

# Planning for change – managing coastal realignment in pastoral landscapes in the face of sea-level rise-induced rises in groundwater and flood risk

## Context

Climate change is globally recognised to exacerbate land degradation, especially in low-lying coastal areas. Aotearoa New Zealand's coastal lowland areas contain nationally significant habitats, recreational and sociocultural assets and features, but are also economically productive. Climate change can thus be expected to have significant social and economic impacts in these areas.

## Objectives

The Earth Sciences New Zealand-led Future Coasts Aotearoa research programme<sup>6</sup> aims to identify sustainable adaptive planning and decision-making frameworks for coastal lowlands. We explore the combined impacts of sudden onset (periodic flooding) hazards and slow onset (rising groundwater) hazards on lowland farming to consider the implications for adaptation.

## Methodology

To develop a high-level conceptual framework to explore the implications of adaption on lowland coastal farming, we:

1. Create a stylised lowland dairy farm as a case study. Our stylised farm operates within a managed drainage area and faces climate change-driven increases in flooding frequency and rising groundwater.
2. Consider the impact on average farm productivity of reoccurring floods and progressively shallower groundwater that waterlogs pasture.
3. Explore the generalised economic consequences of a range of 'what-if' responses to address these threats, and
4. Consider the implications for adaptation and policy.

## Examples of response: what if we ...

### Absorb the risks?<sup>7</sup>

Work to enhance the **absorptive capacity** of our farm to manage negative events. Actions under this approach aim to cope with the worst effects of climate change through short-term fixes such as 'wintering-off' livestock.

### Adapt?<sup>7</sup>

Enhance the **adaptive capacity** of systems to moderate harm and or benefit from opportunities, in order to continue functioning without major qualitative changes. Actions under this approach include upgrading flood management and drainage systems or changing to water tolerant grasses.

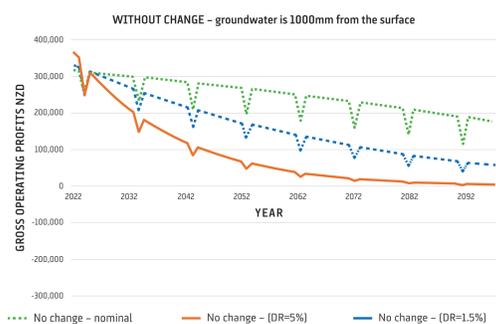
### Transform?<sup>7</sup>

Fundamentally change our approach (**transformational capacity**) through long-term structural or systematic change, such as developing new production systems. This includes options such as converting farmland to wetlands, or leasing out land for other uses, such as solar power generation.

## Results

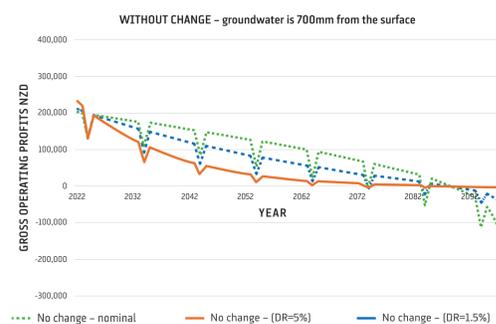
### Doing nothing – what's the problem?

Not adapting to climate change results in a steady decline in farm profits over time as increased flood risk and rising groundwater hamper operations. Higher discount rates (DR) or shallow groundwater mean that doing nothing becomes costlier faster.



With deeper groundwater, the effect of increasingly intense sudden-onset flooding events predominates, causing gradual reductions in farm profitability – regular floods create a 'ratchet' effect in downturns and partial recovery.

If catastrophic flooding were to occur in successive years rather than evenly spread through time, then the effects on farm profitability may be amplified.



With shallower groundwater, slow onset waterlogging compounds the cost of flooding. The effects of flooding become less pronounced and groundwater has an increasingly powerful influence on farm profitability.

## Significance of the work for policy and practice

### Our framework highlights:

- That without change, farming can expect a steady decline in farm profits over time due to increased flood risk which is significantly exacerbated when combined with rising groundwater.
- Conventional approaches like engineered flood management and pumping become more costly over time and merely delay an inevitable more rapid decline in financial viability when they eventually fail.
- Transformative options like converting land to wetlands are potentially valuable. However, the benefits accrue to wider society, not to farmers who foot the bill – policy change is needed if the wider benefits of wetland ecosystem services are to be realised.
- Timing matters. Developers can only be expected to purchase land that is not highly at risk. Land with high flood risk or shallow groundwater are not good for farming, but they are also unlikely to appeal to developers.

### Taking action

Transformative responses, particularly conversion to wetland, generally perform better by 2100. The value of time – measured by discounting – has dramatic effects on the scale of values. With private discount rates of 5%, the flow of economic benefits of transformation appear modest. However, with social discount rates, the flow of economic benefits appears substantial.

#### Gross benefits over time NZD\$ millions: groundwater is 700mm from the surface and the discount is 5%

Strategy	Response	After 25 years	After 50 years	After 75 years
None	No change	2.50	2.95	2.95
Absorb	Wintering-off	1.52	1.68	1.60
Adapt	Council drainage and increasing greater pumping	2.24	2.59	2.55
Adapt	Planting water tolerant grass today	2.38	2.80	2.80
Transform	60% of land progressively converted to salt marsh	1.30	2.10	2.38
Transform	60% of land progressively converted to mangroves	- 1.09	13.92	36.23
Transform	Water tolerant grass and 60% progressive to mangroves	- 1.23	13.76	36.07
Transform	15% of land sold to developers	17.46	22.36	23.73
Transform	60% of land progressively passed over to PV power lease	3.70	4.96	5.41

*When groundwater is already shallow and climate change drives it up further while intensifying flooding, higher discount rates contain the benefits of responding.*

#### Gross benefits over time NZD\$ millions: groundwater is 700mm from the surface and discount rate is 1.5%

Strategy	Response	After 25 years	After 50 years	After 75 years
None	No change	3.46	4.86	4.76
Absorb	Wintering-off	2.07	2.52	1.73
Adapt	Council drainage and increasing greater pumping	3.10	4.19	3.76
Adapt	Planting water tolerant grass today	3.29	4.61	4.51
Transform	60% of land progressively converted to salt marsh	2.10	4.68	6.88
Transform	60% of land progressively converted to mangroves	- 0.33	57.56	247.41
Transform	Water tolerant grass and 60% progressive to mangroves	- 0.53	57.31	247.16
Transform	15% of land sold to developers	24.73	40.93	51.53
Transform	60% of land progressively passed over to PV power lease	5.26	9.50	13.06

*When groundwater is already shallow and climate change drives it up further up while intensifying flooding, lower discount rates can have significant impacts on the scale of response benefits.*

## What next?

Check out the collaborative work by Earth Sciences New Zealand, Kōmanawa Solutions Ltd and the University of Canterbury on groundwater change in New Zealand at [www.niwa.co.nz/future-coasts](http://www.niwa.co.nz/future-coasts).

### References

<sup>6</sup>NIWA (2025) Future Coasts Aotearoa: Transforming coastal lowland systems threatened by sea-level rise into prosperous communities. Available online at: [www.niwa.co.nz/future-coasts](http://www.niwa.co.nz/future-coasts)

<sup>7</sup>FAO (2018) The future of food and agriculture – Alternative pathways to 2050.

Food and Agriculture Organization of the United Nations. Rome. Available online at: <https://openknowledge.fao.org/server/api/core/bitstreams/e51e0cf0-4ece-428c-8227-f6c51b06b16/content>. Accessed 22 April 2025.