Coastal Change Management Areas (CCMAs) – Methodology and Adoption

Work Package 1: CCMA Review

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University of Plymouth

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Work Package 1: Review of CCMAs

Executive Summary

The National Planning Policy Framework (NPPF) requires councils to identify Coastal Change Management Areas (CCMAs) where rates of shoreline change are expected to be significant over the next 100 years, taking into account impacts of climate change. Yet, currently, few local planning authorities (LPAs) have felt confident to undertake this task, citing a lack of reliable or consistent methodology to establish such designations. As such, support for LPAs to manage development in often active coastal zones, with little regard for future coastal erosion or flooding hazards, is limited.

This report provides a review of existing CCMA uptake in England with analysis of the approach and methods adopted to achieve the designations. Broadly speaking, CCMAs are designated as required for regions, within the Shoreline Management Plan (SMP), classed as No Active Intervention or Managed Realignment (NAI/MR) and rarely for Hold The Line (HTL), in-line with NPPF guidance.

A review of approaches within England show methods of CCMA designation driven by a dominance of SMP and EA flood zone input with additional "buffers" applied to provide more conservative boundaries. While there is some variability in "buffers" applied to CCMAs, the underlying approach is to adopt the most recent SMP guidelines/erosion rates

The SMP reflects the combination of multi-agency working and the culmination of several projects that have fed into its development. While it is limited, by not incorporating future climate change impacts and spatially coarse in resolution, it does provide guidelines on a regional scale that are of use. Equally as SMPs are reviewed, updates can be incorporated into the CCMAs, which are seen as a live document, with guidance stating that planners should use the "best available information" in consideration of any development proposals.

One of the concerns identified in this report is the omission of sections of coastline deemed HTL. Given a lack of long-term commitment, to maintain all defences, we would advise a precautionary CCMA designation is used to provide greater checks on development proposals.

It is recommended going forward, that the NPPF provide a structure for LPAs to adhere to, for example covering the specific CCMA region, type of coastline, and methodological approach to use. A standardised approach would limit the complexities in implementing and defining CCMAs, alongside enhancing the consistency between councils, ultimately, enhancing the planning policy practice.

Glossary

Term	Definition
Shoreline Management Plan (SMP)	The Shoreline Management Plan is an assessment of the risks associated with coastal processes. There are 22 SMPs which cover the entire English Coast, exploring a short-term (0 to 20 years), medium-term (20 to 50 years), and Long-term (50 to 100 years) erosion scenarios.
Local Planning Authorities (LPA)	The local government body responsible for formulating and regulating planning policies.
Coastal Change Management Areas (CCMA)	An area identified within Local Development Plans as likely to be affected by physical changes to the shoreline through erosion, coastal landslip, permanent inundation or coastal accretion.
National Planning Policy Framework (NPPF)	The national planning policies for England issued by the Department for Communities and Local Government in March 2012.
Flood and Coastal Erosion Risk Management Strategy (FCERM)	Flood and National Coastal Erosion Risk Management concentrating on rainfall, runoff, rivers, flood inundation, and coastal erosion, as well as the human and socio-economic issues of planning, development and management.
National Coastal Erosion Risk Mapping (NCERM)	National Coastal Erosion Risk Mapping presents comprehensive flood and erosion maps over three epochs; short-term (0-20yr i.e. 2005 – 2025); medium-term (20-50yr i.e. 2025 – 2055); and long-term (50 – 100yr i.e. 2055 to 2105). All erosion extents have been provided at the 5^{th}, 50^{th} and 95^{th} percentile confidence level.
No active intervention (NAI)	Shoreline management plan policy to not invest in providing or maintaining defences or natural coastline.
Hold the line (HTL)	Shoreline management plan policy to maintain or upgrade the level of protection provided by defences or natural coastline.
Managed realignment (MR)	Shoreline management plan policy to realign the 'natural' coastline configuration, either seaward or landward, in order to create a future sustainable shoreline position.
Advance the line (ATL)	Shoreline management plan policy to build coastal defences seawards of the existing defence line where significant land reclamation is considered.

