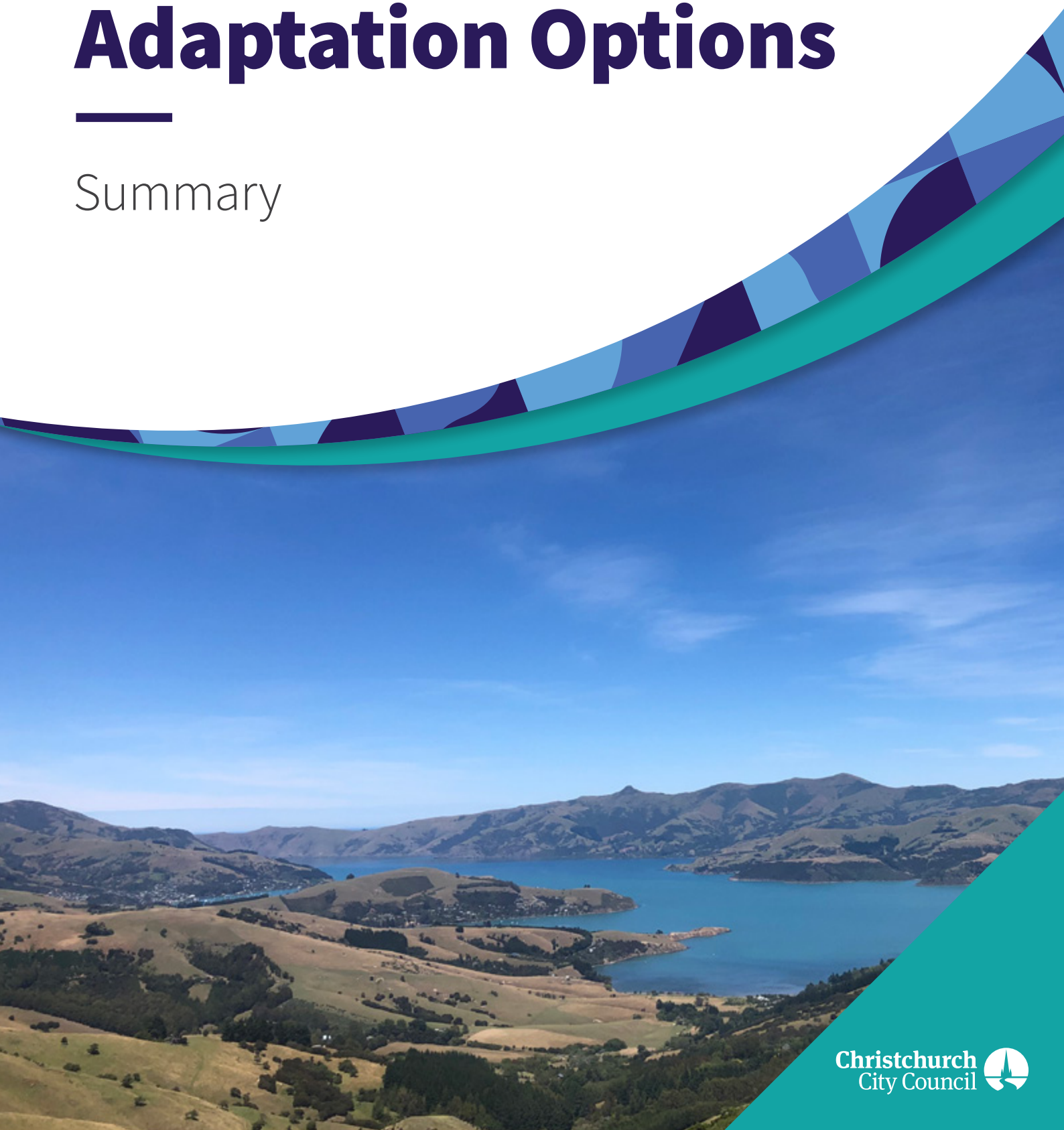
Coastal Hazards Adaptation Planning

Catalogue of Coastal Hazard Adaptation Options

Summary



Christchurch City Council

Purpose of this document

The 2017 Ministry for the Environment's 'Coastal Hazards and Climate Change Guidance for Local Government' report recommends identifying current measures that manage coastal hazards and investigating whether any changes are required, or whether new approaches are needed to address future risks. We have developed a Catalogue of Coastal Hazard Adaptation Options to help us with this step in the adaptation planning process.

