Information Sheet

Managed adaptation options

What is managed climate change adaptation?

Adaptation is defined as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effect, which moderates harm or exploits beneficial opportunities.

Managed adaptation includes the intentional adaptation of human systems for particular goals such as the conservation of coastal ecosystems and species.

On-ground adaptation approaches

On-ground climate change adaptation approaches aim to enable natural coastal systems to better cope with climate change impact. Some are designed to primarily benefit humans, e.g. groynes, dredging and beach nourishment, while others aim to benefit both human and natural systems, e.g. foreshore revegetation, pollution reduction etc. Recent approaches including ecological and ecosystem engineering, aim to maintain and enhance the extent and health of natural habitats while also protecting coastal development. On-ground climate change adaptation options can be 'hard' or 'soft', or a combination of both.


Image: Gwingarra

Broad approaches to managed coastal adaptation

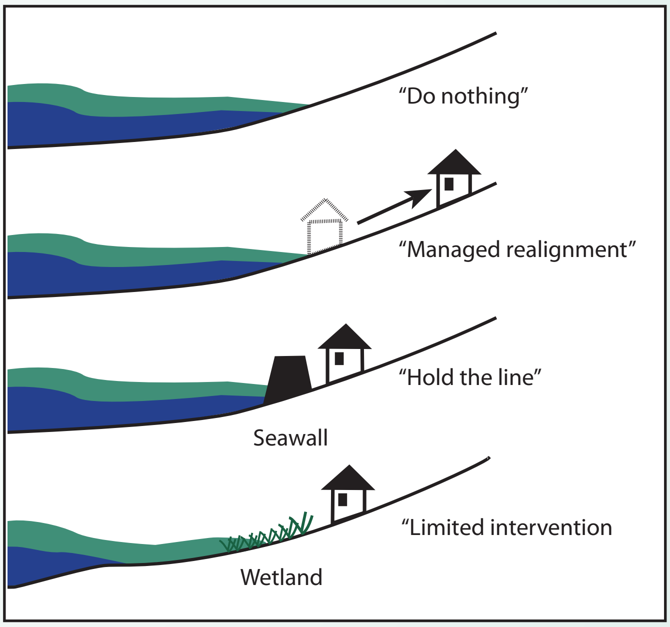
Four broadly different approaches to managed adaptation in the coastal zone can be described, mainly with respect to sea level rise. Each employs a range of practical measures.

1 *Do nothing*: a 'wait and see' approach allows for the destruction of coastal infrastructure as sea level rises but avoids costs of construction and maintenance of hard engineering structures.

2 *Managed realignment*: the planned abandonment of land to the sea as it advances, often involving removal of coastal armouring structures and relocation of infrastructure. This strategy has ecological benefits as it allows ecosystems to migrate landwards and thereby maintain functions and ecosystem services.

3 *Hold the line*: use of hard engineering structures, e.g. seawalls and groynes, and soft engineering methods, e.g. beach nourishment, to attempt to prevent invasion by the sea beyond a set position.

4 *Limited intervention* (or *accommodation*): allows continued occupation of coastal land by modifying building designs so they can be moved or withstand inundation, or ecosystem engineering by using different species to increase coastal elevation or absorb storm impact.

