Adaptation options for coastal environments: ecosystem management

A typical adaptation plan for coastal areas needs to consider a range of different adaptation options and select one or more that best suits the identified risks, the resources available, and the values that are important to stakeholder groups.

In this section, we explore **adaptation options within ecosystem management**. Broadly, for habitats and species, there are four adaptation response categories to climate change and increased risk of inundation and erosion in the coastal zone:

- habitat restoration and enhancement
- engineering or removal of existing infrastructure
- reduction of other stressors
- species-specific interventions.

Within each of these response categories there are a number of potential adaptation options by which each can be operationalised. The table below lists adaptation options in each category. The table is arranged as follows:

- Column 1: Examples of options, classified by type
- Column 2: Climate stressors addressed by each option
- Column 3: Examples of environmental benefits from each option (including direct and indirect benefits)
- Column 4: Examples of environmental risks associated with each option (including the potential for maladaptation).

Three other documents in this series provide information on adaptation options in:

- *Adaptation options: Planning*
- *Adaptation options: Engineering*
- *Adaptation options: Social, community and education measures*.

The purpose is to provide users with quick and high-level information on available adaptation options. The information should not be considered to be exhaustive.

Selected options should match the broader goals of the organisation and its stakeholders. It is important to consider any opportunities that might derive from the selected options and any co-benefits that can be achieved. Environmental outcomes should be explored and taken into account, with options that deliver poor outcomes either discarded or given a low priority.

The infographics *Why should we adapt to sea-level rise?* and *How can we adapt to sea-level rise?* also contain useful information. C-CADS has guidance on developing a suite of adaptation options and how to sequence their implementation (*C-CADS Step 3 Identify options*). Once options have been identified, they should be assessed and those most appropriate for the chosen level of acceptable risk identified (*C-CADS Step 4 Assess options*). Once options are prioritised, more detailed consideration, planning and design of each option may be required.

Additional information on environmental adaptation options is provided in the *Information Manual 10: Ecosystems*.

Table 1: Examples of adaptation options in ecosystem management, arranged according to the four categories identified above, and together with the climate stressor being addressed and the environmental benefits and risks associated with each option.

Adaptation options:	Climate stressors being addressed:	Environmental benefits:	Environmental risks:
A. Habitat restoration or enhancement			
Revegetation of coastal dunes	Sea-level rise, storm surge and associated erosion	• Increased stability of dunes • Habitat for fauna and flora • Shade for beach users • Wildlife corridors	• Bushfire risk (minor)
Rehabilitate degraded ecosystems	All	• Increased habitat • Increased biodiversity • Potential for carbon sequestration	• These measure are limited in their adaptation benefits
Build structures to support continued growth of habitats at risk, e.g. providing raised areas to ensure seagrasses are able to grow on substrate where there is sufficient light availability	Sea-level rise	Maintain habitat for larval and juvenile fish and invertebrates	• Will help to ensure growth of seagrass as higher sea levels reduce potential for light penetration, but does not negate the influence of warmer waters and higher pH
Assist habitats such as salt marsh to accrete thereby maintaining optimal growth e.g. by spraying a light cover of dredged material over salt marsh	Sea-level rise	• Habitat maintenance • Bird and fish feeding sites maintained	• Might lead to short term impact by smothering habitat • Dredged habitat may contain nutrients and heavy metals, or potential acid sulphate soils which could become oxidised once on the surface
Provide structures that enhance growth of reef-building organisms such as mussels and oysters	Sea-level rise, storm surge	• Can help to break up wave energy • Filter feeders can help reduce microalgae concentrations	• Filter feeders can bio-accumulate toxins • Increased reefs may promote recreational harvesting which could require management/restrictions
Plant riparian vegetation along estuary foreshores	Episodic extreme rainfall events	• Bank stability, reduction in erosion • Wildlife corridors • Shading of water (cooling) • Bird and animal habitat	• Loss of views for local residents