The Catalogue shows the wide range of possible adaptation options for low-lying inland and coastal communities. It has been created through a desktop review of relevant national and international literature, policy and planning documents and case studies focused on adapting to coastal erosion, coastal flooding and rising groundwater hazards. It is not an exhaustive list – it is simply intended to help inform and support adaptation planning.

The full Catalogue is more than 80 pages and, while we recognise that this level of information and detail suits some people, we also know that it's not for everyone. So we have also created this Summary document as an overview of the types of measures that are used locally, nationally and internationally to manage coastal hazards. You can find the full catalogue and the summary here: **ccc.govt.nz/how-we-can-adapt-to-coastal-hazards**

Types of options

There are five main types of options for adaptation planning:

- **Maintain:** *We enhance what we're already doing*

We continue to live in an area while increasing knowledge of the environment and aiming to increase community risk awareness. Options include things like emergency response management, maintaining existing infrastructure, broad district-wide land use planning, environmental monitoring and community awareness raising.

- **Accommodate:** *We live with the hazard*

We continue to use land in an area by raising our tolerance to the hazards, which means we can avoid or delay the need to remove or relocate at-risk assets in the short term. Options include things like adapting buildings and infrastructure, raising land levels and managing ground and storm water.

- **Protect:** *We keep the hazard away*

We interrupt coastal hazards using soft engineering approaches, hard-engineered structures, or a combination of the two, to form a barrier between assets and the hazard. Options include things like shoreline nourishment, seawalls, or stopbanks.

- **Retreat:** *We move away from the hazard*

We retreat from coastal areas, or relocate existing and planned development to reduce our exposure to the hazards. The hazard risk to assets is reduced or removed entirely, leaving the coast to respond to natural processes. Options include things like buyouts, land swaps, or leasebacks where property rights are purchased with the provision that the land is leased back to the former owner.

- **Avoid:** *We don't move into the way of the hazard in the first place*

We use planning tools to avoid increasing the risk of harm to people and property. Options include things like land zoning or setbacks that prevent development in some areas.

Within each type, there are a range of potential options. To achieve the best outcomes for adaptation planning, it's likely that a combination of types and options will be needed.

Some literature we reviewed also mentions 'attack' as a type of option – where land is reclaimed from the sea. However, we could only find examples of this being used as an economic tool, rather than a coastal adaptation tool. For this reason, we haven't included attack options in the full Catalogue or in this Summary.

Options

Key

Hazards addressed »

Coastal erosion

Coastal flooding

Rising groundwater

Option addresses the risk of this hazard

Some variations of this option can address the risk of this hazard OR

This option may address some aspects of the risk of this hazard

Option does not address the risk of this hazard

Maintain current infrastructure systems, and continue community education, emergency management and environmental monitoring

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Maintain

Managing coastal hazards as we currently do means to maintain current infrastructure systems and continue improving community education, emergency management and environmental monitoring.

Advantages: Easily implemented with no major change witnessed by the wider community.

Disadvantages: May not be a viable standalone option past the short term in some areas as hazard risks become more severe.

Flood proofing buildings

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Accomodate

Flood proofing buildings is achieved using two main methods: wet or dry flood proofing. Wet flood proofing involves three main techniques; allowing water to enter and leave structures easily to minimise structural damage, using flood resistant materials, or elevating structures and utilities, while dry flood proofing ensures buildings are watertight up to a certain level. Flood proofing measures may be temporary or permanent.

Advantages: Wet flood proofing can prevent large loads on buildings and also encourage a more natural movement of sediment and water. In most cases, flood proofing also requires no extra land, it can be carried out by individual property owners, can increase property resale values and can reduce future damage costs.