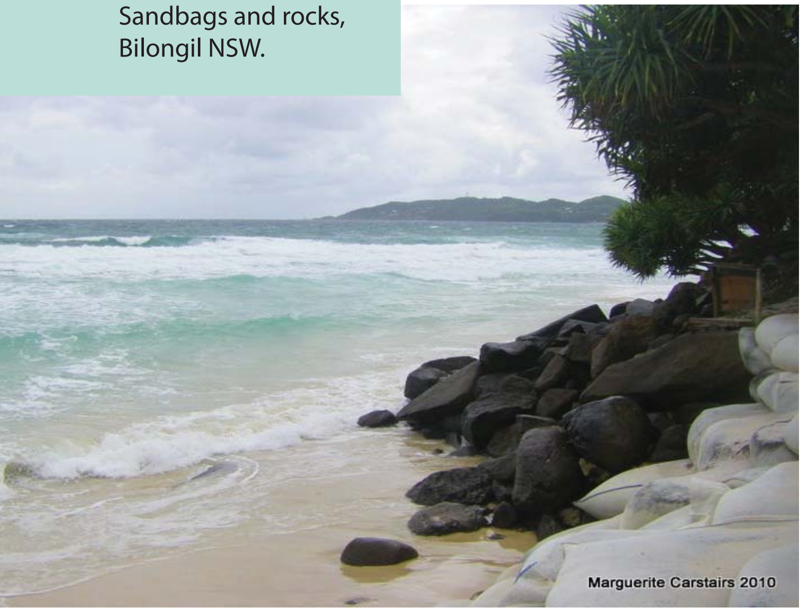


1. Hard engineering approaches

Hard engineering uses man-made structures to intervene in coastal processes by altering the influence of waves on coastal erosion.

Various structures have been used to protect coastal investments from flooding and erosion including groynes, sea walls, revetments, rock armouring, gabions, offshore breakwaters, training walls, artificial reefs and geotextile sandbags. Such structures are also used to prevent sand loss via wave and current action and to maintain beaches for recreation.

Sandbags and rocks, Bilongil NSW.



Hard engineering is used extensively in coastal Australia and is likely to increase as sea level rises.

Typically, hard engineering is implemented for human benefits and ecological impacts are less well known. Hard engineering structures tend to reduce sediment flow along coastlines, accelerate beach erosion and are attributed with the loss of over 80% of soft sedimentary shorelines. Consequently, hard-engineering adaptation measures in erosion and flood prone coastal areas can be considered as maladaptation because it reduces ecological resilience, obstructs autonomous ecological adaptation and increases coastal vulnerability to storms.

2. Soft-engineering approaches

Soft engineering approaches to coastal ecosystem adaptation currently being investigated include managed retreat, beach nourishment, beach drainage, and revegetation.

Managed retreat

Managed retreat removes hard engineering structures to allow coastal areas to retreat in response to rising sea level. Such structures are often replaced by more ecologically beneficial environments such as saltmarsh and mangrove vegetation. Benefits include maintenance of coastal ecosystems and ecosystem services, reduced costs of maintenance and management of public expectations in relation to permissible types of coastal development and the importance of coastal ecosystems. Primary drivers for adoption of managed retreat include recognition of the value of resilient coastal ecosystems and the ecosystem services they provide and an acceptance that 'hold the line' practices only lead to coastal erosion elsewhere.

Revegetation

Revegetation is used extensively in Australia and around the world. Benefits include maintenance of habitat for coastal species, reduction of wind and wave erosion, provision of a barrier to prevent sand and salt spray from damaging less tolerant inland plant species and protection against storms. Since dune vegetation is instrumental in dune formation, dune revegetation can also influence the sand budget of a coastal area.

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Beach nourishment

Beach nourishment is widely used to combat coastal erosion, particularly on high-use beaches for the benefit of tourism and recreation. Typically achieved by importing and bulldozing sand by transferring sand from low to high levels, beach nourishment can maintain the habitat of some coastal species but can also result in a decline in macrobenthos. Recommendations to minimise ecological impacts of beach nourishment include: i) avoiding sediment compaction, ii) carefully timing operations to minimise impacts and facilitate recovery, iii) using locally-appropriate techniques, iv) using several small projects (including numerous shallow applications) rather than one large project to avoid killing fauna by burial, v) careful spacing of operations to ensure interspersed unaffected areas and vi) importing and distributing sediments that match beach conditions and profiles as closely as possible.

Beach drainage

Beach drainage involves localised lowering of water tables beneath beaches to allow sand to dry and allow part of wave swash to 'soak in', thereby depositing part of its suspended sand on the beach.

3. Ecological engineering approaches

Ecological engineering combines hard and soft adaptation measures to protect human coastal systems while reducing impacts on ecosystem health and function.

