arranged with climate hazard and stressor categories in the vertical axis, and 'value domains' in columns. We used impact chain diagrams to display the causal interaction of climate impacts across the different value domains. Using this technique, we could summarise multifaceted information from the workshops into a straightforward diagram and avoid large sections of text.

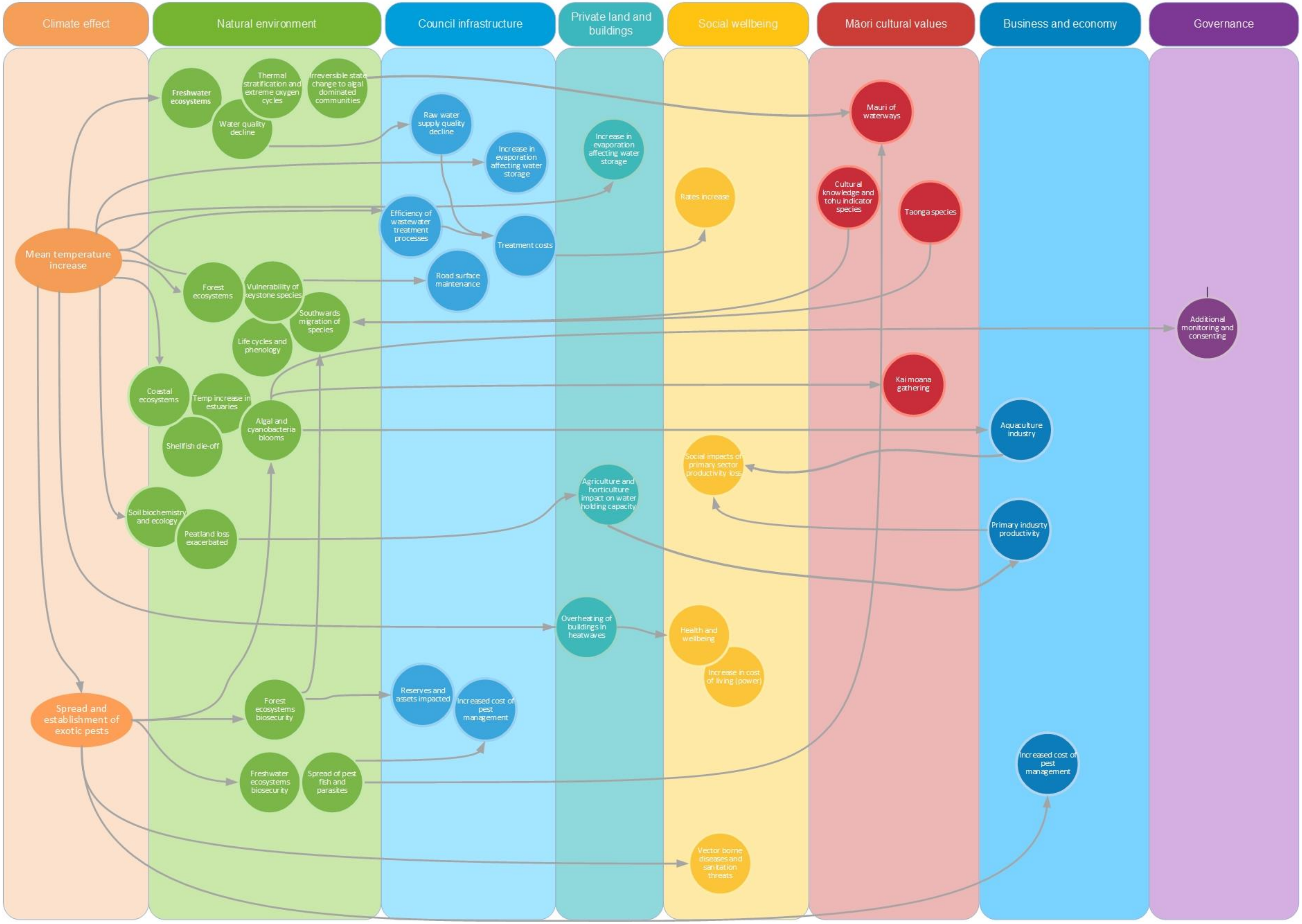
An example of the logic of a simple impact chain diagram is shown below:



