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Coastal Realignment
another coastal challenge

Abstract

While the concept of managed coastal retreat is now familiar to many, the future for rural coastal lowlands has received less attention. Planned processes of coastal realignment can create opportunities, including carbon sequestration, nature-based transformation of coastal interfaces, and evolution of increasingly unproductive farmland towards other beneficial activities. Our present planning system provides high-level policy support for these changes but is mired in detail and short on recognition that the coastal edge will advance inland. While the challenges are being addressed positively in some areas, including by, or in partnership with, iwi/hapū, there is a national lack of leadership in integrated management across the changing land–sea interface, land ownership remains problematic, and funding requirements remain unresolved. New legislation promises improved approaches and is urgently needed.

Keywords coastal planning, managed realignment, sea level rise, wetlands, coastal adaptation

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Most planners in Aotearoa New Zealand will be familiar with the concept of managed coastal retreat. This is the future facing many of our coastal communities because of rising seas due to climate change. However, little emphasis has been placed on the changes which are beginning to be faced in the non-urban parts of our coastal lowlands – our estuaries, foreshores, coastal reserves and wetlands, forests and low-lying farmland. Here, physical changes are starting to occur, with more flooding and salinisation. These changes are encompassed by the term 'coastal realignment'. This term implies allowing space for rising seas, rising groundwater on land, shorelines that are actively moving inland and the adjustments needed in drainage systems near to the coast – to rivers, streams, estuaries, coastal lakes and wetlands.

These are extensive areas. A 2019 Deep South Science Challenge report (Paulik et al., 2019) estimated that just over 4,000 km^2 of production land and 2,100 km^2 of natural or undeveloped land are at risk from coastal flooding in New Zealand. In

contrast, 265 km^2 of urban and transport land are similarly exposed.[1]

The length of our coastline, cost, policy and practicality mean that very few coastal lowland areas will be subject to any form of hard protection from sea walls, bunds or revetments over time. Rather, communities, landowners and government agencies will have to turn their minds to adaptation and adjustment as coastal realignment occurs. This article looks at the basic concepts of coastal realignment, gives some examples of early responses to the changes at the coast, and outlines some planning implications of these changes.

Basic concepts

Sea level rise, and its direct effects such as erosion and flooding in coastal areas, is now recognised globally as an adaptation challenge. Less well recognised is the effect sea level has on groundwater level and salinity close to the coast. Rising seas mean rising groundwater, resulting in changes to drainage patterns in low-lying coastal areas, saltwater intrusion into coastal aquifers, the expansion of estuaries (if not constrained), and more extensive and frequent saltwater flooding of coastal land.[2] This affects coastal and, increasingly, lowland freshwater habitats and the range of species which thrive in them, as well as the commercial productivity of coastal land.

Estuaries, where land drainage systems meet the sea, are particular foci of change. Higher sea levels mean more ponding of fresh water on its way to the sea, and higher tidal wedges extending through estuaries further up rivers, depending on their gradients. Estuaries will expand in response, depending on detailed local topography, presence of flood defences and road causeways, and how sediment supply from land will alter as the climate changes. Estuaries and wetlands are now recognised as among Earth's most dynamic and productive environments, with major roles in the processing of organic matter, including blue carbon (Box 1), nutrient cycling and primary production, which will undergo gradual modification from rising sea levels and climate change.

Coastal squeeze, where there is a man-made barrier such as a revetment or sea wall, and coastal narrowing because of adjacent high coastal topography, prevents or constrains the inland migration of natural coastal systems as sea level rises. This results in the loss or drowning of intertidal habitat, loss of buffering against erosion, inundation of marshes and wetlands, and loss or reduction of other ecosystem services these areas provide. Similar coastal squeeze arises where the lower reaches of rivers and parts of estuaries have been modified and constrained by stopbanks and other structures, which will eventually compromise flood and drainage schemes. Figure 1 shows coastal habitat responses to a rise in relative sea level.[7]

To prepare for these changes in coastal and freshwater lowlands, communities, planners and decision makers need to