Disadvantages: Most measures are only suitable in areas with a small inter-tidal range and where flood depths are low, and in most cases, wet flood proofing can only be implemented in new developments. Measures may also adversely impact the appearance of a building or impact the visual amenity of the wider area. There may be a significant amount of clean up required after a flood event, and if a flood event exceeds design parameters, these measures may provide little to no protection at all.

Flood proofing infrastructure

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Accomodate

Flood proofing infrastructure such as roads, wastewater, stormwater and drinking water networks , and telecommunication infrastructure may involve modifying existing assets or designing new or replacement assets to withstand coastal hazards.

Advantages: Can continue the use of current systems while increasing their resilience and reducing future damage costs.

Disadvantages: Most measures are only suitable in areas with a small inter-tidal range and where flood depths are low, and in most cases, wet flood proofing can only be implemented in new developments. Measures may also require land acquisition where modifications are reliant on the ability to expand the footprint of infrastructure.

Adaptable buildings

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Accomodate

Adaptable buildings are designed to respond to an environmental change while avoiding structural damage.

Advantages: Adaptable buildings allow for the recognition of the high demand and property value in coastal areas while minimising or avoiding the construction or expansion of protection structures. An adaptable approach to planning and building also helps people to recognise that seasonal and occasional inundation will occur and that we must live with water. Adaptable buildings can work with natural processes and allow flood waters to flow under structures rather than obstructing the water.

Disadvantages: It is much easier to implement this option in new developments when compared to existing assets.

Raising land levels

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Accomodate

Land can be raised above an expected inundation level for the purpose of reducing current and future flood risk.

Advantages: This option allows for the continued use of land in otherwise flood-prone areas.

Disadvantages: The edge of the raised land may need protection from erosion in the form of beach nourishment, vegetation planting or hard engineered structures. Options that create a barrier for flood water may also increase the hazard in adjoining areas where the water is redirected to, while another potential limiting factor is the material that is used, how much it needs to be compacted and how much it will subside. Raising land in sections also poses access issues if for example, roads remain at a lower land level and are flooded for periods of time. It is difficult to implement this option in areas with existing developments.

Groundwater management

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Accomodate

The effects of rising groundwater, or the impacts that other adaptation options have on groundwater can be managed in several different ways.

Advantages: Groundwater management systems can provide layered benefits, including reduced liquefaction potential and if combined with stormwater drainage systems, they can both drain water and infiltrate it into the ground when the water table is too low. Relocatable infrastructure such as moveable pump stations can also further increase the resilience of the system in the face of climate change. Water in drains, canals or channels can also add recreational and ecological benefits to an area.

Disadvantages: Pumping groundwater can have adverse effects such as causing land subsidence or leading to saltwater intrusion if too much is removed. The effectiveness and suitability of these options is reliant on the type of soils and groundwater sources in the area. Liquefaction and seismic activity may severely affect some subsurface infrastructure.

Stormwater management

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Accomodate

There are several ways to manage stormwater as the groundwater table and sea levels rise.

Advantages: Stormwater management features can add recreational amenity to an area while also raising awareness to the fact that we must learn to live with water.

Disadvantages: Flat topography that is common in low-lying coastal areas does not highly support gravity-induced systems. This can lead to backflow into the system, damage from erosion, and clogging due to debris and the more frequent and severe storm events. Pumping stations are only recommended where other options are not suitable or feasible due to the high costs and potential problems associated with them. Liquefaction and seismic activity may also affect some subsurface infrastructure.

Diversifying energy and water supply

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Accomodate

The diversification of energy and water supply refers to using different sources, suppliers and transportation routes for these resources to reduce the dependency on a single source or provider. This reduced dependency increases community resilience during hazard events and therefore reduces the risk of hazards.

Advantages: If a hazard or accident causes a disruption to one source, having others that can supply for the demand can increase community resilience. Developing renewable energy sources such as wind power or sustainable water supplies such as treated wastewater can also lead to environmental protection in the sense that these sources emit little to no pollutants, limit the extraction of resources, have minimal impact on the environment and allow for innovation, research and development.