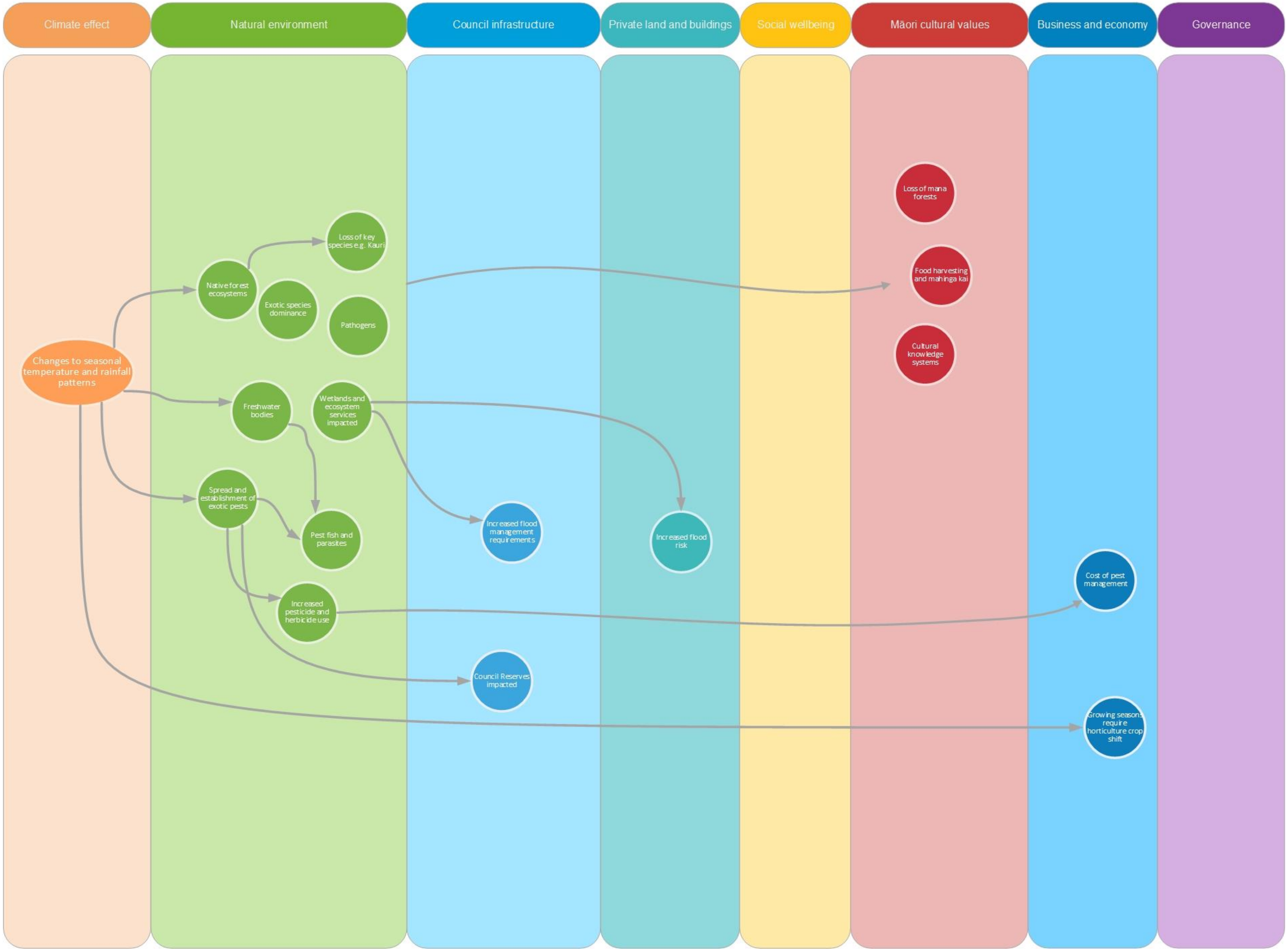
Impact chain diagrams are grouped by climate hazard and presented below as A3 foldouts:

1. Mean temperature increase and heatwaves (p.9)
2. Changing seasons (p.10)
3. Drought and mean rainfall decline (p.11)
4. Wildfire (p.12)
5. Extreme rainfall and storms (p.13)
6. Coastal flooding and erosion (p.14)
7. Permanent tidal inundation due to sea level rise (p.15)
8. Marine impacts (p.16)