BOX 1 Blue carbon sequestration: opportunity to incentivise managed realignment

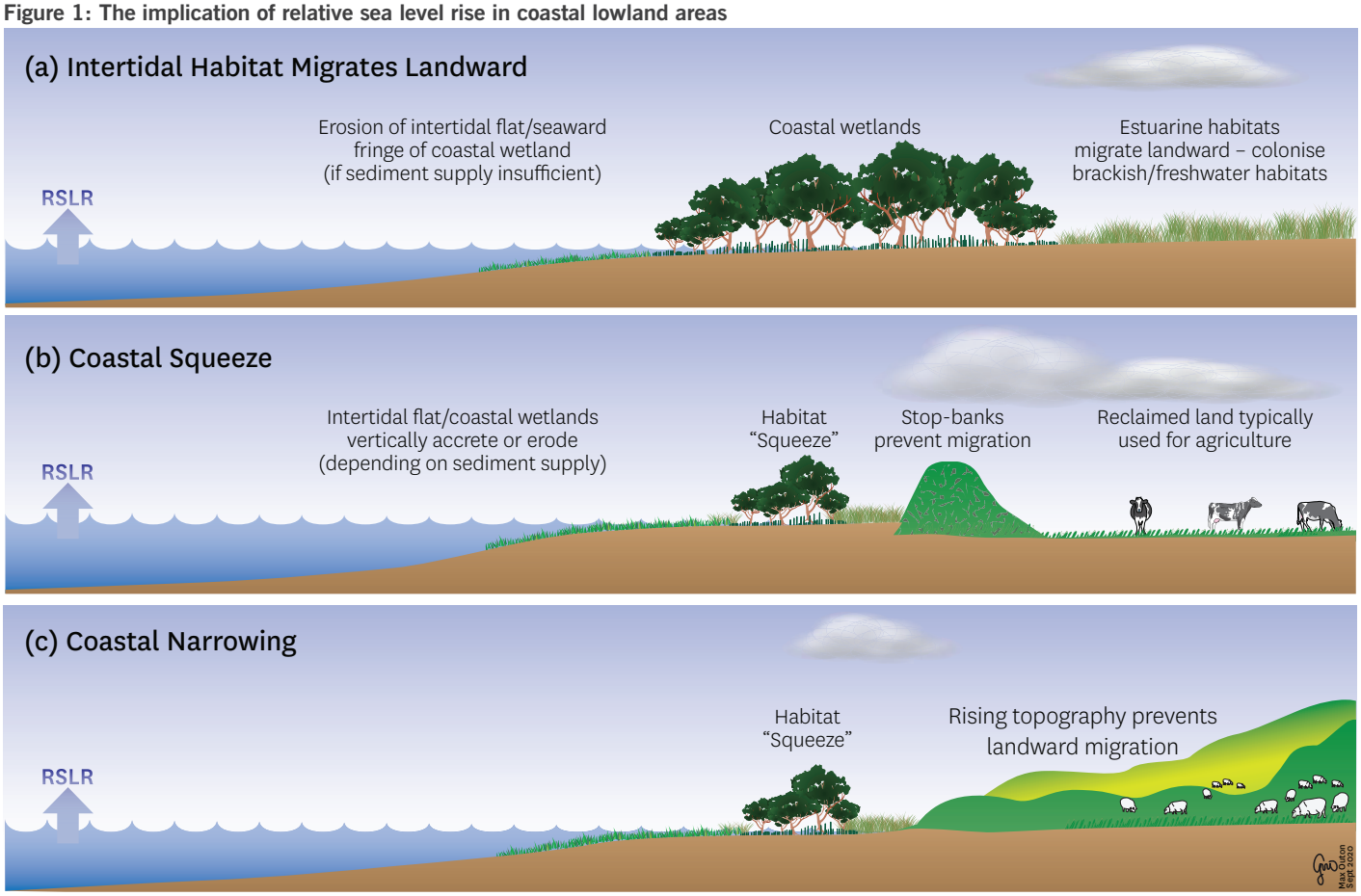
Coastal wetlands, marshes and intertidal estuarine habitats contain large amounts of water and act as significant 'blue carbon'[3] sinks through plant photosynthesis and sedimentation (Lovelock and Reef, 2020; Swales, Bell and Lohrer, 2020). Coastal saltmarshes and wetlands are among the most productive ecosystems in the world, sequestering and storing substantial carbon in their soils, where it may remain for millennia if undisturbed: they have rates of carbon sequestration in their sediments per area of habitat that are up to ten times that of terrestrial ecosystems. Accounting for blue carbon provides opportunities for both mitigation of climate change and climate adaptation, while increasing biodiversity and ecosystem services for coastal areas, including flood protection and improved water quality. Conversely, coastal wetlands and marshes that were historically drained to provide land for agriculture or housing have become long-term sources of carbon dioxide emissions, so avoiding any further loss of these ecosystems would avoid further emissions (Climate Change Commission, 2021).

