Developing Signals, Triggers and Adaptation Thesholds for the Northern and Central Adaptation Areas

Date:	28 November 2023
Project name:	Takutai Kāpiti
Project no:	IS355300
Attention:	Abbey Morris
Company:	Kāpiti Coast District Council
Prepared by:	Monique Eade
Reviewed by:	Derek Todd, Andrew Henderson
Document no:	IS355300-NC-MEM-0008
Revision no:	Final
Copies to:	Jason Holland

Level 2, Wynn Williams Building
47 Hereford Street
Christchurch Central 8013
PO Box 1147
Christchurch 8140
New Zealand
T +64 3 940 4900
www.jacobs.com

Purpose

This Memorandum has been developed to provide high-level general advice on the setting of signals, triggers, and adaptation thresholds for the North and Central Adaptation Areas. This is intended to provide a possible starting point for community engagement focused on setting Management Unit specific signals, triggers, and adaptation thresholds. The Coastal Advisory Panel (CAP) will propose a set of strawman thresholds as part of their recommendations. These could function as a starting point for Council to directly engage with affected communities in the Kāpiti District after Takutai Kāpiti and the CAP. The detailed community engagement for signals, triggers and adaptation thresholds for each Management Unit is anticipated to occur post Takutai Kāpiti.[1]

Background

Like many coastal communities around New Zealand, Kāpiti faces significant environmental challenges caused by the changing climate and associated rising sea levels. While there is still much uncertainty about how significant these challenges will be and how quickly they will happen, likely climate change effects need to be anticipated, prioritised, and planned for in the Kāpiti District.

The Takutai Kāpiti Project has split the coastline into four Adaptation Areas (Northern, Central, Raumati and Paekākāriki). Each adaptation area has been further split into Management Units based on the hazard, the coastal geomorphology and land use. Each Adaptation Area is being considered separately by the Takutai Kāpiti Coastal Advisory Panel (CAP).

CAP is developing coastal adaptation pathways to respond these challenges. CAP will provide these recommendations to the Kāpiti Coast District Council (Council) for consideration. An adaptive planning approach is being adopted and the *Takutai Kāpiti: Coastal Hazards Adaptation Decision-Making Framework* (2022)[2] was developed to detail the approach. An adaptive plan relies on the development of adaption thresholds, triggers, and signals.

[1] Subject to Council's Long Term Plan process

[2] Available at: https://takutaikapiti.nz/wp-content/uploads/2022/09/Kapiti-Coast-Coastal-Adaptation-Decision-Making-Framework.pdf

1. Adaptive planning

Adaptive planning allows us to prepare for the future despite the future being uncertain. It works by preparing multiple pathways that are designed to be dynamic or flexible. This allows decisions to be revisited as new information, funding, or management approaches become available.

The Takutai Kāpiti Project identifies adaptation options and actions. Adaptation Options is the overview term used to group adaptation actions which have similar objectives and outcomes, i.e., Enhance, Accommodate, Protect, Retreat, Avoid. Adaptation Actions are the specific measure taken to reduce or eliminate long-term risk associated with the hazard(s).

Long term coastal management approach

Adaptive planning encourages the development of a long-term coastal management strategy to avoid ad hoc coastal management approaches being adopted that deliver poor longer-term outcomes. It considers the full suite of feasible options to ensure a holistic view is taken. It aims to shift away from short-term decision-making, recognising in particular that the best management approach may cost more in the short term but be more effective and cheaper in the long term.

It also encourages community engagement to occur proactively and before action is required. Decisions are often made under urgency and stress after an event. This environment does not allow a good platform for community-driven solutions. Adaptive planning can help by saying if this situation occurs, we will respond in this way.

Adaptation Actions are left on the table

Adaptive planning encourages as many Adaptation Actions to be left on the table for as long as possible. This acknowledges that there are numerous uncertainties, including the needs of future communities, the legislative framework, and the beach's response to sea level rise.

The purpose of assessing all of the Adaptation Actions upfront is to ensure any short-term Adaptation Actions taken do not prevent better Adaptation Actions being taken in future.

Trigger-based, not time-based

An adaptive plan is trigger-based, not time-based. This means we don't act until we need to; but we need to know what we will do, how it will be funded and who wants to be involved. Adaptive planning means we are not locked into future Adaptation Actions. If the impact of climate change and sea level rise on the shoreline are not as significant as first thought, we don't need to do anything. Conversely, communities are prepared with a plan if the impacts are greater or occur earlier.

Impact focused

An adaptive plan is impact-focussed. Thresholds are based on the impact of the event, not the scale of the event. The occurrence of a 1% Annual Exceedance Probability flood is not a threshold. The threshold may be that 10 properties are flooded within a set timeframe.

It relies on the development of adaption thresholds, triggers, and signals.

- **Adaptation Thresholds** describe the situation where the management approach is no longer delivering the desired outcome. The thresholds need to respond to community values, risk exposure and agreed levels of service.
- **Triggers** are the point at which we need to progress a change in the management approach. They allow sufficient lead in time to ensure the new option can be undertaken prior to the threshold being meet.
- **Signals** provide early warning that a trigger is approaching. They indicate that we should start thinking about early engagement on the change.

