Managing the twin risks of flooding and erosion in coastal areas - UK

1. Policy Objective & Theme

- ADAPTATION TO RISK: Managing impacts of climate change and safeguarding resilience of coasts/coastal systems
- ADAPTATION TO RISK: Preventing and managing natural hazards and technological (human-made) hazards
- ADAPTATION TO RISK: Integrating coherent strategies covering the risk-dimension (prevention to response) into planning and investment
- SUSTAINABLE USE OF RESOURCES: Preserving coastal environment (its functioning and integrity) to share space

2. Key Approaches

- Knowledge-based
- Socio-economic

3. Experiences that can be exchanged

In order to generate new insights into the effects of climate change and coastal management practises on coastal erosion and flood risk, an integrated assessment of both phenomenon over 72 km of shoreline for the twenty-first century on the East Anglian coast of England has been done. This is a site of significant controversy about how to manage coastal flood and erosion risks over the twenty-first century. The principles shown here could be applied in other environments such as estuaries and deltas which have also been identified as very vulnerable to climate change

4. Overview of the case

Risk analysis under scenarios of future climate and socio-economic change has been applied to analyse alternative coastal management options on a 72 km stretch of UK coastline that has experienced flooding and cliff erosion for many centuries. Whilst the concept of integrated assessment of coastal risks is not new, this analysis is notable in its deployment of physically-based models over such a large spatial scale and extended timescale.

5. Context and Objectives

a) Context

The case study site is a 72 km length of coastline and hinterland between Weybourne and Lowestoft on the east coast of England. It is designated as a ‘coastal sub-cell’ (number 3b) in UK coastal management planning which means that it is reasonably self-contained in terms of sedimentary interactions with neighbouring coastlines. The north of the site is comprised of retreating chalk and till cliffs, whereas the southern area of the site is generally low lying and at risk of coastal flooding. There are currently almost 20,000 properties at risk of coastal flooding in the area, over 3,000 of which are non-residential. Almost 50% of the floodplain, which is almost 340 km2, is premium agricultural land. Some 35%, is registered as being environmentally sensitive (with Sites of Special Scientific Interest, Ramsar, salt marsh, national nature reserve designations). Along the 32 km stretch of eroding coastline there are almost 1,400 properties within 100 m of the cliff top. Of this area, 37% is premium agricultural land and a further 50% is less productive agricultural land. The study area has a long history of erosion and flooding, but climate change exacerbates both these risks in terms of loss of buildings on the cliff coast and increased flood risk in the coastal lowlands. Erosion risk is exacerbated by trends for increased building in these areas, although planning regulations for cliff top areas do take specific account of risks associated with coastal erosion.

The risks to human populations in coastal areas are changing due to climate and socio-economic changes, and these trends are predicted to accelerate during the twenty-first century. To understand these changing risks, and the resulting choices and pathways to successful management and adaptation, broad-scale integrated assessment is essential. Due to their complexity, the two risks of flooding and erosion are usually managed independently, yet frequently they are interconnected by longshore exchange of sediments and the resulting broad scale morphological system behaviour. Given the uncertainties in the future sea level rise, and the extent to which this influences the effectiveness of different management strategies, an adaptive strategy that is continuously reviewed in the light of new information is most appropriate.

b) Objectives

The aim of the work was to apply risk analysis under scenarios of future climate and socio-economic change to analyse alternative coastal management options on a 72 km stretch of UK coastline that has experienced flooding and cliff erosion for many centuries.