At this stage, Aotearoa New Zealand only recognises the potential contribution of coastal wetlands, marshes and estuaries in our nationally determined contribution (under the Paris Agreement)[4] and the government's first emissions reduction plan (Ministry for the Environment, 2022b).[5] Blue carbon contributions have not been sufficiently investigated to be included in the national inventory at this stage. However, research is underway: for example, NIWA's Future Coasts Aotearoa science challenge, Tasman Environmental Trust's Blue Carbon Core and Restore project, and GNS-led research on the blue carbon potential of coastal saltmarshes,[6] while the Department of Conservation in the biodiversity strategy (under objective 13) has set a goal that by 2030 'carbon storage from the restoration of indigenous ecosystems, including wetlands, forests, and coastal and marine ecosystems (blue carbon), contribute to our net emissions targets' (Department of Conservation, 2020).

Australia is further ahead, with a blue carbon method introduced in January 2022 for restoration of coastal marshes and wetlands, which includes lowland freshwater habitats likely to be affected by sea level rise in the next 100 years. The new method (Australian Government Clean Energy Regulator, 2022) covers projects that introduce tidal flows to allow the establishment of coastal wetland ecosystems, including supratidal forests, mangroves, saltmarshes and seagrass, through the removal or modification of a tidal restriction mechanism. The sequestration of carbon and avoidance of emissions earns Australian carbon credit units.

Coastal lowland ecosystems are vulnerable to climate change themselves, leading to uncertainties in the future efficacy of these ecosystems, especially if squeezed against land barriers by rising sea level. Blue carbon sequestration in estuarine and wetland ecosystems is enhanced if landward migration of these habitats is purposefully enabled as sea level rises. Managed coastal realignment provides opportunities for both mitigation of climate change (through increasing blue carbon storage) and adaptation of squeezed coastal lowland hydrosystems and adjoining land, enhancing ecosystem services and reversing declining wetland biodiversity.

Figure 1: The implication of relative sea level rise in coastal lowland areas



Source: Swales et al., 2020 Graphics: Max Oulton

understand the local impacts of climate change, and what responses may be possible (see Ministry for the Environment, 2017). A broad understanding of the processes needs to be accompanied by a more detailed understanding of the characteristics of the local area, including how it might have been modified since human occupation. A range of future response options, including allowing space for estuaries and wetlands to change over time, and accompanying land use adjustments, can then be assessed against a range of future climate and relative sea level rise scenarios as part of developing an adaptive strategy. Long-term monitoring of actual changes is essential to signal the emergence of flooding and salinisation thresholds, to assist decision makers to respond with sufficient lead time.

In general terms, decisions that involve nature-based solutions (Box 2), that seek to capitalise on unavoidable trends and achieve environmental, social and cultural benefits, are to be preferred over options that are expensive to communities, that require maintenance and eventually will fail to provide benefits as sea rise continues. Similarly, pastoral production can be expected to have to withdraw from extensive lowland areas as part of coastal realignment as areas become increasingly marshy and salty. There is still uncertainty about the ability of existing terrestrial systems to transition to intertidal geomorphological and ecological (wetland/marsh) systems, and how long this might take (Rullens et al., 2022). For future generations, it is important that our planning systems start to help facilitate these transitions now and do not impede them.