Figure 1 shows the decreasing performance of a coastal management approach. Early on a signal is reached indicating that the current management approach is losing effectiveness. The schematic includes triggers for three different Adaptation Options each requiring a different lead in time to implement the specific option. An option needs to be implemented prior to the adaptation threshold being reached. If a trigger is passed and no action is taken it may limit the Adaptation Options that remain on the table.

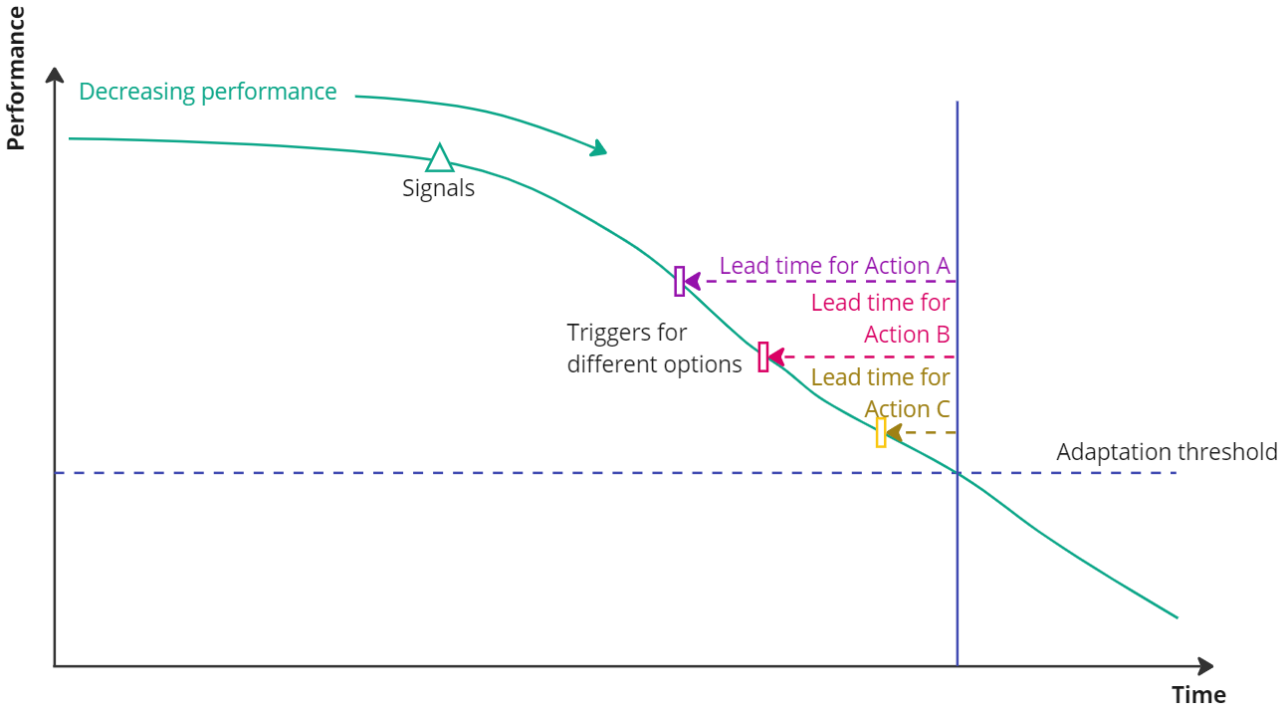

Figure 1.1: Graph showing the signals and triggers relative to the adaptation threshold

2. Case Study: Amberley Beach

Amberley Beach is a small coastal settlement of 109 dwellings. A manmade bund currently separates the settlement from the sea. This offers protection from coastal inundation and has helped reduce the rate of coastal erosion. The bund currently erodes at a rate of approximately 0.7m per year. Relocating the bund inland as the beach erodes continues to buy the community some time but it does not remove the increasing level of risk. Additional to the coastal inundation and erosion risk, the settlement is also subject to fluvial (river) flooding, pluvial (extreme rainfall) flooding and a high groundwater table.

Figure 2.1: The bund at Amberley Beach in need of maintenance

The community developed the following objectives:

1. Ensure houses are kept free from water and remain insurable and serviceable.
2. Retain the small-town community feel whereby residents can feel safe and close to the natural environment.
3. Secure and safe access is provided to and from Amberley Beach 24/7.

2.1 Developing thresholds

For Amberley Beach the objectives formed the basis of adaptation thresholds. For example, Objective One can be read as: a threshold is met when water enters a house. The thresholds were developed to respond to all hazards facing the community.

2.2 Developing triggers

Seven triggers were developed to respond to the various risks and ensure we changed management approach before any thresholds were met. When one of the seven trigger points is reached, the community and Council agreed to restart the conversation - and when two of the seven trigger points are reached a decision will be made. This could be a decision that no action is required at this time. Two examples of the triggers are:

Trigger One: Toe of backslope of the bund is within 5 metres of the nearest property boundary.

