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MANAGED REALIGNMENT

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Synonyms

De-embankment; Managed retreat; Setback

Definition

Managed realignment most often involves the planned breaching or removal of coastal defenses to create new intertidal habitats aiming to improve flood risk management with added environmental value. Managed realignment is usually implemented in low-lying estuarine or open coast sites, and may require the construction of a new line of defenses to control flood risk. Hence, the expression "managed realignment" may refer to the relocation of both the coastline and the flood defense line. An overview of the different definitions used in the literature is provided in Esteves (2014).

A shift from the traditional 'hold-the-line' approach of coastal protection

Managed realignment is one of the soft engineering approaches to coastal protection (see "Coastal Protection (Soft Engineering)"). By working with coastal processes, managed realignment aims to increase the sustainability of coastal protection while at the same time reducing adverse environmental impacts normally associated with hard engineering (French, 1997). For centuries, hard engineering structures (see "Coastal Protection (Hard Engineering)") have been built to protect assets at the coast from erosion and flooding events. These hard structures have created a legacy of coastal management problems, which are now considered unacceptable, including the loss of intertidal habitats due to coastal squeeze (Figure 1a).

The two most important climate change effects predicted for coastal areas are sea-level rise and more frequent and intense extreme weather events (e.g., IPCC, 2007). Climate change impacts are likely to increase the risk of flooding and erosion posing a greater threat to people and infrastructure at many coastal locations. It is therefore required that coastal defenses are upgraded and more frequently maintained so they continue to provide the current level of protection to inland areas in the future. The consequent increase in costs of coastal protection has made the traditional "hold-the-line" approach unsustainable in many coastal areas. Managed realignment is an increasingly popular alternative to address both the economic viability and the environmental sustainability of coastal protection, especially in reclaimed estuarine areas (French, 2001).

Unlike coastlines "fixed" by hard coastal engineering, natural coasts dynamically respond to changes in accommodation space due to sea-level fluctuations or alterations in sediment budget. Saltmarshes, for example, depending on a number of interacting biotic and abiotic variables (e.g., the accommodation space and sediment supply), can migrate inland and accrete vertically, naturally adjusting to rising sea levels. These intertidal habitats provide a number of ecosystem services (e.g., Luisetti et al., 2011), such as natural coastal protection by dissipating wave energy (Möller et al., 2007), therefore contributing to reduced flood risk to inland areas and the associated cost of maintaining existing flood defenses.

Geographic distribution

The first managed realignment projects were implemented in France in 1981 and in Germany and the Netherlands in 1989 (Esteves, 2014). Managed realignment has since become increasingly popular in northern Europe

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(Mazik et al., 2010), especially in England (where the highest number of projects has been implemented), Germany, the Netherlands, Belgium, and France. A list of projects implemented in Europe, including their main characteristics, is available from the *ABPmer Online Managed Realignment Guide* (http://www.abpmer.net/omreg/). The main objectives and the way projects are implemented vary considerably between these countries.

In England, managed realignment is implemented to create intertidal habitat and to deliver more sustainable flood risk management, e.g., by reducing costs and aggregating environmental and amenity values (Esteves, 2013). In Germany, managed realignment sites are found along the coast of Lower Saxony (by the North Sea) and Mecklenburg–Western Pomerania (by the Baltic Sea), but the objectives differ across these two areas (Rupp-Armstrong and Nicholls, 2007). In Lower Saxony, managed realignment is usually implemented for compensation reasons (i.e., loss of intertidal habitats due to coastal development, port construction etc.). In Western Pomerania managed realignment often combines the need for improvement of flood defenses and creation of new intertidal habitats. In Belgium most projects have been implemented along the Scheldt Estuary through the mechanism of controlled reduced tide (Beauchard et al., 2011; Teuchies et al., 2012) for compensation of damage or loss of intertidal habitats.

Outside Europe, managed realignment projects exist but are not known as such, being difficult to ascertain how many already exist. Although the terms managed realignment and managed retreat are often used interchangeably in the UK (e.g., French, 2001), elsewhere managed retreat refers to the relocation of people and assets at risk (e.g., National Oceanic and Atmospheric Administration (NOAA) Office of Ocean and Coastal Resource Management; http://coastalmanagement.noaa.gov/initiatives/shoreline_ppr_retreat.html).

How does it work?

By allowing tidal waters to flow further inland through breached defenses, managed realignment creates new intertidal areas (Figure 1b) and accommodation space for sediment deposition. It is expected that the realignment site will act as a sink for sediments, favoring the development of saltmarshes. The resulting wider intertidal profile provides natural coastal protection through the dissipation of wave energy (French, 1997), which tends to be significantly greater over saltmarshes than over un-vegetated intertidal flats (Möller et al., 2007). Saltmarsh development enhances local biodiversity and the sustainability of coastal protection and, therefore, is crucial for the success of managed realignment as a sustainable coastal management approach.