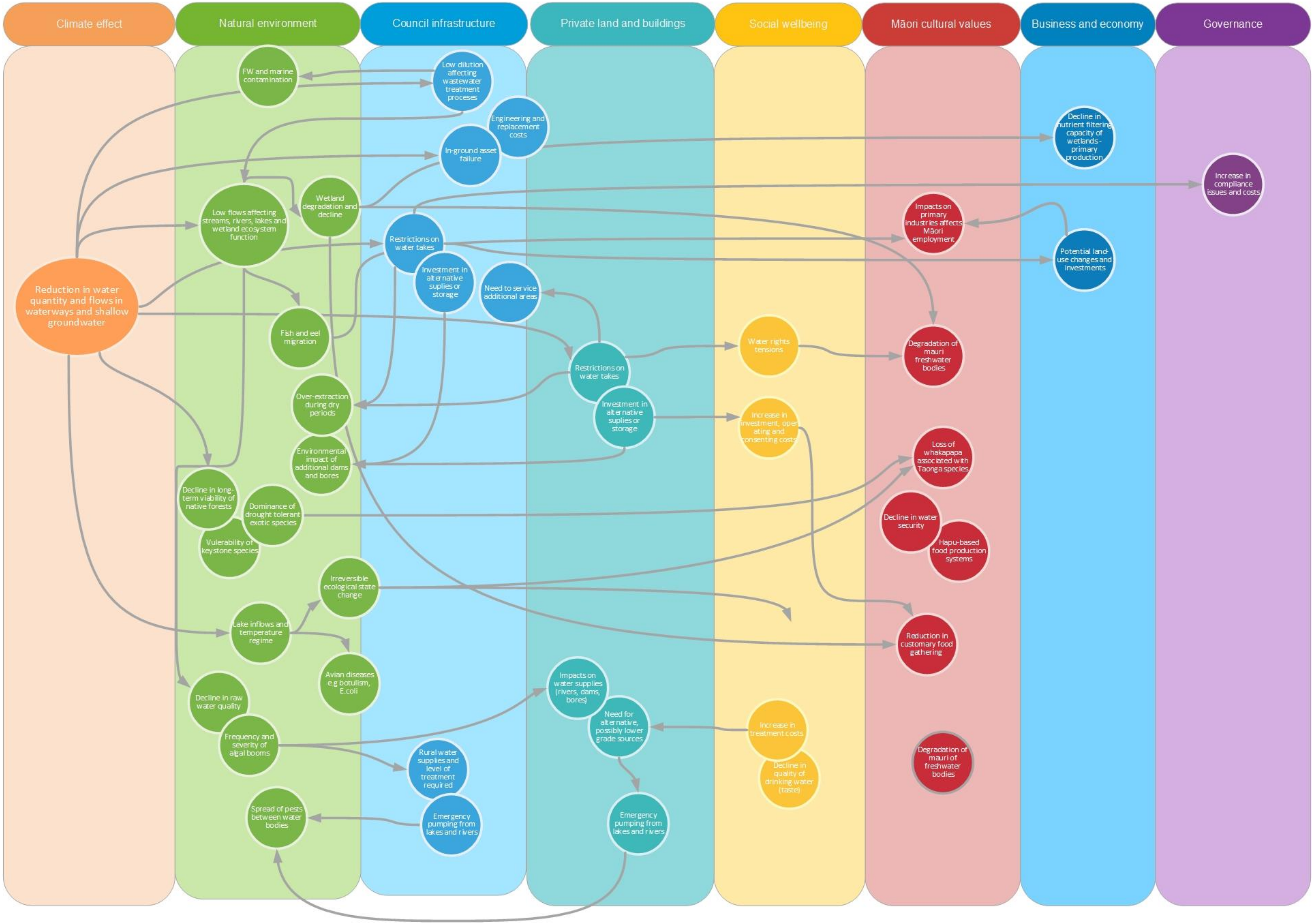
Mean temperature increase and heatwaves



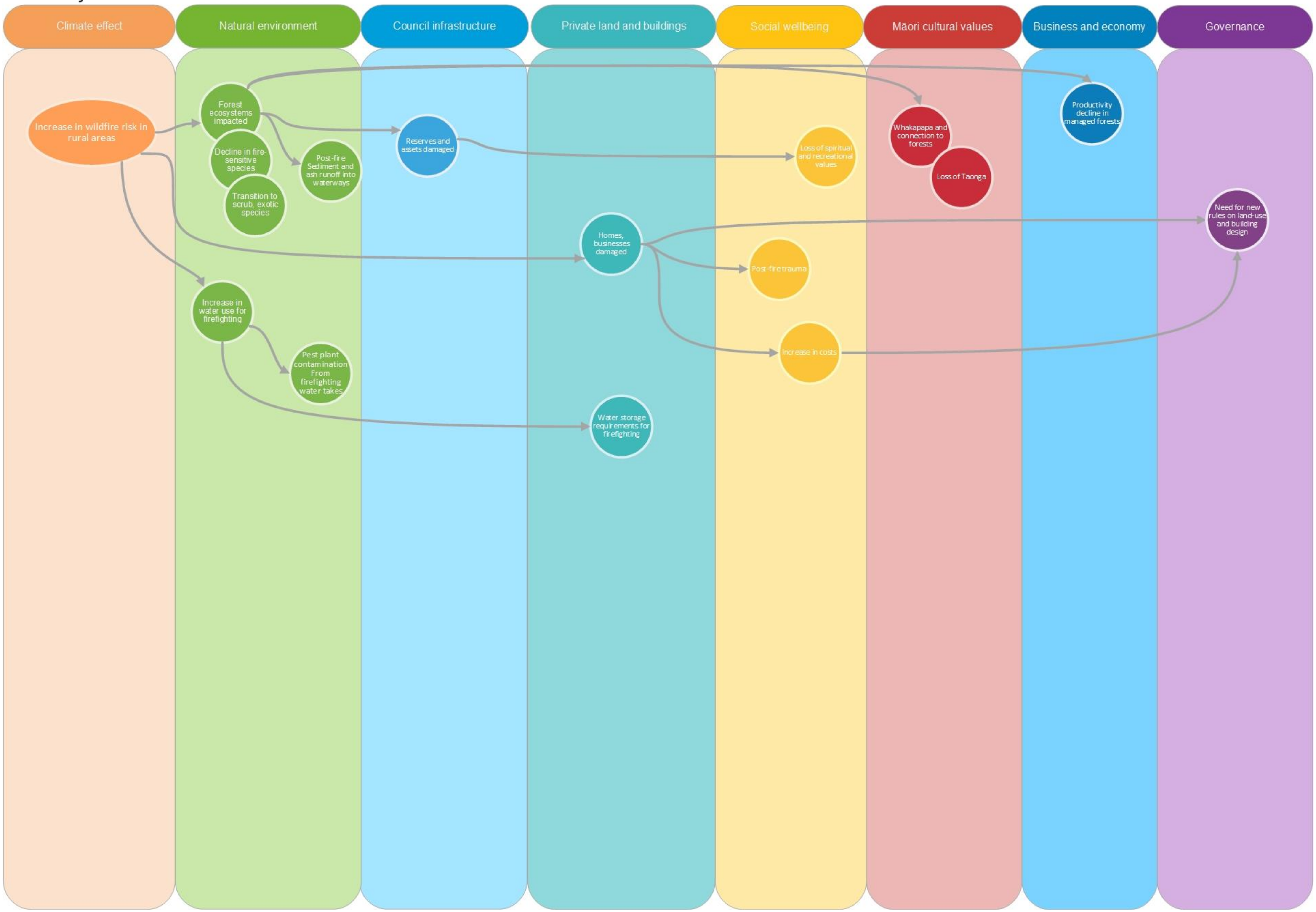
Changing seasons



Drought and mean rainfall decline

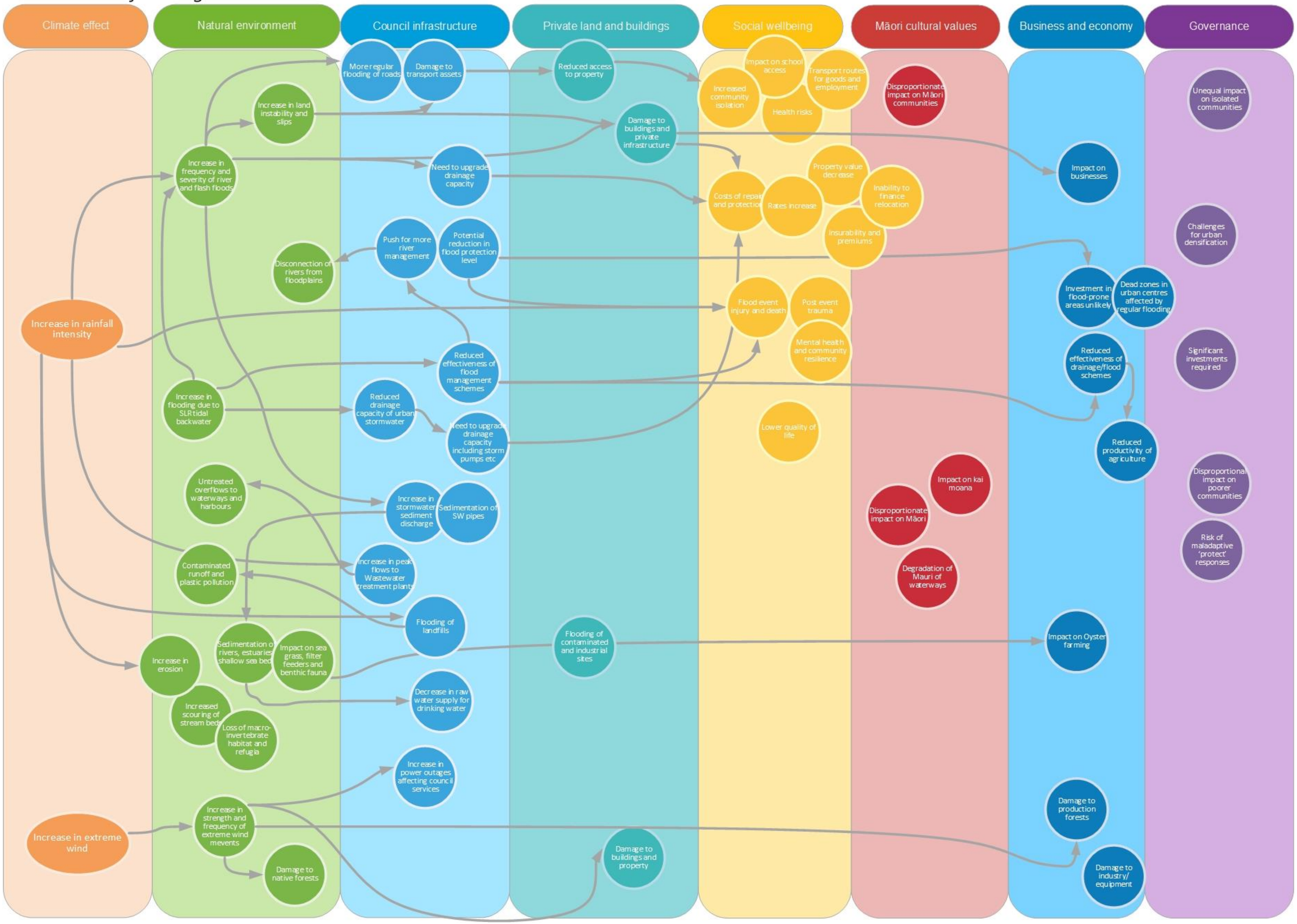


Wildfire

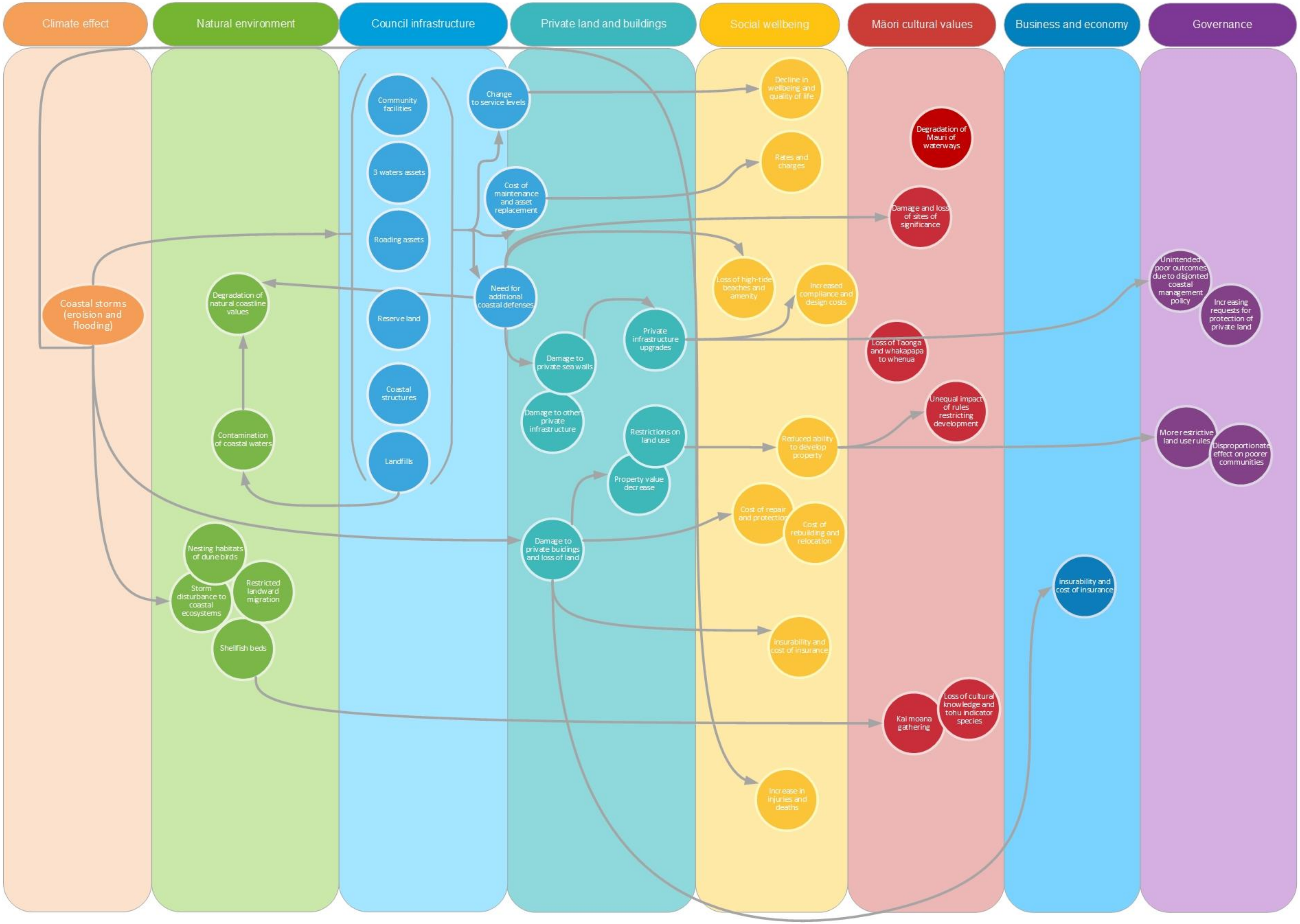


Climate effect
Natural environment
Council infrastructure
Private land and buildings
Social wellbeing
Māori cultural values
Business and economy
Governance
Increase in wildfire risk in rural areas
Forest ecosystems impacted
Decline in fire-sensitive species
Transition to scrub, exotic species
Post-fire Sediment and ash runoff into waterways
Increase in water use for firefighting
Pest plant contamination From firefighting water takes
Reserves and assets damaged
Homes, businesses damaged
Water storage requirements for firefighting
Loss of spiritual and recreational values
Post-fire trauma
Increase in costs
Whakapapa and connection to forests
Loss of Taonga
Productivity decline in managed forests
Need for new rules on land-use and building design