The bund provides inundation protection. To remain effective and affordable the bund needs to retreat over time. There is currently approximately 22 metres between the toe of the backslope of the bund and the nearest property boundary. Measurements will be taken from the backslope of the bund and the nearest

property boundaries after each renourishment. This trigger will be reached when the ongoing coastal erosion means that the bund needs to be located at or about 5 metres from the nearest property boundary. This intends to provide sufficient lead in time to install hard protection or proactively retreat (their two feasible options).

Trigger Two: Two flood events occur with water depths of more than 0.15 m in any 12-month period.

Water ponds within the settlement from a variety of sources. These events may occur individually, or they may occur together. Most of the dwellings within the settlement have a finished floor height of around 0.3 m although there is some variation to this. If two floods of 0.15 m occur within 12 months, they have a return period of around 1 in 6 months. At this point a flood of 0.3 m has a return period of around 1 in 3 years. This would mean we would expect dwellings to be inundated every 3 years in normal conditions. A static post is to be installed at three locations within the settlement to measure the depth of flooding.

2.3 Developing signals

Amberley Beach is currently in the stage between when a signal has been passed and before a trigger has been reached. Therefore, at Amberley Beach signals were not set. The speed of erosion suggests that change has already occurred and continued conversations are required on the implementation of future options. Figure 2 shows temporal relation between signals, triggers and thresholds at Amberley Beach.

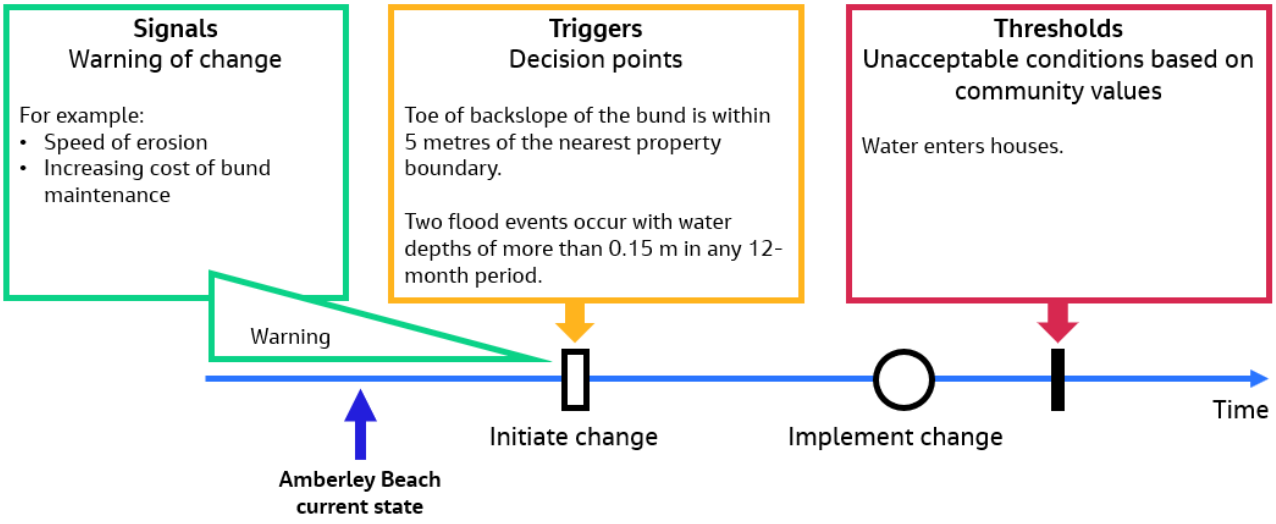

Figure 2.2: Schematic showing a signal, trigger and threshold for Amberley Beach

3. Setting of adaptation thresholds

Adaptation thresholds are the point when the current management approach is no longer tolerable. This point may differ for property owners, asset managers and recreational users. By determining this point we can put a plan in place to ensure it is not reached; or if it is, it is only reached once. Thresholds need to belong to the community. The example thresholds have been developed based on the Risk Assessments and Objectives for the Northern and Central Adaptation Areas for the Takutai Kāpiti project. They are intended as a starting point for discussion only, with the intent that they can be developed further with (and tailored by) affected communities in the Kāpiti District after Takutai Kāpiti.

Adaptation thresholds are:

- **Independent of the adaptation action to be implemented.** Adaptation thresholds do not consider the action to be implemented. They purely say this is the point we don't want to reach and before we get there something needs to be done.
- **Personal to individual communities.** Tolerance of risk will vary from person to person and the adaptation thresholds need to reflect the overall community's tolerance of risk. Some individuals will have a higher or lower tolerance than the collective view. The community's tolerance to risk may change over time as the population ages or new property owners move in. For example, access into and out of a property during an event might not be an issue until reliable access to the hospital is required at which point it may become a non-negotiable.
- **Cover a range of different values and risks.** The feedback from the Community Values sessions highlights the range of different things people value about their community. Multiple thresholds need to be developed to ensure this range is captured.