Examples of coastal realignment

There are already examples of areas in New Zealand where decisions have resulted in steps towards effecting coastal realignment. These have not necessarily been driven by climate change concerns, but rather by a desire to restore natural systems, often iwi- or hapū-led.

The Kaituna River rediversion and Ōngātoro/ Maketū Estuary enhancement project

This project aimed to address the ongoing and cumulative adverse effects which resulted from works originally undertaken in 1956 to provide for direct discharge from the Kaituna River to the sea through the Te Tumu Cut. These works meant that the river was largely disconnected from its estuary. Later works involved stopbanks, reclamation and land drainage, with the effects on the estuary being compounded by agricultural runoff. The project involved re-establishing the river's connection to and through the estuary, removing stopbanks, creating new wetland areas and enhancing existing ones. The project was an important component of a 2009 community-based strategy which aimed to achieve multiple benefits for the area, including healthy functioning ecosystems, restoring the mauri of the river and the estuary, replenishing natural sources of food and fibre, and enabling kaitiakitanga and local people's stewardship.[9] The project involved the designation of 46 ha of mostly private land and multiple resource consents. Among the purposes of the designation was to 'improve the resilience of the estuary and its various ecosystems to the effects of projected climate change'. Twenty hectares of former wetland were reinstated and restored. Project construction was completed in

2020, and monitoring is showing that the physical and ecological health of the estuary is improving, and restored habitats are thriving.

Coastal land between the Ōhau River and the Waikawa River, Horowhenua

This area is being managed as part of a long-term, Māori-led, evidence-based and action-orientated research project. Since 2002, local hapū, alongside the Kei Uta Collective, have been investigating and documenting options to adapt to the changing climate and rising seas along approximately 5 km of coast. The project encompasses two Māori farming incorporations and whānau coastal blocks. Initially, hapū-led teams worked on revegetating a coastal wetland forest, while also seeking to improve water quality in the lower reaches of the rivers. More recently, climate change risks and response options have been identified. This is now leading to work on diversification of farming economies and operations, focusing on more water-based land uses (paludiculture) and enhancement of habitats for taonga species, such as tuna and īnanga. This will involve gradual transition from dairying to recreated constructed wetland habitats, beginning in 2023. Key elements have involved consultation with and the agreement of shareholders and the farm board, obtaining science input to understand and model future changes, and the design of ponds and wetlands. Initially the transformation will be pioneered on the most unproductive farmland. The wetland systems and pond areas have been designed to be resilient and protected from river flooding during the critical spawning period of March to the end of May.

The project is long-term and open-ended. It is based on Māori systems, values and cultural precepts as a demonstration of how local indigenous knowledge can effectively underpin responses to the impacts of changing climate in coastal areas. Overall, the project is intended to contribute to cultural and economic well-being within an adaptive context (Smith et al., 2022).

International experience

Internationally, particularly in the United Kingdom and some European Union countries, small-scale coastal realignment projects have been undertaken to enable landward extension of estuaries and wetland extension further inland (often abandoning coastal defences or causeways). One example is the River Otter Estuary in Devon, where 200-year-old sea defences are now starting to fail and becoming increasingly hard to maintain. The Lower Otter Restoration Project is working with local people and partner organisations to adapt and enhance the downstream part of the River Otter, its estuary and its immediate surroundings for future generations in the face of a rapidly changing climate.[10]

A similar situation has been evolving at Abbotts Hall, Essex, where almost 300ha of high-grade agricultural land was protected by a 3.5 km sea wall. The topography of the area was considered optimal for salt marsh creation. Community concerns were overcome through numerical modelling of proposed sea wall breaches, development of feeder creeks, inland relocation of sea defences and creation of spur walls. The availability of national funding mechanisms and the involvement of the Essex Wildlife Trust were vital to the project's success.

Another significant realignment project has been taking place on the south bank of the Humber Estuary in Lincolnshire. Here, more than 90,000 ha of land are already below the current level of the highest tides, and relative sea level rise of 1.2 m by 2100 is expected. The rise in sea level would place major industries, power stations, the country's largest shipping complex, extensive farmland and the homes of 400,000 people at risk. The realignment project at Alkborough Flats aims to create a large capacity for water storage through managed coastal breaches and the creation of new habitat. The scheme increases the level of protection by reducing the high tide levels in the upper estuary. It is regarded as a cost-effective project with numerous community and ecological benefits (NCCARF, 2017).