6. Implementation of the ICZM Approach (i.e. management, tools, resources)

a) Management

The work was conducted in the Tyndall Centres for Climate Change Research in the School of Civil Engineering and Geosciences, Newcastle University; the School of Civil Engineering and the Environment, Southampton University; the School of Mechanical, Aerospace and Civil Engineering, University of Manchester; and the School of Environmental Sciences, University of East Anglia as well as the School of Geography, Geology and Environmental Science, the University of Auckland and ABP Marine Environmental Research, Southampton.

b) ICZM tools

The study looked at five cliff erosion management scenarios ranging from a highly artificial state in which the whole coast is permanently protected with a through to full abandonment for which all defence structures are removed. Intermediate management scenarios corresponded closely to suggested strategies that have been proposed in practice i.e. some form of coastal defence (seawall, groynes, or palisades) is maintained along about 71% (the current state), 34% and 16% (Scenario D) of the cliff coast. The assessment was conducted with a coupled system of hydrodynamic, morphological and impacts models used in a baseline assessment of the risk in 2003 and then modified to include scenarios of climate change, demographic & economic change and shoreline management options implemented separately and/or in combinations. Because the occurrence of damaging erosion or flooding on the coast is determined by highly variable marine processes (surge tides, extreme waves) and the (uncertain) responses of the coastal system, it was impossible to predict coastal flooding and erosion in deterministic terms. Therefore, a risk-based approach was adopted in which coastal behaviour was predicted, through time, in probabilistic terms and combined with an assessment of impacts in order to quantify the ‘expected annual damage’. The primary parameter used for the comparison of scenarios and management options was economic risk but this could be supplemented by indicators of potential social or environmental impact if available.

A coupled system of hydrodynamic, morphological, reliability and socio-economic models was developed for the analysis, implemented under scenarios of coastal management, climate and socio-economic change. Such an integrated assessment allowed the effects of (1) a range of climate change factors, particularly (a) sea-level rise, (b) wave height, and (c) wave direction, (2) different coastal defence management choices, and (3) socio-economic development, on the evolution of flood and erosion risk to be examined. The analysis indicates that the main drivers for flood risk over the 21st Century in northern East Anglia are a consequence of a combination of rising sea levels, local and broad-scale natural and anthropogenically driven morphological change that may lower or raise beach levels and changes in exposure to flooding and erosion due to socio-economic changes.

The results from this study have quantified the connectivity between the various geo-morphological features that comprise the natural coastal system and shown, quantitatively for the first time, that the vulnerabilities of the different parts of a coastal sub-cell are not independent. Clearly it is inappropriate to consider erosion and flood hazards in isolation. Rather, analysis of climate impacts and long-term coastal management must be implemented at a broader scale that accounts for this morphological inter-dependence. Currently, this is generally not the case. Coastal erosion and flooding are typically assessed independently and the governance structures do not always match the scale at which management is required.

The results also demonstrate that over the twenty-first century, significant benefits in terms of mitigating flood risk can be obtained by allowing previously defended cliffs to erode naturally. These benefits are greatest under high sea level rise scenarios. The economic analysis also strengthens the argument for allowing some of the coastline to return to a more natural configuration and for negotiating compensation to landowners and householders to facilitate a change back to a more natural and dynamic shoreline. However, the social implications for cliff-top communities of such a policy are significant. The changes in risk are predicted to be quite steady over the first half of the twenty-first century, allowing time for planned adaptation. However, given the slow turnover of housing and infrastructure, plans for managed retreat from parts of the coast need to be implemented now if excessive adaptation costs are not to be incurred in the latter half of the twenty-first century.

7. Cost and resources

This work was funded by the Tyndall Centre for Climate Change Research through their ongoing coastal programme.

8. Effectiveness (i.e. were the foreseen goals/objectives of the work reached?)

Within the UK there are now moves to develop a more holistic approach to flood and erosion management that is risk based and recently there have been a range of strategies, consultations and planning documents produced that impact on the management of the coast e.g. Shoreline Management Plans. Other important initiatives include Making Space for, planning guidance through Planning Policy Statement 25 and Local Development frameworks as well as a number of coastal and maritime strategies.

9. Success and Fail factors

Visualisation of the results from the simulation models provide a potentially powerful tool for motivating and engaging policy makers and stakeholders.

10. Unforeseen outcomes

The progressive transformation of policy in the UK is proving controversial due to commonplace expectation amongst the general public that a ‘hold the line’ policy will be maintained. Further work is needed to better understand the socio-economic issues associated with coastal risk management.

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13. Sources

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