3.1 Limitations of adaptation thresholds for Takutai Kāpiti

There are two key limitations in developing adaptation thresholds for Takutai Kāpiti.

1. Coastal inundation vs other sources of flooding

The depth, volume or frequency of flooding is likely to be an adaptation threshold for the inundation Management Units. When the community sets thresholds in these areas, they will naturally consider flood risk independent of the source. The scope of Takutai Kāpiti is limited to coastal hazards, and the pathways developed by CAP responding to flooding are to be limited to the coastal inundation risk. Therefore, the pathways developed in Takutai Kāpiti may not be the most appropriate pathways to address the flood risk from other sources.

A multi-flood hazard assessment is being completed by Awa. Once this work has been completed consideration will need to be given to what flood management actions are required to ensure that all multi-flood adaptation thresholds are not met.

2. Individual versus community thresholds

Adaptation thresholds are community thresholds and are intended to represent the collective community tolerance. There will be members in the community with a higher or lower tolerance than others. These members may choose to take their own action prior to the community threshold being met. For example, they may choose to sell their current property and move to a lower risk location.

4. Example thresholds

Thresholds should be specific to each community. Values feedback was obtained for both the Northern and Central Adaptation Areas which aimed to capture what the community valued most about their beach. Risk Assessments were prepared which considers the risk to the build environment, human domain, ecology, natural character, and cultural values. These were used as a basis to develop example thresholds.

The thresholds below have been prepared as a place to start a community discussion. They are not intended to be a comprehensive list of potential thresholds, nor are all thresholds going to be appropriate for all communities. Commentary is provided as to why a threshold may be considered. Thresholds will be developed by CAP and refined, built on, or replaced through engagement with affected communities in the Kāpiti District after Takutai Kāpiti.

Threshold 1: Insurance

Example: ___ dwellings are unable to obtain insurance for coastal hazards.

The values obtained for both the Northern and Central Adaptation Areas show that people value the ability to have affordable insurance on their property. Insurance is important to property owners for financial security, and in many cases is a condition of a mortgage over the property.

Insurance is based on risk and is determined independently by the Insurance Council of New Zealand and not by Council. Premiums or excesses may be increased, or insurance may be declined altogether if the risk is perceived to be too high. Implementing an adaptation option may sufficiently reduce the risk to prevent insurance being declined or may allow insurance to be reinstated once the mitigation works are complete.

Insurance cover may not be offered for a range of reasons; therefore, the threshold should be specific to the impacts of coastal hazards. Coastal erosion is already excluded from some insurance policies in New Zealand, and accordingly it might be more appropriate for such a threshold to be limited to coastal inundation in some communities.

Dwellings has been suggested as the metric rather than properties as sheds and garages are often allowed to be constructed to a lower floor level with some allowance that these structures may flood from time to time. There are situations where the dwelling is insurable but the shed on the same property is not.

Threshold 2: Dune width

Example: The dunes at _____ Beach are less than __ m in width.

Dunes currently offer protection to private properties from coastal erosion and inundation. As the dunes erode the level of protection offered to properties reduces.

The September 1976 storm event is the largest on record in Kāpiti. The observed short-term erosion from this storm at Peka Peka is between 5-10 m (Gibb and Wilshere,1976),[3] and this is assumed to be to be similar at Te Horo and Ōtaki Beach. The dunes are important as they provide inundation protection to the land behind the dunes. When the dunes are less than 10m in width they could be totally breached in a single storm event, based on the observations of Gibbs and Wilshere (1976), significantly increasing the exposure of properties to coastal inundation.

[3] Gibb J.G. and Wilshere D.S. (1976). Coastal Erosion – Kāpiti Coastline. Notes on storm Saturday 11-Monday 13 September 1976.

In Te Horo the gravel ridge may roll back naturally onto private properties. While this may impact on the enjoyment of the property the dune would still provide protection from coastal inundation events. The dune could be allowed to roll back until the dwelling is threatened by the natural process and therefore would require a different threshold.

Marine Parade, Ōtaki Beach is located seaward of private properties. If the road is to remain useable the dune may need to be prevented from rolling back. This would cause the dune to narrow over time. When the dune is less than 10 m in width the whole width of the dune could be breached in one significant event. This would significantly increase the exposure of the dwellings behind the dune to inundation.

The maximum observed width of dune erosion varies between settlements, the condition of the dune varies, and the land use behind the dune differs. These factors would impact on what an appropriate threshold might be for individual settlements.

Threshold 3: Frequency of coastal flooding

Example: __ m or more of water ponds at _____ (specified location/s) for a continuous period of more than __ days.

970 properties in the Northern and Central Adaptation Areas are potentially exposed to some degree of flooding in a 1% Annual Exceedance Probability (AEP) event by 2050 after 0.2 metres of sea level rise. This does not consider the depth of water expected on properties or whether the water is threatening the dwelling. Some properties will experience deeper or more regular ponding than others.