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1. Introduction

This report is the first work package (WP1) of the SWEEP Coastal Change Management Area (CCMA) project, intended as a summary review of the current status of existing CCMA adaptation and implementation, both in the UK and any similar schemes internationally. The document outlines the current status of CCMAs within England and provides an overview of the methodology used by different Local Planning Authorities (LPAs) for the development of CCMAs. The report provides a framework to complete WP2 and WP3 which will focus on the development of a CCMA methodology for North Devon Council, Torridge District Council and East Devon Council, with the approach being applied on two case study sites – the Taw Torridge Estuary and East Devon Coastline. This document will cover:

(1) Definition of CCMAs and where they sit within the National Planning Policy Framework
(2) Requirement for Local Planning Authorities (e.g. legislation & requirements)
(3) Existing uptake and implementation (e.g. CCMAs in England)
(4) Specific case studies and overseas examples

1.1. Coastal Change Management Area: Legislation & Requirements

Coastal Change Management Areas (CCMAs) were introduced in 2010 to reduce the risk from coastal change to vulnerable areas (National Trust, 2015). CCMAs provide LPAs in England the ability to identify and designate areas of coastal risk which can provide greater control over future developments. The National Planning Policy Framework (NPPF) defined CCMAs as "An area identified in plans as likely to be affected by physical change to the shoreline through erosion, coastal landslip, permanent inundation or coastal accretion" (NPPF, 2019). Additionally, the NPPF requires LPAs to identify areas of change and, during the designation process, LPAs ought to consider UK marine policy documents and plans.

CCMAs are only defined in regions where shoreline change is expected to be significant over the next 100 years, in accordance to the Shoreline Management Plans (SMPs), whilst taking into consideration climate change. Furthermore, CCMAs are not typically defined or implemented where strategies to the coastal zone currently include hold or advance the line, in accordance to the SMP, for the foreseeable future. Both Hold the Line (HTL) and Advance the Line (ATL) already involve maintaining or upgrading current defences, or building new defences seaward of the current line where significant land reclamation is possible. Therefore, only areas identified as No Active Intervention (NAI) or Managed Realignment (MR) within the SMP are usually considered for CCMA status.

Coastal Change Management Areas are implemented to protect the surrounding communities, housing settlements, and natural capital, susceptible to coastal change in the coming years (Halcrow, 2015; National Trust, 2015). Defining a region as a CCMA, therefore, limits development within the zone to mitigate the risk of future erosion and flooding. Once the extent of a CCMA has been defined, LPAs, in collaboration with National Planning Practice Guidance, develop regulations for each specific region regarding new development and infrastructure construction within the CCMA zones (NPPF, 2019). Development within CCMAs are then regulated and planning applications within these zones may require a Coastal Vulnerability Assessment (CVA) to be undertaken to determine the impacts of coastal change

(East Suffolk Council, 2013). However, a CVA is dependent on the type of proposed development and specific authority regulations. LPAs will only permit development when the CCMA designation is not compromised and there will be no adverse effect on the coast during the lifetime of the development. The exact nature of development permitted within a CCMA is determined by individual LPAs and is not fixed nationally.

1.2. Development of a CCMA

The identification, development and adoption of a CCMA is not a pre-defined "tick box" process. It requires the involvement and expertise of a range of community groups, planning authorities, the Environment Agency (EA) and coastal specialists to help inform and shape the final implementation and definition. In August 2015 Halcrow produced a "Coastal Change Adaption Planning Guidance" report for East Riding of Yorkshire Council (Halcrow, 2015). This document was a response to the Government's Department for Environment, Food and Rural Affairs (Defra) Coastal Change Pathfinder (CCP) programme which took place between 2009 and 2011. The project was set up to explore new ways of adapting to coastal change by following 15 projects delivered by English local authorities that addressed planning and managing coastal change.

The Halcrow (2015) report provides a clear breakdown of the logical steps through which they propose a CCMA should be developed (Figure 1-1). Of the steps identified, the SWEEP CCMA project is focused on Steps 1-3 and principally **Step 3: Mapping Areas of Risk** which focuses on the method by which the coastal risk is identified. As identified in Figure 1-1, Step 3 is a complex process involving multiple data sources, agencies and expert judgement. The exact makeup of this step will vary between authorities depending on the data available and experience retained within the council. The principal steps are discussed further in Section 2, followed by some example case studies where CCMAs have been adopted and the methods used discussed.