BOX 2: Nature-based solutions: what are they?

Like other countries, Aotearoa New Zealand has traditionally relied on hard engineering solutions, such as sea walls and stopbanks, to protect land against floodwater intrusion from rivers and the coast. Lately, there has been a growing interest in responses to coastal change that involve working with nature.

Applying a nature-based solutions approach to address the impacts of climate change is not a new concept. However, the term 'nature-based solutions' is relatively new and can cover a variety of concepts, such as ecosystem-based adaptation, ecosystem-based climate adaptation/mitigation, hazard risk reduction, ecological engineering, and green/blue infrastructure (Nesshover et al., 2017; Schaubroeck, 2017; Seddon et al., 2020). The Department of Conservation defines nature-based solutions as solutions 'that are inspired and supported by nature, cost-effective, and simultaneously provide environmental, social and economic benefits and help build resilience' (Department of Conservation, 2020, p.62).

When nature-based solutions work well, ecosystems thrive and negative impacts of hard engineering options, such as coastal squeeze and increased surface runoff, are avoided. For example, when mangroves are established along shorelines to reduce the impacts of waves and storms, biodiversity can be restored. This can enhance a community's climate resilience, as other ecosystem services benefits improve, such as mahinga kai, fisheries, carbon sequestration, recreational and paludiculture opportunities.

In general, nature-based solutions aim to address societal challenges effectively and adaptively, while striving to improve both human well-being and biodiversity. Effective nature-based solutions are inclusive, transparent and empower communities. This means that nature-based solutions should incorporate multi-stakeholders' participation and weave in different types of mātauranga and te ao Māori perspectives so that solutions address local needs and improve a community's resilience in a changing climate.

Does the current resource management system help or hinder coastal realignment?

The answer to this question is complex. Starting from the highest policy level, the system appears to have all the elements to identify and respond to the changes we are facing. The Resource Management Act 1991 (RMA) itself has among its purposes 'sustaining the potential of natural and physical resources … to meet the reasonably foreseeable needs of future generations' as part of managing their use, development and protection (s5(2)(a)). The 'coastal environment' is a recognised concept which includes both the coastal marine area and adjacent land where coastal processes or influences are significant (including climate change effects) (Department of Conservation, 2010, policy 1). Its natural character must be preserved and wetlands and rivers and their margins (including those in the lower reaches within the coastal environment, estuaries and other land/sea interfaces) must be protected from inappropriate subdivision, use and development (RMA s6(a)). These are dynamic concepts, and the planning challenge is to foresee change and ensure that what we plan for and do now does not become a limitation and burden on future communities.

As national direction, the *New Zealand Coastal Policy Statement 2010* (Department of Conservation, 2010) requires integrated management across mean high water springs, with particular consideration of situations where development or land management practices may be affected by physical changes or potential inundation, including as a result of climate change (policy 4). Areas potentially at risk of coastal hazards over at least the next 100 years must be identified and their risks assessed (policy 24). In addition, natural defences that protect coastal land uses are to be protected, restored and enhanced (policy 26). A precautionary approach to the use and management of coastal resources is needed in areas vulnerable to the effects of climate change so that natural adjustments of processes, natural defences, ecosystems, habitats and species can occur (policy 3). Regional policy statements and regional and district plans are required to give effect to these policies.

> While the national environmental standards for freshwater appear likely to deliver improvements to many parts of hydrological and associated ecological systems through integrated management, estuaries and coastal wetlands are not well served by the national policy statement …

Many local authorities have not made the changes needed to reflect these policies, even though they were required to do so 'as soon as practicable' after 2010.[11] It is, however, debatable whether plan reviews or changes would have made much difference to rural coastal realignment practices, as the major focus of coastal planning since the *New Zealand Coastal Policy Statement* was published has been on coastal urban areas and settlements and the management of hazards and risk in that context. Where consents are required to achieve realignment projects, unless the activity is permitted, controlled or restricted discretionary, in the absence of relevant policy in regional policy statements and regional or district plans, the national policy statement must be referred to when making decisions.