Disadvantages: Diversification constraints vary depending on the quantity of natural resources available, the demand experienced, and geopolitical constraints.

Emergency management

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Accomodate
- Protect
- Maintain

Although emergency management does not reduce the risk of hazards themselves, the responses that come as a result of this management such as education campaigns, evacuation plans, civil defence emergency management, and temporary accommodation and protection measures, do increase community resilience and reduce the risk of hazards.

Advantages: Emergency management allows for planning ahead and can help to minimise fear and panic in the community.

Disadvantages: Responsive measures taken under emergency management such as temporary bunds may have negative environmental effects or be poorly engineered and have a shorter life span due to the time constraints during planning and construction.

Shoreline nourishment

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Protect

Shoreline nourishment involves the addition or redistribution of sediment on foreshores, beaches or dunes to help maintain or advance the shoreline position. This can help combat erosion by providing a temporary buffer zone, allowing waves to run up and dissipate energy, and increasing the volume of sediment available in the system.

Advantages: This is a flexible option that is unlikely to prevent or inhibit other options in the future. It is also likely to benefit adjacent areas due to longshore drift that redistributes material. Benefits can also be seen on hard structures such as seawalls behind a wide, nourished beach as some wave energy is absorbed before hitting the structure.

Disadvantages: This process does not prevent or stop erosion, it merely adds sediment to the shoreline which will then normally require a re-nourishment, maintenance and monitoring programme.

Dune reconstruction and regeneration

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Protect

Dunes provide a dynamic store of sediment landward of the high tide line that can change in response to wind, waves or sea level. This store of sediment can act as both a barrier to water and it is able to supply sediment to the beach during times of erosion and store it again after.

Advantages: Dunes are a flexible protection option that can support other adaptation options in the future. They also have the ability to restore natural character to an area, provide habitats for animals and plants, and may even encourage sustainable coastal developments in the future. Dunes may also be used to relieve pressure on hard structures built on the landward side of them.

Disadvantages: The large footprint and scale of dunes means that they may act as a barrier to beach access and coastal views and also require a large amount of land that may currently be used for other purposes. Depending on the size and extent of the dunes, the severity and frequency of storms, and the amount of sea level rise, dunes require frequent monitoring and maintenance along with the possibility of requiring re-nourishment.

Beach drainage

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Protect

Beach drainage involves the placement of drains parallel to the shoreline, under the exposed beach face, which are connected to a well so that water which enters the system can be pumped out. Beach drainage lowers the water table and increases the depth of the unsaturated zone under the ground. Under low to moderate wave conditions, this lowering of the ground water table encourages sediment deposition on the beach, reduces sea-ward transport of sediment and therefore causes accretion.

Advantages: This option has a relatively low impact on the environment and has little effect on the visual amenity of the area. It may also be used to increase the design life of other options further inland.

Disadvantages: Although this option is relatively easy to implement, it has high maintenance and management requirements. Beach drainage has also been seen to not be significantly effective during storms and may result in the beach being drawn down to the point where the pipes become exposed.

Coastal wetlands, riparian management and living shorelines

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Protect

These vegetated areas act as a buffer to coastal hazards. Vegetation protects the shoreline by increasing the roughness of the surface which causes waves to dissipate energy. In addition to this, vegetated areas act as a sediment trap which causes accretion, while the vegetation roots stabilise sediments and minimise erosion.

Advantages: These natural areas are capable of adapting to sea level rise autonomously, they can relieve pressure on hard structures built on the landward side of them, and they provide ecosystem services such as accumulating contaminants and nutrients, filtering water, providing habitats and providing vital nutrients to the food web through the deterioration of organic debris. These areas can be very low maintenance once created.

Disadvantages: The large footprint and scale of some of these options means that they may act as a barrier to beach access and coastal views and also require a large amount of land that may currently be used for other purposes.

Groynes and attached breakwaters

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Protect

These structures are built perpendicular to the shoreline out into the sea to catch sediments that are transported along the coast by longshore drift. By trapping sediment, the beach is widened and therefore more wave energy can be dissipated and erosion can be reduced.