Information on the performance of managed realignment projects is still scarce as most projects do not benefit from systematic long-term monitoring (Spencer and Harvey, 2012). Although many gray literature reports have been produced by consultants contracted to conduct the design, implementation, and monitoring of the schemes, only few independent monitoring studies have been published in peer-reviewed journals. The existing articles indicate diverse findings on the development of saltmarshes at managed realignment sites.

Vegetation colonization at managed realignment sites is reported to occur rapidly, most commonly dominated by pioneer saltmarsh species, as reported in sites along the Blackwater Estuary in England. Garbutt et al. (2006) suggested that the low elevation of the Tollesbury site contributed to the dominance of pioneer saltmarsh recorded 6 years after the breaching of defenses. At Orplands Farm, 8 years after managed realignment, the site showed low species saturation index and was dominated by pioneer and low marsh species due to poor drainage and seed availability (Spencer et al., 2008). At Freiston Shore (The Wash, England), high sediment input favored rapid colonization by pioneer saltmarsh vegetation (Friess et al., 2012). However, sediment had originated from the erosion of adjacent established habitats caused by the unexpected growth of the tidal creeks at the breaches (Rotman et al., 2008).

In their analysis of saltmarsh re-creation in Europe, Wolters et al. (2005) observed that only 50 % of the expected species were found at sites smaller than 30 ha. The authors concluded that biodiversity increased at sites larger than 100 ha, where the largest range of elevations between mean high water of neap and spring tides occur. Many managed realignment sites in England and elsewhere are small ($<$20 ha), low-lying, and confined by a new line of coastal defenses. These characteristics compromise the sustainability of managed realignment sites, as the lifetime of the newly created intertidal habitats depends on whether sediment availability (and other variables) will allow vertical accretion at rates that will cope with rising sea levels (Esteves, 2013). If saltmarshes are not able to fully develop (e.g., due to the small size or low elevation of managed realignment (MR) sites), it is just a matter of time until water levels reach the new line of defenses and the new intertidal habitats are again lost due to coastal squeeze (Figure 1b).

Many managed realignment projects have re-creation of intertidal habitats as a primary objective. This approach is partially driven by the need to address statutory duties (e.g., the EU Habitats Directive) to take all necessary measures to avoid detrimental impact to designated conservation areas and provide compensation for loss of these habitats. However, recent studies have indicated that marshes created by managed realignment are “significantly impaired” in their ability to deliver ecosystem services when compared with natural systems (Spencer and Harvey, 2012) and do not meet the requirements of the EU Habitats Directive (Mossman et al., 2012). Ecosystem services valuation (Luisetti et al., 2011) concluded that managed realignment can be economically efficient at time frames longer than 25 years. However, results are site-specific and should not be generalized, especially when "complex social decisions" are involved (Luisetti et al., 2011), such as in areas where people and assets are at risk.

Managed realignment versus managed retreat

The focus of managed realignment projects oscillates between improved flood risk management and environmental objectives, often with a bias toward habitat creation. Usually, medium- to long-term effects on flood risk to inland areas are not clearly assessed, probably due to uncertainties on the type of intertidal habitat that will develop and how they will evolve through time. Where saltmarshes fail to develop, coastal squeeze resumes as sea level rises, posing a higher risk of flooding to people and property. Conceptually, managed realignment has great potential to (1) provide space for the creation of intertidal habitats, (2) provide natural defense against storms and rising sea levels, and (3) contribute to the achievement of EU directives (i.e., floods, habitats, and water framework). Esteves (2013) states that for this potential to be realized, it is necessary that managed realignment implementation (1) follows a long-term strategic plan that effectively integrates its multiple objectives (e.g., habitat creation, flood protection, and amenity), (2) has clearly defined local and national targets at known time frames, (3) benefits from systematic monitoring so performance can be adequately measured against targets, and (4) is evaluated based on evidence so adjustments to the strategy can be put in place where necessary.

In contrast with managed realignment, the main objective of managed retreat is the relocation of people and assets at risk. Implementation of managed retreat might include relocation of single structures at risk (e.g., the historic Cape Hatteras Lighthouse, USA) or a series of measures to reduce the number of people and property at risk (e.g., the compulsory purchasing of property at high risk adopted in France after the aftermath of the Xynthia storm of 2010). Implementation of such schemes is complex due to the range of public perception conflicts (e.g., Roca and Villares, 2012), in addition to institutional capacity and economic constraints. Managed retreat usually requires strong integration between long-term planning and the sustainability of risk reduction measures, which is often deficient in public administrations. However, challenging times require drastic changes and the only safe climate-proof response at all temporal and spatial scales is to reduce the number of people and assets at risk. As it is an effective mechanism to reduce risk from both climatic variability and extreme events, managed retreat has increasingly been implemented (or planned) in many locations worldwide.