Adaptation options:	Climate stressors being addressed:	Environmental benefits:	Environmental risks:
B. Engineering hard structures or removal of existing infrastructure			
Develop artificial reefs to reduce wave erosion of shorelines. • Protect saltmarshes and wetlands from wave erosion by installing artificial breakwaters (railway sleepers, rock sills) that reduce wave energy	Storm surge, sea-level rise	• Provides habitat and increases colonisation potential	• Could provide habitat for introduced species
Engineered solutions to prevent encroachment of saltwater into freshwater systems	Storm surge, sea-level rise	• Could help to maintain freshwater supplies for nearby communities and farmers	• Could prevent upstream or downstream migration of fish • Could reduce flushing and increase potential for eutrophication
Prohibit or delay construction of hard shoreline defences • Remove structures such as levees to allow landward migration of coastal habitat	Sea-level rise	• Potential for increase in blue carbon (mitigation) • Maintenance of fish nursery grounds • Maintenance of habitat for shorebirds	• Potential for increased mosquito habitats and concerns of nearby residents about mosquito borne viruses
C. Reduction in other stressors			
Reduce external pressures on key habitats to enhance resilience to climate change impacts, e.g. • use of water sensitive urban design principles • sediment removal • increase flushing capacity of estuaries • produce oyster reefs to filter water • prevent fishing in areas to maintain biodiversity including grazers (algal control) • fence creeklines to prevent livestock encroachment • control invasive species	All	• Better conditioned ecosystems and better water quality • Immediate and long-term benefits	• There are limits to the extent of climate impacts that these measures will address • Not all stakeholders will favour some of the approaches

Adaptation options:	Climate stressors being addressed:	Environmental benefits:	Environmental risks:
Ensure that habitats and associated buffers are protected in infrastructure and development planning regulation	All	• Habitat maintenance • Ability for habitats to migrate as sea levels rise • Protection for habitat from direct effects and disturbance associated with future developments	• May be a cause for concern for property owners and developers
Provide environmental water flows into coastal habitats during prolonged dry periods	Sea levels rise, any increase in drought occurrence	• Increased productivity of estuarine species (commercial and non-commercial) • Helps prevent encroachment of saltwater species upstream	• May be of concern for coastal communities who may feel that the water should be preserved for human consumption
D. Species-specific interventions			
Assisted colonisation to enhance distribution shifts	Increased temperatures, changes to ocean currents	• May enhance recreational and commercial fisheries once populations are established	• Could have negative consequences on existing habitats and species (e.g. increased predators may influence prey distributions) • May be challenging for stakeholders to accept and requires substantial engagement
Stock enhancement – addition of desirable species to a coastal region	Declining recruitment due to habitat quality decline	• Could enhance recreational and commercial fisheries once stocks are enhanced	• Could have unforeseen consequences on remnant existing populations • May be challenging for stakeholders to accept and requires substantial engagement
Management of competing species		• Increases potential for maintaining biodiversity and existing fisheries	• Could be time consuming and expensive to monitor and manage • May be challenging for stakeholders to accept and requires substantial engagement

Further reading:

Creighton, C., P.I. Boon, J. Brookes, and M. Sheaves, 2015: Repairing Australia's estuaries for improved fisheries production: what benefits, at what cost? Marine and Freshwater Research, 66(6), 493-507.

Hobday, A.J., L.E. Chambers, and J.P.Y. Arnould, 2015: Prioritizing climate change adaptation options for iconic marine species. Biodiversity and Conservation, 24(14), 3449-3468.

Pecl, G.T., and Colleagues, 2014: Preparing fisheries for climate change: identifying adaptation options for four key fisheries in South Eastern Australia. Fisheries Research and Development Corporation, Project 2011/039. Accessed 12 June 2016. [Available online at http://frdc.com.au/research/Final_Reports/2011-039-DLD.pdf].

Sheaves, M., and Colleagues, 2014: Climate Change Adaptation Strategies to Support Australia's Estuarine and Coastal Marine Ecosystems. Fisheries Research and Development Corporation, Project 2011/040. James Cook University, Townsville. Accessed 12 June 2016. [Available online at http://frdc.com.au/research/Final_reports/2011-040-DLD.pdf].

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