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The adaptation-resistance spectrum: A classification of contemporary adaptation approaches to climate-related coastal change

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ABSTRACT

The realisation of climate change and its potential impacts on coastal environments and coastal communities has prompted much activity in the realm of 'adaptation'. Adaptation is typically viewed as actions in response to climate change that seek to limit its impacts and/or bring some benefit to human society. In this paper we consider adaptation actions in response to the twin risks of coastal flooding and recession both of which are likely to increase in frequency/rate and magnitude as a result of global climate change. Adaptation actions are classified on a spectrum based on the degree of planned modification of (i) human activities or (ii) the physical coastal environment.

At one end of the spectrum is a set of activities that involve changing human activities to suit the changing environment (e.g. innovative building design, relocation of infrastructure and/or people, changing landuse or livelihoods). At the other extreme are activities (e.g. building or raising flood defences, building or strengthening seawalls, nourishing beaches) that involve resisting environmental change in order to preserve existing infrastructure and human activities. Between these two extremes are a few initiatives that involve components of both approaches. A qualitative review of current practice suggests that most adaptation activity is in the category of seeking to preserve human activities and infrastructure. This form of response is better termed 'resistance' than 'adaptation'. These conservative and short-term goals of protecting fixed assets and existing activities, are damaging to the environment, involve significant cost and increase future risk of catastrophic failure. Those measures that involve adaptation of human activities in response to the changing coastal environment are likely to be more sustainable in the longer term, but are politically more difficult to implement.

1. Introduction

Global climate change is manifest in different ways according to location. There is consequently great variability in the nature and degree to which its impacts will be reflected in the natural and built environment. In coastal zones global climate change is generally and primarily manifest in rising sea levels, changes in precipitation (amount, timing and nature), changing wind and wave patterns, increased land and sea temperatures and ocean acidification. Other impacts related to the frequency of extreme events, and delivery of sediment (e.g. from rivers) are highly site-specific. These factors interact with each other and produce a range of subsequent changes in the natural and human coastal environment (Cooper, 2009). It is anticipated that human interaction with the coast will change as a result of global climate change, creating a new relationship between humans and their coastal environment. The way in which humans react to these actual or projected changes is frequently termed 'adaptation' (Adger et al., 2009).

There is a significant body of literature on the need for adaptation to climate change and the constraints (legislative social, political and economic) upon it. There is rather less discussion on the nature of actual adaptation measures beyond individual or regional case studies (Kenchington et al., 2012). The European Commission (2007, p.3) provides as examples of adaptation, "using scarce water more efficiently, adapting existing building codes to stand future climate conditions and extreme weather events, construction of flood walls and raising levels of dykes against sea level rise, development of drought tolerant crops, selection of forestry species and practices less vulnerable to storms and fires, development of spatial plans and corridors to help species migrate". In this paper we assess the types of actions being undertaken as adaptation measures in coastal environments in response to the likelihood of increased rates of shoreline recession and flooding. On the basis of the extent to which these adaptation

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measures represent modifications of the environment or of human actions, we present a novel classification.

2. Definitions of adaptation

Adaptation has been defined in many different ways. Early definitions of 'adaptation' reviewed by Klein and Tol (1997) include:

- The process through which people reduce the adverse effects of climate on their health and well-being, and take advantage of the opportunities that their climatic environment provides (Burton, 1992);
- Adjustments to enhance the viability of social and economic activities and to reduce their vulnerability to climate, including its current variability and extreme events as well as longer-term climate change (Smit, 1993);
- Any adjustment, whether passive, reactive or anticipatory, that is proposed as a means for ameliorating the anticipated adverse consequences associated with climate change (Stakhiv, 1993);
- All adjustments in behaviour or economic structure that reduce the vulnerability of society to changes in the climate system (Smith, 1996).