Persistent shallow ponding of salt water can kill off gardens, cause health issues and be a nuisance. The continuous duration of standing water is likely to cause more issues than the total number of days ponding is experienced in any given year.

The depth of flooding, the location the depth is measured at, and the duration should be refined by individual communities. Public locations allow for greater transparency of water depths, and better reflect the overall impact of water on the community. Property owners may have their own independent threshold when they need to address ponding issues on their own individual property.

Threshold 4: Depth of flooding

Example: Water enters __ dwellings within _____(specified community) __ times in __ years.

Flooding has the potential to cause damage to buildings and their contents through waterlogging, sediment deposition, contamination from pollutants, debris impacts and erosion. Flood-affected buildings need to be repaired or rebuilt, depending on the severity of the damage, and contents replaced.[4] This can affect future insurability of properties and quality of life.

Specific consideration should be given to where the affected dwellings are located. Community-wide adaptation may not be the best approach to address the flood risk to a few dwellings that may be built in a slight depression or have lower floor levels. This risk may be better addressed at a property-specific level. The threshold should capture community-wide flood risk.

[4] Flooding can occur from a range of sources (rainfall, river flooding, high groundwater table and coastal inundation), and may be the result of a combination of these. The Takutai Kāpiti project is focused on coastal hazards only and therefore the options and pathways are designed to manage the coastal inundation risk only. In determining a threshold, you cannot separate out the source of the flooding as coastal inundation depths may be amplified by other sources of flooding or the maintenance of stormwater infrastructure. The management approach for rainfall driven events will be different.

Threshold 5: Water supply and wastewater infrastructure

Example: Critical water infrastructure is within __m of Mean High Water Springs

Drinking water and wastewater infrastructure are essential for maintaining sanitary dwellings and are a requirement for the continued occupation of dwellings. The roading network is located seaward of the nearest dwellings in some parts of the North and Central Adaptation Areas. Three waters services are often located within the roading network. This means that properties on the landward side of the road are impacted by erosion indirectly before the property is directly at risk.

The appropriate distance from Mean High Water Springs will depend on the location, type and vulnerability of the infrastructure, shoreline trends and any protection works.

Threshold 6: Septic tanks

Example: Septic system disposal fields are inundated for more than ___ days per year.

Te Horo and Peka Peka rely on onsite wastewater systems (usually septic tanks). In significant flood events water can enter the system causing raw sewage to spill into the environment. This can become a serious health hazard. Regular maintenance of septic tanks can help reduce the impact however, when the soil is saturated, it loses its ability to absorb the treated wastewater causing it to pond on the surface.

In such events alternative temporary toileting facilities may be required. This may be a situation that can be tolerated if it occurs very infrequently by the community but if this were to become a regular occurrence, the health risk may be determined to be unacceptable, by the community or Council.

Threshold 7: Beach access

Example: It is no longer possible to walk along the foreshore of _____ Beach during high tide.

The Values for Northern and Central Adaptation Areas identified beach access as being very important for recreation and wellbeing. If the shoreline is to be held in a particular position by protection works, access along the beach may be impacted by a narrowing of the foreshore. This may limit the times that you can use the beach for walking, running, surf casting or other passive beachfront recreation activities. Access to the beach can also be restricted by the erosion or inundation of carparks, walking tracks, or roads.

Consideration should be given to what is important about beach access. For example, a walkway along the top of a seawall may provide an acceptable level of beach access for running and walking but would not be appropriate for building sandcastles.

Threshold 8: Significant event

Example: Any serious injuries and/or fatalities that occur as a result of a coastal erosion or coastal inundation event.

Example: A coastal storm significantly compromises the effectiveness of the existing inundation (or erosion) protection structures.

Example: A coastal storm causes damage to more than __ dwellings in _____(specified community).

The safety of the community and beach users is paramount. If lives are at risk, then a new management approach is required. Alternatively, if a coastal storm compromises the effectiveness of the existing erosion

protection a new management approach may be required. This may be an opportunity to consider a more transformational change as opposed to trying to repair the existing structure.

A threshold could consider the impact of erosion or inundation events on private property. Damage to private properties has the potential to be costly, temporary displace people, and cause anxiety. Damage to an individual private property from time to time may be tolerable but widespread community damage may not be. The extent of damage will be specific to each community.

Threshold 9: Ecology

Example: The dune volume decreases by __% from the 2023 benchmark at _____ location threatening significant nesting habitat.

The preservation of the natural environment was recognised as important in the Values for Northern and Central Adaptation Areas. Dunes are a natural dynamic environment providing key habitat and breeding grounds for indigenous flora and fauna. If the dunes are unable to migrate, key habitat may be permanently lost. An ecological threshold can be developed that responds to these concerns.

Threshold 10: Cost to public maintenance

Example: The overall cost of the current publicly funded (specified) management approach exceeds $__ per year.

Example: A targeted rate of more than $__ per year is required to fund the ongoing publicly funded maintenance of the current (specified) management approach.