It is important to note that, so far, managed realignment has been implemented only in rural areas. However, as flood defenses are moved further inland, a long-term strategy is required to prevent risk to inland areas becoming unacceptable. Managed retreat deals with development in hazard-prone areas and, combined with long-term planning, may be applicable to a range of urban and industrial areas. A more effective strategy to reduce the risk of flooding to people and property would involve long-term planning objectives with both managed realignment and managed retreat implemented in predefined time frames.

Summary

Managed realignment is a soft engineering approach that aims to create intertidal habitat (especially saltmarshes) through the artificial breaching or removal of flood defenses. The creation of intertidal habitats has two main aims: (1) to offset the loss of designated intertidal habitat (due to coastal squeeze and developmental pressures) and (2) to dissipate wave energy to offer sustainable coastal protection. Managed realignment is becoming a popular coastal management approach in northern Europe. As managed realignment is a relatively new approach, there is a need to better understand the short- to long-term effects on (1) local sedimentary processes, (2) inland flood risk and development of intertidal habitats (and associated biota), (3) and wider socioeconomic and environmental implications.

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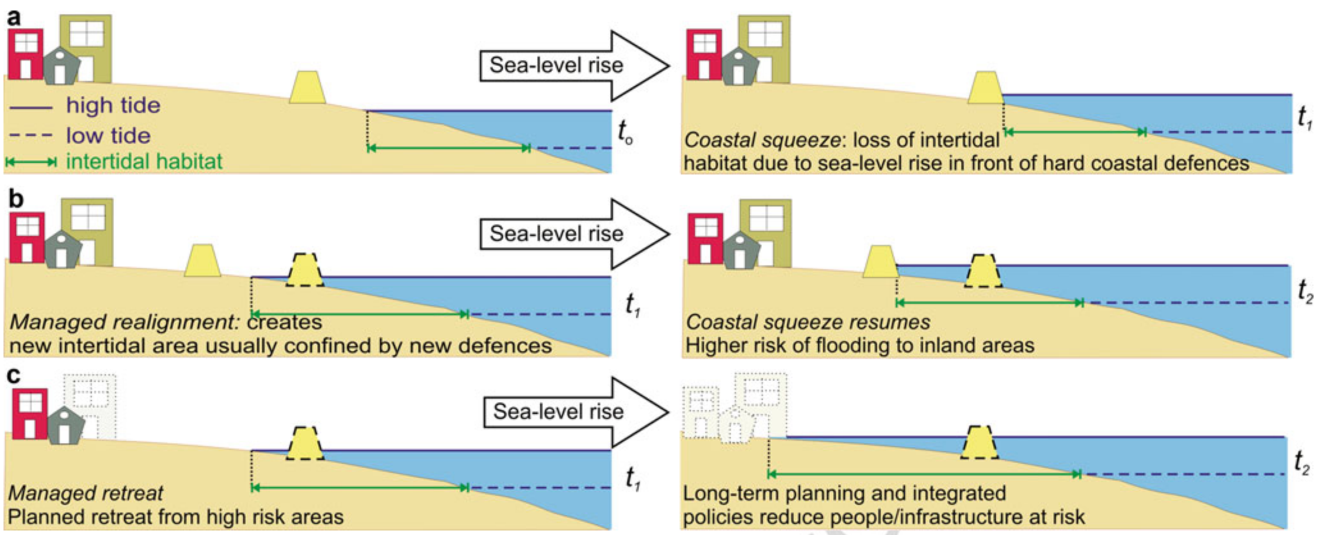
Cross-references

Climate Change Effects
Coastal Engineering (Hard Engineering)
Coastal Risks/Floods
Coastal Squeeze
Coastal Wetlands
Habitat Loss
Integrated Coastal Zone Management
Mudflat
Saltmarsh
Sea-Level Rise Marsh Effects



Managed Realignment, Figure 1 Schematic diagram representing: (**a**) coastal squeeze, the loss of intertidal areas due to rising sea levels in front of fixed coastlines; (**b**) managed realignment, the creation of new intertidal area and the return of coastal squeeze at sites where saltmarshes fail to develop; and (**c**) managed retreat, which integrates land-use planning and long-term risk reduction by creating new intertidal habitats and removing people and property from risk areas. Different moments in time are indicated by t_{0-2}