The UNFCCC (United Nations Framework Convention on Climate Change) website (http://unfccc.int/focus/adaptation/items/6999.php) glossary subsequently (2006) defined adaptation as:

- Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.
- Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation
- A process by which strategies to moderate, cope with and take advantage of the consequences of climatic events are enhanced, developed, and implemented (UNDP, 2006).
- The process or outcome of a process that leads to a reduction in harm or risk of harm, or realisation of benefits associated with climate variability and climate change (UK Climate Impact Programme – UKCIP, 2003).

In a report for OECD (The Organisation for Economic Co-operation and Development) the following definitions are provided and discussed (Levin and Tirpak, 2006):

- Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation (IPCC TAR, 2001)
- Practical steps to protect countries and communities from the likely disruption and damage that will result from effects of climate change. For example, flood walls should be built and in numerous cases it is probably advisable to move human settlements out of flood plains and other low-lying areas…" (UNFCCC)
- A process by which strategies to moderate, cope with and take advantage of the consequences of climatic events are enhanced, developed, and implemented (UNDP, 2006).
- The process or outcome of a process that leads to a reduction in harm or risk of harm, or realisation of benefits associated with climate variability and climate change (UK Climate Impact Programme (UKCIP, 2003)).

The European Commission (2007, p. 3) considers that "Adaptation actions are taken to cope with a changing climate, e.g. increased rainfall, higher temperatures, scarcer water resources or more frequent storms, [either] at present or anticipating such changes in future. Adaptation aims at reducing the risk and damage from current and future harmful impacts cost-effectively or exploiting potential benefits […] Adaptation can encompass national or regional strategies as well as practical steps taken at community level or by individuals. Adaptation measures can be anticipatory or reactive. Adaptation applies to natural as well as to human systems. Ensuring the sustainability of investments over their entire lifetime taking explicit account of a changing climate is often referred to as 'climate proofing'."

This selection of definitions demonstrates some commonalities and some major differences in conceptions of adaptation. Some definitions restrict adaptation to human actions while others include natural changes. Levin and Tirpak (2006) contend that the term would benefit from further clarification. Until such times as that happens, they recommended use of the IPCC TAR (2001) definition above. This definition, however, includes natural responses of the environment to climate change. These are by definition, outside the realm of human influence and are therefore in themselves outside most conceptions of 'adaptation' which limit the concept to changes influenced by deliberate human actions.

Central to all of the definitions of adaptation is the reduction of harm and/or realisation of benefits to humans. In the coastal zone the notion of harm and benefits has, however, been shown to vary according to the individual's perspective (Cooper and McKenna, 2008a) and deciding on which human benefit to favour in taking decisions on adaptation is not straightforward. For example, protection of land on a retreating sandy shoreline by coastal defences may be beneficial to the landowner (at least in the short term and especially if someone else pays for the defences). It is, however, damaging to the coastal ecosystem and to beach users and economic costs accrue in the construction and future maintenance of the defences (Cooper and McKenna, 2008b). Conversely, permitting beachfront property to be lost as a shoreline adjusts is beneficial to the coastal ecosystem and coastal users but economically harmful to the property owner.

Some of the definitions above are focussed on immediate benefits to humans rather than on long-term sustainability of the coastal environment. These differences in definition of adaptation lead to different stakeholders interpreting them to suit their own needs (Srinavasan, 2006). Similar selective interpretation of poorly defined terms in coastal management has been alluded to in the EU's ICZM Recommendation (McKenna et al., 2008) and many examples exist in which opposing interests use the same principle to support different management actions. Consequently, adaptation is not a straightforward concept and can be the basis of considerable conflict. Tompkins et al. (2010) consider adaptation to involve two components: building adaptive capacity, and implementing adaptation decisions. Here we focus on the implementation aspects.

3. Physical manifestation of global climate change at the coast

Rising sea levels precipitate changes in coastal configuration as the coastal morphology adjusts to the changed conditions (Wodroffe, 2002). The changes are strongly 3-dimensional and may involve changes in plan as well as profile. Many factors (in particular, sediment supply and antecedent topography) influence the nature of coastal change in response to rising sea level (Cooper and