There is a financial cost of holding the line. This may include the maintenance costs of repairing the road after a storm, the costs of continuing to build up or maintain the dune system or the cost of cleaning up debris from private properties. The increase in cost may also be driven by external factors such as the closure of a local quarry and the need to source material further afield which may drive up the costs.

If the cost of maintaining the status quo or enhance actions becomes prohibitive, there may be a need to consider other more affordable approaches.

Threshold 11: Recovery time between events

Example: _____ community is required to respond to __ significant coastal storms within __ years at _ location.

Example: Emergency works are required _____ (frequency) to repair dunes or protection structures within a settlement.

Responding to, and recovering from, significant events is tiring and expensive for the community. It takes a toll on the mental and physical health of members of the community. A community's capacity to respond to events may reduce over time if such events occur too regularly. There may be a point where a community can no longer tolerate the frequency of events and a new management approach will be required. The adaptive capacity of different communities will be different.

A number of storms in a period of time is recommended to capture the trend of events over a number of years. This helps to remove any unseasonably stormy periods and allow time for the beach to respond and recover naturally where possible.

Threshold 12: Cultural

Mātauranga Māori holds valuable knowledge on the history of the coast and how it has changed over time. This may be best woven into the above thresholds or Ngā Hapū o Ōtaki and Te Ātiawa ki Whakarongotai may have separate specific cultural thresholds that should be included as part of a suite of thresholds.

5. Setting triggers and signals

Triggers need to be suitably far in advance that a change in management approach can be implemented prior to a threshold being meet. Triggers link to the agreed thresholds and are specific to the possible Adaptation Actions available. As CAP are still developing pathways and no thresholds have been agreed the below focuses on the principles of how to set triggers. The detailed triggers and signals are expected to be consulted on with the community per Management Unit post Takutai Kāpiti and the Coastal Advisory Panel.

Lead in time for implementation

To determine the triggers, we first must understand how long we need to implement an action. Depending on the specific option the lead in time will vary. Most Adaptation Actions will need time to:

- confirm the preferred action,
- source funding, and
- co-design the preferred action with iwi partners, the local community and other beach users.

For protection actions this will also include time to:

- undertake the technical design of the structure (multi design steps – concept, initial and detailed),
- prepare technical reports to support a resource consent application,
- consent the structure, and
- build the structure.

For retreat, this could also include time to:

- develop the retreat approach with the affected parties,
- acquire suitable land to retreat to,
- rezone land,
- demolish old dwellings, public infrastructure, and buildings,
- construct new dwellings,
- move and complete associated legal requirements, and
- rehabilitate retreated land.

There may be variations between communities and the timeframes may vary depending on the scale of works required. As a guide the following timeframes can be used as a starting point.

Adaptation option	Indicative lead in time	Commentary
Nature based solutions (ie. dune or wetland enhancement)	1-3 years	Limited or no consenting hurdles and generally supported by the community. Funding will still be required. If this is to be provided by Council, this may need to wait for Council's Long Term Plan (3 yearly) process although funding may be available from other external sources.
Soft or hard protection	5 years	Assumed one year for co-design and engagement processes, one year for the preparation of technical reports, one year for consenting, one year in case of appeal to Environment Court and

		one year for design to ensure construction can occur during the appropriate season. The scale of the project, sensitivity of the site, community views on the option and the existing environment will affect the implementation time.
Retreat	5 years (reactive retreat) -10 years+ (proactive retreat)	Proactive relocation may be undertaken in various ways. This is currently being explored by numerous Councils within New Zealand. The time required will depend on the number of dwellings affected, whether a collective solution is sought, and whether the relocation requires new land to be made available for subdivision.

Triggers linked to the selected thresholds

Each trigger should link to an agreed threshold. A trigger may respond to more than one threshold.

For example, the depth of flood water will affect:

- Whether water enters a dwelling,
- Whether road access is maintained,
- Whether septic tank systems remain operational, and
- Subsequent cost of repairs.

Four separate thresholds may exist for each of these however, one trigger may be able to respond to all of these. An example trigger could be: Water reaches __ depth on __ structure __ times within __ years.

The depth of water tolerable would consider the floor height of the at-risk dwellings and the depth of flooding that makes the road impassable. This event then has an anticipated cost which may link to a cost-based threshold. The location where the water depth is measured may not be the lowest point in the settlement. It could be a marker on a public building or lamp post (or similar). The purpose is to set a static marker that can be used to show a relative depth of flood water.

Alternatively, multiple triggers may respond to one threshold. For example, the threshold could be that a road is closed for over 48 continuous hours twice in 10 years. One trigger could consider the overall duration of the road closure while another considers more frequent but shorter closures.