Nevertheless, coastal realignment projects must face a plethora of consent requirements. Despite what would seem to be favourable national policy, the detail of the RMA includes consent requirements for almost all the steps that may be needed to facilitate coastal adjustment to sea level and ground water changes. Seemingly simple aspects, such as removing or enlarging culverts, reinstating drained land to wetlands, removing stopbanks and structures, creating ponds and drainage areas, and realigning watercourses or artificial drains, all involve complex disturbance, discharge and modification consent requirements relating to land, water, river or stream bed or the coastal marine area. Straight rural land use changes, such as a change from intensive dairying to extensive grazing, do not require consents. With the transitory line of mean high water springs forming a planning demarcation between the responsibilities of regional and territorial authorities, there is often added complexity in interpretation of rules and management through conditions across the line.[12] The demarcation of mean high water springs in estuaries[13] is often not entirely in line with natural processes, and, as a management tool, may date over time with sedimentation, sea level rise, salinisation and groundwater rise.

Designations, which have proved a useful tool[14] in projects such as the Kaituna River rediversion, cannot be applied in the coastal marine area.

The *National Policy Statement for Freshwater Management 2020* (Ministry for the Environment, 2020) and the national environmental standards for freshwater involve catchment-based planning for freshwater and acknowledge the coastal marine area, including estuaries, as part of the receiving environment of freshwater management units. The purpose of the *National Policy Statement for Freshwater Management* is to drive improvements in river water quality over time, through setting target attribute states and time frames to achieve them. The net loss of natural inland wetlands[15] must be avoided, and an effects management hierarchy is applied to their management. There are, however, exceptions for natural hazard works and for flood control, flood protection and land drainage works. While the national environmental standards for

freshwater appear likely to deliver improvements to many parts of hydrological and associated ecological systems through integrated management, estuaries and coastal wetlands are not well served by the national policy statement, and consideration of climate change effects in the lower reaches of catchments through sea level and groundwater rise over time appears to be absent. In late 2021, the national environmental standards were found to apply to coastal wetlands within the coastal marine area.[16] Following consultation, the minister for the environment has now modified the standards so that they apply to inland natural wetlands only.[17] This highlights the lack of consideration of the coastal interface (both current and with sea level rise) in detailed policy and the national requirements for wetlands inland of the coastal margin, including in rural areas where the inland migration of such systems could be facilitated by more enabling provisions.

When detailed analysis is undertaken, such as the investigation of the planning context of Brooklands Lagoon at the mouth of the Waimakariri River near Christchurch/Ōtautahi (Urlich and Hodder-Swain, 2022), a planning and management system of great complexity, but also with problematic gaps, emerges. The study concludes that 'the issue is perhaps not more science, additional policy, or more lengthy collaborative processes, but the effective implementation and monitoring of existing policy, and convincing those who are contributing to cumulative effects that change is necessary'. While that study focused on estuaries and the need to enable their future expansion and migration, the same can be said of coastal wetlands and tidal flats, beaches and the lower reaches of rivers in many parts of the country.

The RMA can be said to provide policy which should assist with coastal realignment, even though the emphasis is on a natural hazard and risk management approach. However, it is unlikely that at the local level, detailed policy and plan provisions will provide easy routes through the organisational, integration and consenting regimes necessary to achieve on-the-ground transition to coastal systems that are more natural and able to adapt to the changes ahead. The RMA, however, has not prevented planning, often through non-statutory means, and consenting to achieve the first steps in a coastal realignment response to rising seas in the examples outlined above, and others in the Bay of Plenty (Crawshaw et al., 2022).

BOX 3: Who should pay?