Advantages: The calmer areas down-drift from groynes or in the sheltered area of a breakwater may provide areas where ecosystems such as saltmarsh can establish, providing further coastal protection and environmental benefits.

Disadvantages: Structures that impact the longshore drift of a coastal system can have a negative impact on the transportation and sedimentation patterns of down-drift areas, causing erosion in these areas. These hard protection structures may also have adverse visual impacts on the area and impact how the beach can be used.

Detached breakwaters and artificial reefs

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Protect

These structures reduce the wave energy that is reaching the shore through the dissipation, reflection and diffraction of oncoming waves. This creates a low-energy environment close to the shore that encourages the deposition of sediment, and therefore also promotes the build-up of a wider beach.

Advantages: The calmer conditions created on the landward side of breakwaters and artificial reefs can provide areas where ecosystems such as saltmarsh can establish, which provide further coastal protection and environmental benefits. These calmer conditions can also help to increase the design life of other options implemented at the coast or further inland. Artificial reefs specifically have also been seen to create marine habitats and provide recreational amenity to beaches. Artificial reefs can also be easier to implement, less intrusive and less likely to suffer damage when compared to regular breakwaters as they are exposed to a less direct impact.

Disadvantages: Erosion can be made worse in some instances if careful analysis is not carried out. There is limited data on artificial reefs in regard to what the optimum crest height and distance offshore are. Traditional offshore breakwaters may also have adverse visual impacts and impact how the area can be used.

Armouring

Type of option:

- Protect

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Armouring hardens the edge between land and water. This may take the form of seawalls, revetments, gabion baskets, reno mattresses or cobble beach armouring.

Advantages: These options are space conservative and their height may be increased over time as needed.

Disadvantages: Hard protection structures interrupt natural processes such as sediment movements and habitat migrations. These structures can also affect the size of the intertidal area, cause edge effects, overtopping and collapse, and hinder beach access. There is also a potential for water to seep through the structure and collect behind the barrier which then requires management on the 'dry' or landward side.

Stopbanks and bunds

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Protect

These structures protect low-lying areas from inundation by building an elevated barrier. They are usually earthen, covered with vegetation and in the context of coastal hazards are parallel to the shore of low-lying coastlines and rivers.

Advantages: When compared to vertical structures, the edges of stopbanks and bunds result in reduced wave loadings and a reduced risk of scour due to the angle of the seaward slope that directs down-rush away from the base of the structure.

Disadvantages: The low slope results in a large footprint that requires significant space. These options also impact habitat migration, the size of the intertidal area and access to the water. There is a potential for water to seep through the structure and collect behind the barrier which then requires management on the 'dry' or landward side.

Storm surge barriers

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Protect

Storm surge barriers prevent flooding in tidal inlets, rivers or estuaries. They do this by blocking storm surges from travelling inland and therefore keeping upstream water levels low. Barriers may be moveable or fixed.

Advantages: Storm surge barriers can be easily integrated into a larger flood prevention system and decrease reliance on other flood and erosion defences inland of the barrier. Movable barriers that are open under normal conditions allow the continued use of the environment for transport, recreational use and a migration passage for organisms.

Disadvantages: Significant investment is required for the construction and maintenance of these structures. Additionally, investments in flood warning systems must be made to ensure the barrier is closed at appropriate times. Changes in water salinity, temperature, suspended matter and nutrients may occur on the landward side of fixed barriers or in instances where moveable barriers must remain closed for extended amounts of time, which can impact organisms in the area. These structures may also have adverse visual impacts and impact how the area can be used. Both structural and technical failure is also a risk.

Buyouts

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Retreat

The government acquires land in at-risk areas by agreement, to reduce vulnerability to hazards. After land has been acquired, it will usually have structures removed and a deed restriction or conservation easement will be placed on the land to prevent future development. Acquired land can be used to manage coastal hazards by allowing space for erosion and/or inundation, or for the installation of protection measures.