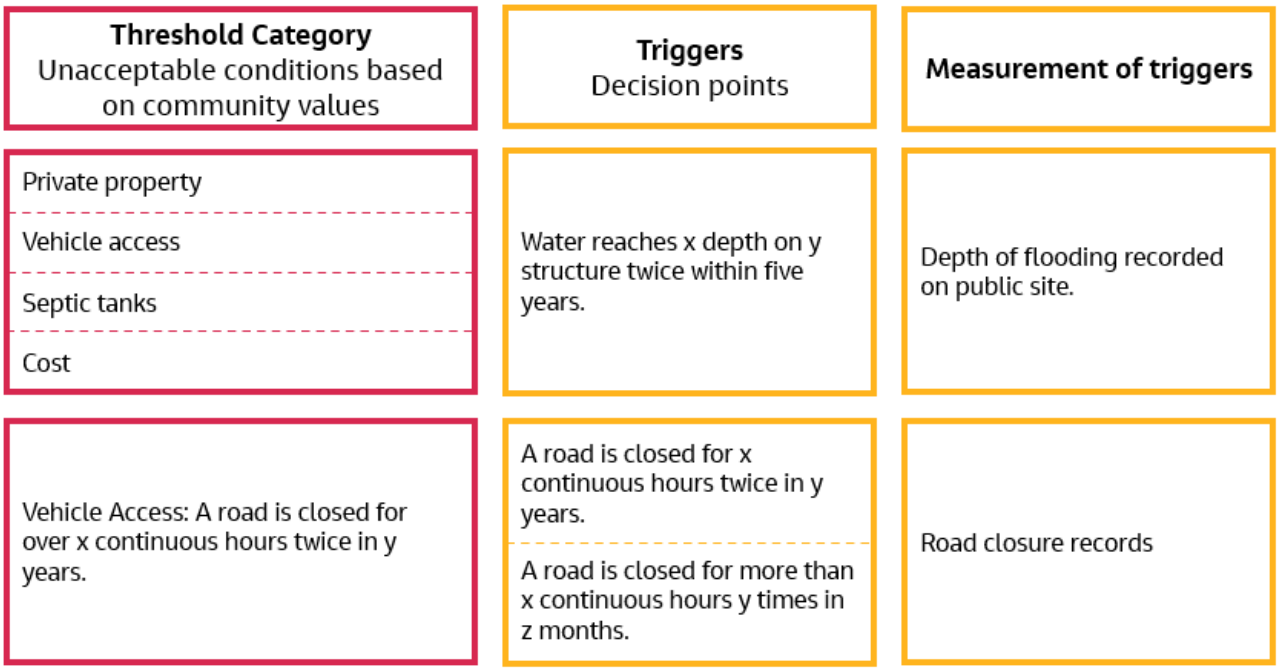

Figure 5.1: Multiple thresholds can be addressed by a single trigger and one threshold may be addressed by two triggers

No regrets decision points

Adaptive planning aims to leave as many Adaptation Actions on the table as possible for as long as possible. This may mean that the trigger points may be required to make active decisions not to proceed with particular Adaptation Actions. For example, soft engineering approaches require a certain amount of beach width to be effective - if the approach is not implemented by a certain point, it will no longer physically be an option.

Monitorable triggers

Triggers need to be able to be monitored. These can be qualitative, but they will be easier to implement if they are quantitative. The triggers may involve a mixture of scientific monitoring and community monitoring. Some options are set out in Appendix A.

Setting signals

Signals provide early warning that change is occurring. They look at long term trends and ideally should remove year to year variability. They are closely tied to long term monitoring. Signals are not change points, rather they are intended to give warning that the environment is changing. Signals can be useful to help allocate resources to enable the process to commence when the trigger point is reached.

6. Example Triggers and Signals

Figure 6.1 below shows two examples of how signals, triggers and thresholds come together.

Example 1: The dunes at Ōtaki Beach are currently 30-80 m wide and the beach is currently still accreting. When the dunes start to show a pattern of erosion, we know change is occurring (this is a signal). The trigger sets a minimum dune width that provides enough time for a change in management approach to occur before the threshold is met.

Example 2: Dwellings within the settlement are still eligible for insurance. Insurance companies are likely to raise excesses or premiums prior to declining insurance. Therefore, when insurance companies start to raise excesses due to coastal hazard risk, we know the industry is concerned by the risk (signal of change). It may not be until new owners have trouble acquiring insurance that a trigger is reached or a few of the most vulnerable dwellings have insurance withdrawn. Acting at this point aims to avoid the threshold being met.