Some work has been done in Aotearoa New Zealand to explore funding strategies for climate change adaptation (Boston and Lawrence, 2018; Boston, 2019). This has focused on issues of relocating people and built environments, including infrastructure, and has proposed a range of mechanisms, including national pre-funding to compensate (in full or in part) for the inevitable change and to help prepare communities. By contrast, coastal realignment, without the pressure of large affected human populations, may be able to draw on a wider range of funding sources. To date, local authorities have identified benefits from public works based on nature-based solutions (Box 2) for coastal resilience and have drawn on their rating bases to purchase necessary land. They have chosen to fund planting and coast care programmes, undertaken alongside communities who also see ecological benefits from the work they do. Landowners may act altruistically and gift land for coastal realignment, also recognising wider public benefits.[20] If the role of wetlands and other coastal carbon sinks (Box 1) is recognised, this may also provide incentives and sources of income. Some seed funding provided by central government to change to new productive systems, such as paludiculture, and other adjustment strategies, including biodiversity enhancements, may also be necessary. While these options might be a small component of the larger climate adaptation challenges and costs facing the nation, they should not be lost sight of within that broader context.

Land ownership

One of the most problematic aspects to be addressed in coastal realignment is the matter of land ownership. Many, but not all, of our coasts are fringed by esplanade reserves (the Queen's chain) or road reserve. Beyond this is land held privately or communally, under a range of ownership types, or by public bodies. The Marine and Coastal Area (Takutai Moana) Act 2011 made provision for the title of all land which was within the coastal marine area to be part of the common marine and coastal area.[18] Specific provision is made for loss of land which is road or owned by the Crown or a local authority. Freehold land which becomes part of the coastal marine area due to 'a natural occurrence or process', however, unless purchased[19] by the Crown or a local authority appears to retain its title as freehold land. The planning framework nevertheless sees land which is overtaken by sea level rise as within the coastal marine area and subject to the limitations of the RMA. This situation is likely to lead to pressure for coastal protection (and hence coastal squeeze), or purchase by a public agency, a situation which is generally at present not funded.

Low-lying land landward of mean high water springs which is being affected by rising seas can be expected to lose productive value. In the transfer to a more sustainable use, whether to lower intensity farming, paludiculture, or to wetlands or other more sustainable purposes, including natural coastal defence purposes (which arguably have a wider public benefit) and the opportunity to increase blue carbon sequestration, owners may expect some form of financial compensation. This issue has not yet been resolved, but is increasingly raised in relation to policies for coastal managed retreat and the relocation of at-risk communities (Box 3).

What changes are ahead?

The current review of resource management legislation is expected to bring a 'sea change' over the next decade in how many current environmental challenges are addressed. The new legislation rests on an ethos of environmental responsibility and recognition of the concept of 'te oranga o te taiao' – supporting the health and ability of the natural environment to sustain life, recognising the interconnectedness of all

parts of the environment and the intrinsic relationships between indigenous people (iwi and hapū) and the natural world, and environmental management through good practice and restoration where the environment is currently degraded.

The three proposed new legislative instruments – the Spatial Planning Act, the Natural and Built Environment Act and the Climate Adaptation Act – together should enable a more purposeful approach to planning for changes in coastal lowlands, including risk management for coastal communities and enabling adaptive changes and coastal realignment in the nation's more rural areas. The national planning framework within the Natural and Built Environment Act is likely to contain national direction, including policy to manage climate (and other natural hazard) risks and coastal change. Regional spatial strategies should identify areas of greatest community risk and areas where resilience-based adaptive change is needed. They should develop policy targeted at such areas and ensure that these do not become more developed. They need to consider future infrastructure needs and relocation of existing infrastructure where necessary, which could pave the way for coastal realignment projects. They should provide a positive regional framework to support change that provides for resilience in coastal areas and enables natural defences against sea level rise through coastal realignment. Under the Natural and Built Environment Act, plans must be consistent with national direction and regional spatial strategies, and also with the emissions reduction plan and the national adaptation plan.[21] Expectations for the Climate Adaptation Act are that this legislation will address the complex issues of funding, property ownership and compensation.

National responsibility for policy towards the coastal environment is expected to shift from the minister of conservation to the minister for the environment, with the minister of conservation retaining responsibility in the coastal marine area only. A consultative arrangement will remain across the land–sea interface between the two ministers.