Advantages: Once land has been acquired, it can reduce or avoid future maintenance, service, infrastructure and disaster recovery costs. The space that is created after land is acquired can be used for implementing protection measures or creating a natural buffer zone that can also in turn provide habitats and recreational amenity to the area.

Disadvantages: If not planned adequately, buyouts may have adverse social, cultural and environmental impacts. The initial compensation scheme can be very expensive for governments, especially with the cost of land restoration and long term management also factored in. The message that buy out schemes present are also a challenge; people may view land acquisition as a tool to continue to invest in at-risk coastal land without financial risk.

Land swaps

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

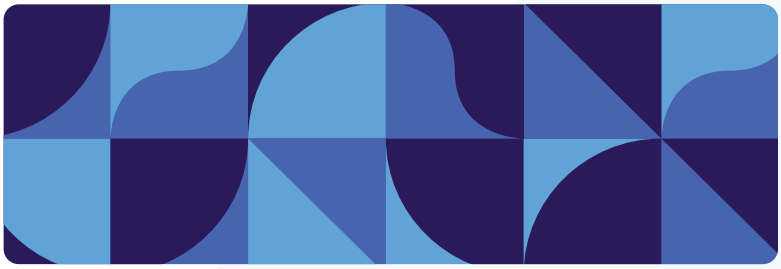
- Retreat

During a land swap, landowners in a hazard zone are given the opportunity to swap their title to land for a comparable sized parcel in a lower risk area. The acquired, at-risk land can be used to manage coastal hazards by allowing space for erosion and/or inundation, or for the installation of protection measures.

Advantages: Once land has been acquired, it can reduce or avoid future maintenance, service, infrastructure and disaster recovery costs. The space that is created after land is acquired can be used for implementing protection measures or creating a natural buffer zone that can also in turn provide habitats and recreational amenity to the area. If the land that is being swapped is already public land, it can help governments to avoid spending money. When compared to other land acquisition tools, land swaps may have a higher participation rate as landowners know where their new land is located at the start of the process. Land swaps also preserve social cohesion when planned so that whole communities are able to move together.

Disadvantages: If not planned adequately, buyouts may have adverse social, cultural and environmental impacts. If the land that is being swapped is already public land, it can be controversial as some people may oppose the idea of privatising public land. Suitable areas for people to move to must be found and available.

Leasebacks



Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Retreat

Leasebacks involve the acquisition of at-risk land with provision for it to be leased back to the former owner or a third party with terms and conditions that facilitate the management of hazards. The former owners or third party, now the lessee, pays rent and uses the land in accordance to the terms of the lease, but no longer owns the land. When a certain point in time or a hazard trigger, as agreed in the terms of the lease, is reached, acquired land can be used to manage coastal hazards by allowing space for erosion and/or inundation, or for the installation of protection measures.

Advantages: Continued use of land is allowed until a certain point in time, or a hazard trigger has been reached. This provides for landowners current needs and facilitates an easier transition to a new location while preserving social cohesion. This option generates revenue for a period of time which can reduce maintenance costs, and once land has been acquired, it can further reduce or avoid future maintenance, service, infrastructure and disaster recovery costs. The space that is created after land is acquired can be used for implementing protection measures or creating a natural buffer zone that can also in turn provide habitats and recreational amenity to the area.

Disadvantages: This option is not viable where risk is imminent and immediate retreat is necessary.

Future interests

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Retreat

The acquisition of a future interest involves the purchase of a right to acquire land in specified circumstances in return for an agreed upfront fee. For example, it may be agreed upon that once a certain height of sea level rise has been reached, the holder of the future interest (usually a government agency) has the right to acquire the land. Acquired land can be used to manage coastal hazards by allowing space for erosion and/or inundation, or for the installation of protection measures.

Advantages: Future interests can offer a more flexible and attractive approach for both governments and landowners than a buyout scheme. They can also increase participation and help minimise some negative consequences of buyouts by allowing owners to stay on the land for longer. Future interests can also enable the phasing of acquisition costs over a longer time period. Once land has been acquired, it can reduce or avoid future maintenance, service, infrastructure and disaster recovery costs. The space that is created after land is acquired can be used for implementing protection measures or creating a natural buffer zone that can also in turn provide habitats and recreational amenity to the area.