This approach emphasises the creation of artificial habitats that potentially enable ecosystems to adapt by replacing habitat that has been destroyed or degraded or provides new habitat or habitat associated with existing hard engineering structures.

Artificial habitats are provided with an aim of increasing species abundance and diversity and enabling species to remain or move to new locations.

Retrofitting hard engineering structures

Hard engineering structures such as groynes, rock walls and other forms of coastal armouring, can be retrofitted with design features that provide habitat such as holes and caves. In Sydney Harbour, artificial structures know as 'flower pots' were retrofitted to sea walls to provide 'rock pools'.

Artificial reefs

Artificial reefs are used as marine habitat to benefit both human and natural coastal systems.

Artificial reefs can provide habitat for fish, coral and plant species and repair damaged habitat often with benefits for recreation fishing, surfing and diving industries. Artificial reefs also provide beach protection.

While the use of artificial reefs is promoted in the NSW Estuarine and Offshore Artificial Reef programs, the NSW Marine Parks Authority outlines issues in their Artificial Reefs Policy document including: i) whether or not artificial reefs increase biological production, ii) encouragement of aggregations of fish from other areas leading to overfishing, and iii) possible pollution from reef construction materials.

The South Australian Government has discouraged use of artificial reefs since 1993 due to concerns about their effectiveness. The placement and construction of artificial reefs in Australia requires a sea dumping permit through the *Environment Protection (Sea Dumping) Act 1981*.

Artificial reef: The '*Hobart*' was scuttled in Yankalilla Bay, South Australia in 2002.

Image: Marv4mart

4. Ecosystem engineering approaches

Ecosystem engineering refers to the use of species with the ability to 'engineer' or create ecosystems with particular characteristics. While such approaches can encourage the development of beneficial habitats and attract and shelter many organisms, coastal ecosystems may also be negatively affected if introduced ecosystem engineering species become invasive, replacing native species and interfering with physical processes. This may have major consequences for native populations, communities and food webs.

Oyster and mussel beds

Reef building species can act as ecosystem engineers by modifying their local hydrodynamic and sedimentary surroundings, thereby influencing other species. In particular, bivalves such as oysters and mussels, provide new substrates for colonisation by other species, generating greater amounts of available habitat, and stabilising soft sediments to allow greater numbers of species to occur at a location.

Coral propagation and translocation

Coral seeding and transplantation are being used to enable coral reefs, and the species that depend upon them, to recolonise existing locations after major disturbances or to migrate to new, more suitable locations.

Dune grass

The use of ecosystem engineering dune grasses, e.g. Marram grass to stabilise foredunes has been implemented widely throughout the world.

5. Minimising non-climatic human impacts

Minimisation of disturbance produced by non-climatic human impacts reduces the vulnerability of coastal ecosystems to climate change by enhancing their ecological resilience.

Examples of non-climatic human impacts that may be reduced through policy and planning regimes include:

- unsustainable harvesting of organisms, e.g. fishing;
- reduction of water quality by pollution;
- introductions of exotic species;
- development in erosion and flood prone areas; and
- adaptation practices designed to protect human coastal systems, e.g. groynes and sea walls.

Questions to consider when evaluating climate change adaptation actions

1. What are the goals of the adaptation action?
2. Which climate change driver(s) or ecological impact(s) does the action address?
3. What are the spatial and temporal scales for implementing the action?
4. What are the likely intended ecological consequences of the action?
5. What are the possible unintended ecological consequences of the action?
6. What are the potential human consequences of the action, e.g. impacts on settlements, infrastructure and communities?
7. What are the likelihoods of these unintended consequences?
8. What are the biophysical and socioeconomic constraints that might inhibit uptake and implementation of the action?

More information...

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For further information about the project, or to obtain a copy of the full scientific report or synthesis report from the project, as well as other information sheets, visit: www.nccarf.edu.au/cerccs

Image: Cyndy Simms Parr