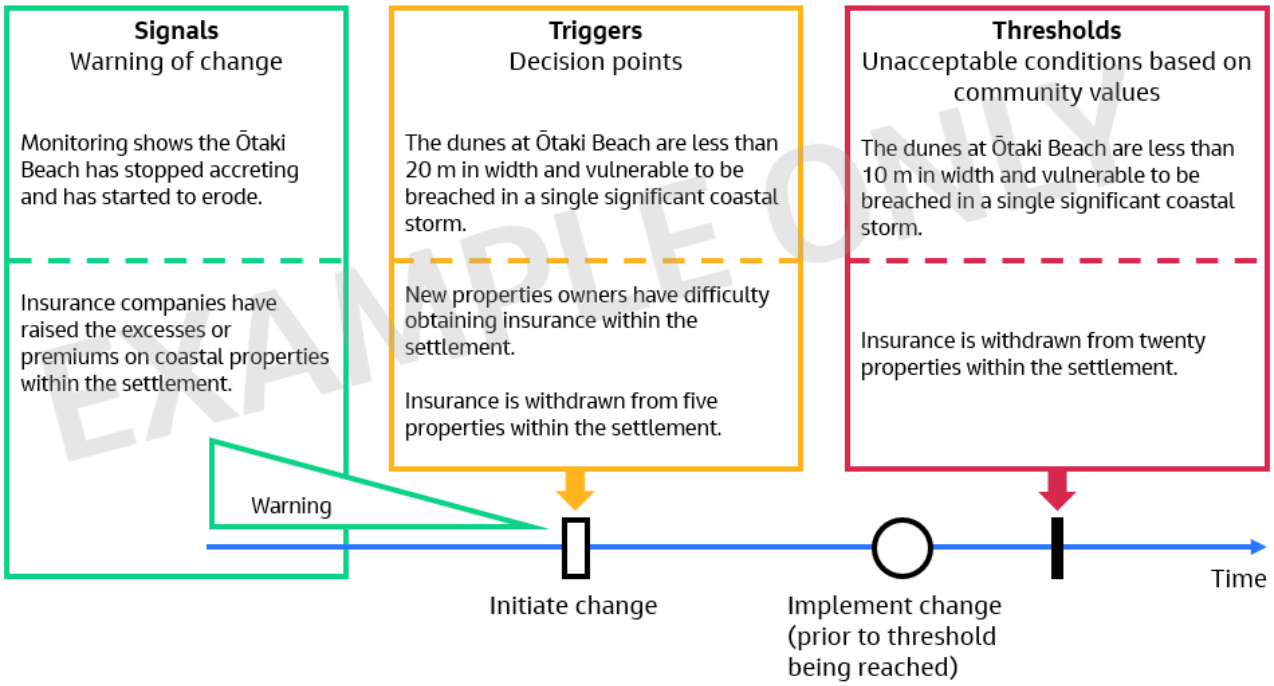

Figure 6.1: Example of how signals, triggers and adaptation thresholds come together

7. Options discounted as thresholds and triggers

The following thresholds were considered but discounted for the reasons explained below.

Sea level rise

As sea level varies from year to year, a midpoint is used to average out the variations. We can continue to follow the national data on the rate of regional sea level rise (e.g., Wellington Harbour) and local Vertical Land Movement to help determine what future relative sea level rise might look like on the Kāpiti Coast and further refine the science. However, of greater concern is how the local beaches respond to sea level rise, in which there are still uncertainties. Due to the year-to-year fluctuation, as well as uncertainties in beach response, it is not considered a suitable trigger on its own.

Civil Defence Emergency Response Capacity Impacted

Civil Defence Emergency Management have several roles but most visibly they are the lead agency when disaster strikes. Their work helps minimise the risk to the community through helping with evacuations if required and supporting recovery. If proactive evacuations are occurring regularly or their capacity to respond and assist in a disaster is limited, the risk profile to the community changes. This may trigger a discussion about the need to do things differently or earlier.

Half of property owners request action sooner than planned

The triggers aim to capture the various elements of risk to ensure we all agree on when change is required. As the risk increases there may come a time when the community is no longer comfortable with the level of risk. If the community are no longer comfortable with the risk, they may choose to write to Council requesting that the adaptation plan be implemented sooner.

Half of property owners is almost certainly not the right number. Absentee owners may be more ignorant of the increasing risk or there may be property owners that will never engage in a process. The correct number would vary settlement by settlement.

Appendix 1 Possible monitoring options

The implementation of triggers requires regular long-term monitoring using standardised methods. Monitoring results provide the ability to track when signals, triggers and thresholds are being met. The specific monitoring required will depend on the signals, triggers and adaptation thresholds adopted by specific communities.

Monitoring can be split into technical environmental monitoring and citizen science monitoring approaches. Citizen science monitoring can be effective as it allows more regular monitoring than what may be possible through a Council monitoring programme.

Table 1 suggests some possible monitoring approaches.

	Environmental monitoring	Citizen science
Routine monitoring	• Annual beach topographic and profile surveys • Regular aerial photo imagery • Satellite imagery interpretation • Repeat LiDAR surveys • Asset monitoring • Tracking of asset maintenance frequency and costs	• CoastSnap monitoring (photos from set public location) • Installation of fixed benchmarks to take shoreline measurements from
Post-storm monitoring	• Documentation of physical drivers of significant events • Beach survey to measure impact of storm • Pre and post storm photos • Depth of water at particular locations • Duration of ponding at particular locations • Civil Defence Emergency Management call out records • Number of issued s124 notices (Dangerous, affected, or insanitary buildings) • Tracking cost of responding to events	• Pre and post storm photos • Depth of water on property • Duration of ponding on property • Visual inspections and reporting of damage to dunes and infrastructure