Disadvantages: This option is not viable where risk is imminent and immediate retreat is necessary.

Conservation easements

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Retreat
- Avoid

Conservation easements are agreements under which limitations are placed on land use in order to sustain an area's natural function. They can be used to proactively plan for hazards by tailoring agreements to the areas current and future risk, suitability for industry, and values. Rolling easements allow for limited development of upland portions of a land parcel but as the shoreline line recedes, the easement automatically moves or 'rolls' landward and requires the removal of structures once they encroach on the easement area.

Advantages: Landowners can continue to develop and use their land until a hazard threatens this development. This option also helps to preserve shorelines, access to the coast, and native ecosystems. The purchase of an easement can be less costly than the purchase of a whole land parcel.

Disadvantages: This option is not viable where risk is imminent and immediate retreat is necessary.

Transferable development rights

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Retreat

Development rights can be separated from land and transferred to another area. Transferable development rights are a market-based mechanism that can increase development potential in areas where development is desired, and decrease or eliminate the potential in areas that should be preserved. Transferable development rights can be sold to a landowner or developer in a receiving area, or they can be transferred directly if both parcels of land are under common ownership.

Advantages: Once land has been acquired, it can reduce or avoid future maintenance, service, infrastructure and disaster recovery costs. The space that is created after land is acquired can be used for implementing protection measures or creating a natural buffer zone that can also in turn provide habitats and recreational amenity to the area. Social cohesion may be preserved when it is proactively planned that whole communities are able to move together.

Disadvantages: Suitable areas for people to move to must be found and available.

Zoning

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Retreat
- Avoid

Zoning can be used to: allow increased development density in lower risk areas, downzone at-risk areas, create areas where new development is not permitted, change future land use in at-risk areas from low resilience to high resilience, and prohibit hard shoreline protection structures, among other things.

Advantages: Zoning can help to phase out high risk land uses over time while still allowing land owners to continue to use their land for some time. Zoning can also ensure that future land uses are compatible with projected coastal hazard risks and enable the creation of buffer areas.

Disadvantages: Phasing out development through zoning takes time and may not be appropriate in areas at immediate risk.

Trigger-based or time-limited land use consents

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

- Retreat
- Avoid

Trigger-based or time-limited land use consents include conditions linked to hazards such as sea level rise or erosion rates that create a finite term for a particular land use. The land use consents allows development or redevelopment with the expectation that such uses can only continue until specified trigger points are reached or for a specified time period.

Advantages: This option allows landowners to continue to use land until a certain point in time, or a hazard trigger has been reached. Once the certain time frame or trigger has been met, the space can be used for implementing protection measures or creating a natural buffer zone that can also in turn provide habitats and recreational amenity to the area.

Disadvantages: Uncertainties associated with different hazards over time may lead to maladaptation if time-bound conditions are imposed, therefore, event trigger conditions are preferred.

Setback controls

Hazards addressed:

- Coastal erosion
- Coastal flooding
- Rising groundwater

Type of option:

Avoid

New development and land use in high risk areas can be restricted through the imposition of building setback controls. Setbacks are building restrictions that establish a distance from a pre-determined point that factors in future erosion rates where landowners are prohibited from building structures, or they establish a minimum elevation for development that factors in sea level rise, coastal inundation and groundwater levels. Setbacks can be determined as either a fixed setback that prohibits development up to a fixed distance landward of a reference feature, or as a floating setback which can change according to an areas topography or shoreline position.

Advantages: Setbacks are highly effective in minimising building damage due to coastal inundation or erosion, while allowing landowners to continue to develop and use parts of their land. This option also helps to preserve shorelines, access to the coast, and native ecosystems.

Disadvantages: Typically, setbacks only provide a small buffer which may not be appropriate in areas at immediate risk.

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Christchurch City Council