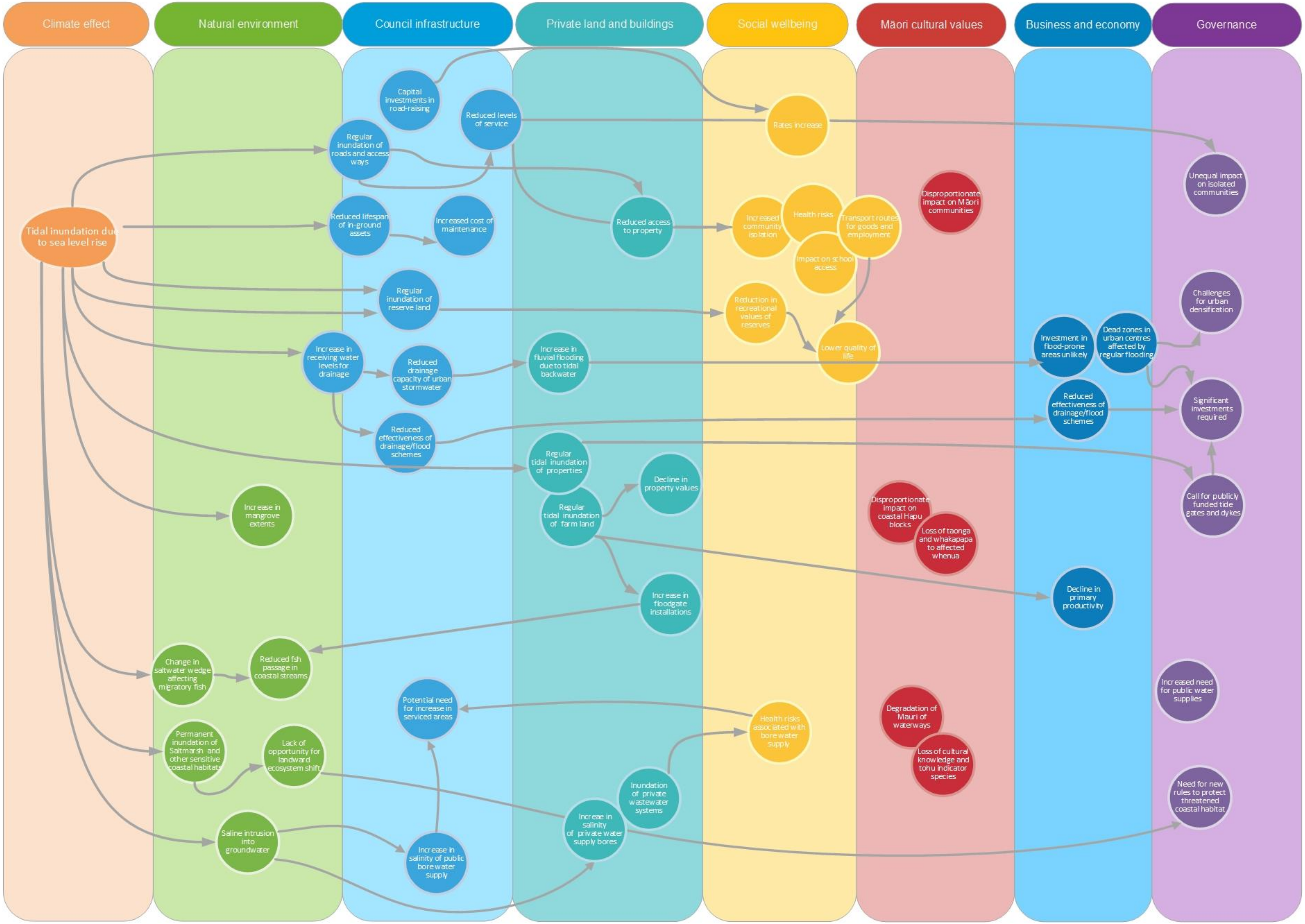
Storms and flooding



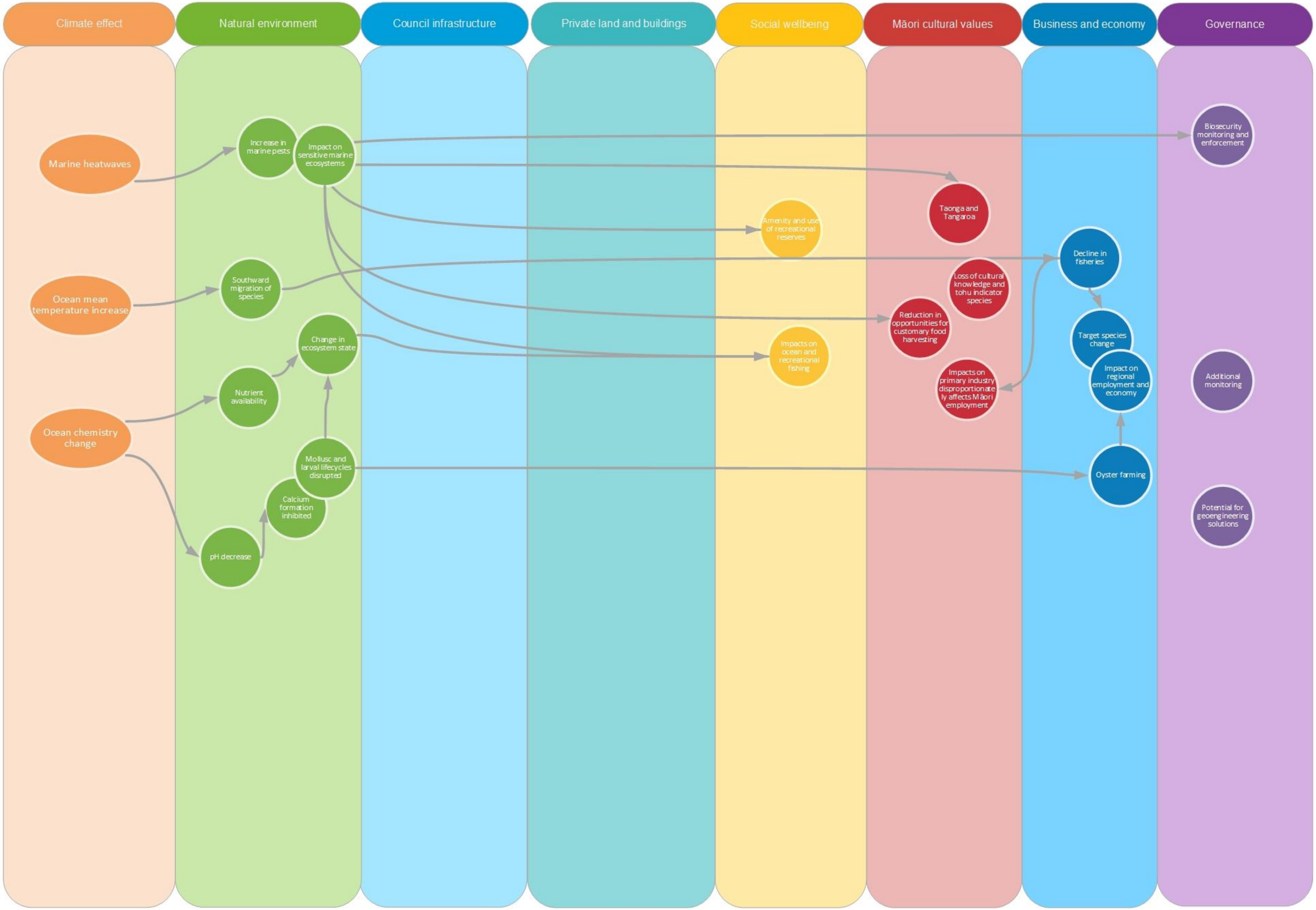
Coastal flooding and erosion



Permanent tidal inundation due to sea level rise



Marine


Climate effect
Natural environment
Council infrastructure
Private land and buildings
Social wellbeing
Māori cultural values
Business and economy
Governance
Marine heatwaves
Ocean mean temperature increase
Ocean chemistry change
Increase in marine pests
Impact on sensitive marine ecosystems
Southward migration of species
Change in ecosystem state
Nutrient availability
Mollusc and larval lifecycles disrupted
Calcium formation inhibited
pH decrease
Amenity and use of recreational reserves
Impacts on ocean and recreational fishing
Taonga and Tangaroa
Loss of cultural knowledge and tohu indicator species
Reduction in opportunities for customary food harvesting
Impacts on primary industry disproportionately affects Māori employment
Decline in fisheries
Target species change
Impact on regional employment and economy
Oyster farming
Biosecurity monitoring and enforcement
Additional monitoring
Potential for geoengineering solutions