Those who work and plan in the coastal edge, from local authorities to landowners to New Zealand's many coast care groups, will be looking for stronger, more integrated and more enabling policy for managing change at coastal margins. This should be directed at avoiding coastal squeeze wherever possible, and should recognise the co-benefits of coastal ecosystems in providing ecosystem services, providing habitat, sequestering carbon, providing nature-based coastal defences and flood detention, and underpinning many of the resources on which people and communities rely. There is no shortage of knowledge now; the challenge is to get moving and act on coastal realignment and achieve the benefits and opportunities which lie there.

1 This is conservatively estimated, taking into account up to 3m of sea level rise to allow for inaccuracies in topographical information from satellites. However, it does not include the more recent information on vertical land movement, which indicates relatively higher levels of inundation around many parts of New Zealand's coasts: see www.nzsearise.nz
2 New Zealand has a wide range of types of coasts, and coastal hydrosystems, each affected by tidal range, wave energy and climate: see Hume et al., 2016.
3 Blue carbon is carbon dioxide removed from the atmosphere by ocean and coastal ecosystems (including mangrove and other coastal forests, wetlands and marshes).
4 New Zealand's first nationally determined contribution was updated on 31 October 2021: https://unfccc.int/NDCREG.
5 https://environment.govt.nz/publications/aotearoa-new-zealands-first-emissions-reduction-plan/
6 https://niwa.co.nz/natural-hazards/research-projects/future-coasts-aotearoa; https://www.tet.org.nz/projects/blue-carbon-core-and-restore/; https://www.gns.cri.nz/research-projects/blue-carbon-potential-of-new-zealand-coastal-saltmarshes/.
7 Relative sea level includes sea level rise and any vertical land movement component.
8 Wet horticulture – e.g., harakeke (flax).
9 The Kaituna River and Ōngātoro/Maketū Estuary strategy, adopted by the Bay of Plenty Regional Council, was developed to 'provide a framework for local authorities, government agencies, tangata whenua, local communities, industry organisations, and non-governmental organisations to co-ordinate and prioritise their actions that will achieve the vision and outcomes of the Strategy'.
10 https://www.lowerotterrestorationproject.co.uk
11 Over half of the regional and unitary councils have still not changed their regional policy statements or regional plans to reflect the *New Zealand Coastal Policy Statement* requirements (Department of Conservation, 2017; Urlich, White and Rennie, 2022). District councils' practice varies considerably.
12 For example, structures such as fences and low retaining walls, which are permitted on the land side of mean high water springs, may be built to function as future sea walls, in opposition to policy and rules which would make such structures impossible to consent within the coastal marine area. With sea level rise, these can cause coastal squeeze, or become stranded assets with unclear responsibilities for their removal.
13 Defined in the RMA as either a kilometre upstream from the river mouth, or a distance upstream five times the width of the mouth and mapped in regional coastal plans.
14 Through integrating project purposes and addressing land use consent requirements.
15 Excluding artificial wetlands (unless constructed as part of an offset or a restoration of a pre-existing wetland), a geothermal wetland, or a wetland in the coastal marine area.
16 *Minister of Conservation v Mangawhai Harbour Restoration Society Incorporated* [2021] NZHC 3113; see also Ministry for the Environment, 2022a.
17 Changes to the definition of 'natural inland wetland' in the National Policy Statement for Freshwater Management, and to a range of provisions in the national environmental standards for freshwater, took effect on 5 January 2023.
18 Common law relating to accretions and erosion was, however, not affected.
19 Section 17: 'whether by purchase, gift, exchange, or by operation of law'. A 'knock-on' provision in section 25 provides that where a council has purchased parts of titles below mean high water springs which are then divested of title, it can seek financial redress from the minister of conservation on the same basis as it originally acquired the land.
20 The QEII National Trust provides a model for this type of landowner contribution towards intangible, but very valuable, national benefits.
21 Recently implemented provisions of the RMA (under the RMA Amendment Act 2020, ss17–18, 21) add the emissions reduction plan and the national adaptation plan to matters which local government must 'have regard to' in developing policies and plans.

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