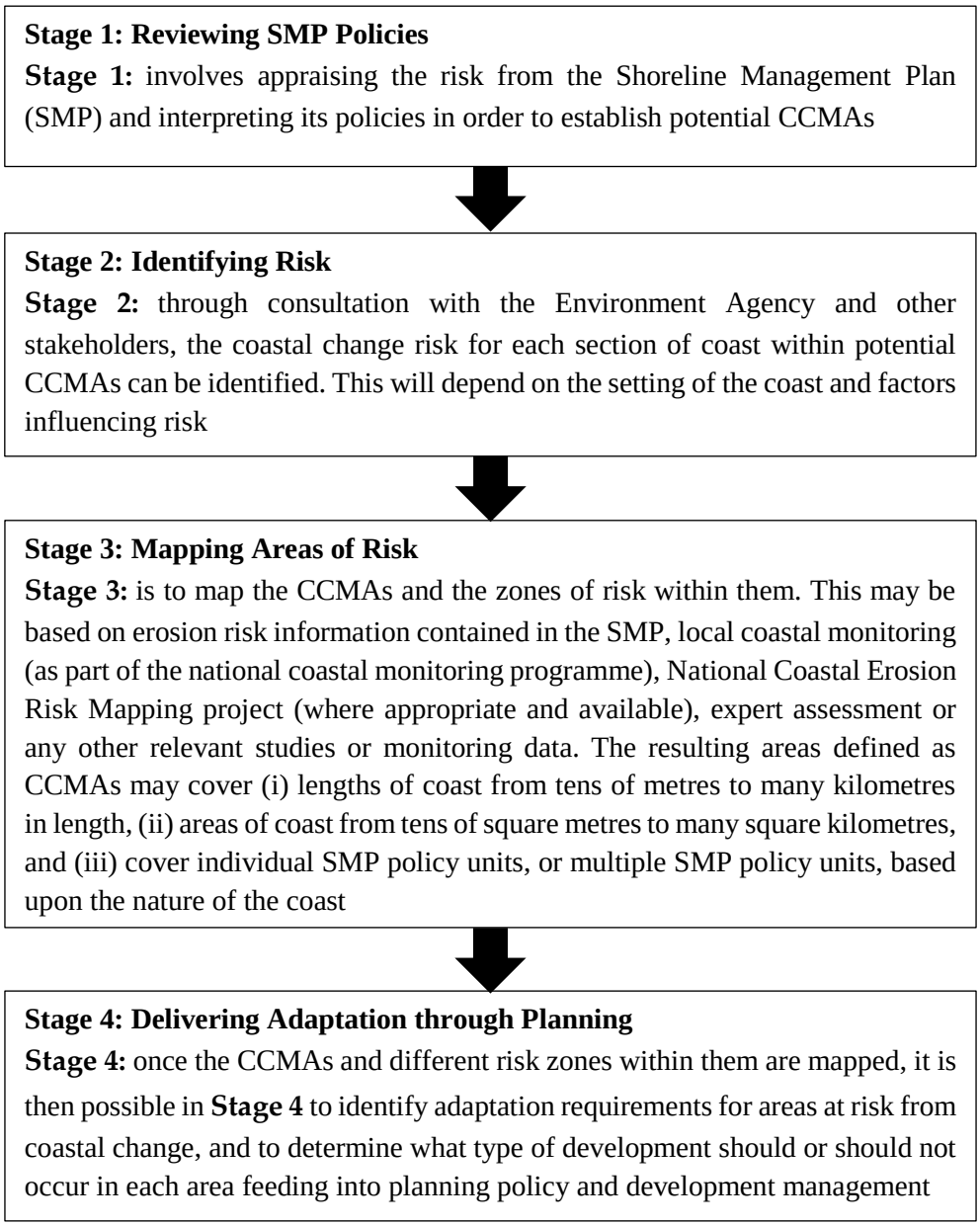

Figure 1-1. Flow diagram setting out the staged approach to developing CCMAs as presented by Halcrow (2015).

2. CCMAs in England

A systematic review of England's Coastal Planning Authorities (CPAs) was conducted between by searching for publicly available data through LPA websites and sending a short questionnaire to LPAs through the Local Government Association Coastal Special Interest Group (LGACSIG). Research was undertaken to establish the geographical distribution of CCMAs within England, as well as reviewing the specific methodology used to define the CCMA extent. During this process, Local Development Plans (LDPs) and other information available on specific planning portals were reviewed, alongside liaising with specific council regions to obtain further information. Additionally, a short questionnaire was sent to coastal CPAs who are members of the Local Government Association Coastal Special Interest Group (LGACSIG). The original questionnaire responses are supplied in the Appendix and aspects included within the text. The results revealed that 22 out of 95 CPAs are currently using CCMAs, with a further 10 LPAs discussing CCMAs with the intention to update their policy within the next LDP (Figure 2-1).

Importantly, CCMAs are often spatially sporadic within LPAs, with particular sub-regions implementing CCMAs over a small stretch of coast, rather than the CCMA being adopted for the whole stretch of coastline. For example, within Cornwall, Newquay has recently adopted a CCMA through its Local Plan and a few other areas are planned to follow suit. In contrast, other regions, for example Dover District Council, have developed CCMAs along the full stretch of NAI or MR coastline, using a consistent method.

To the best of our knowledge, the information presented is the most up to date review of the available data on CCMAs within England (Table 2-1). However, there may be slight discrepancies as data were difficult to obtain from each individual authority as there is no standard requirement or approach to presenting relevant details on CCMAs within LDPs

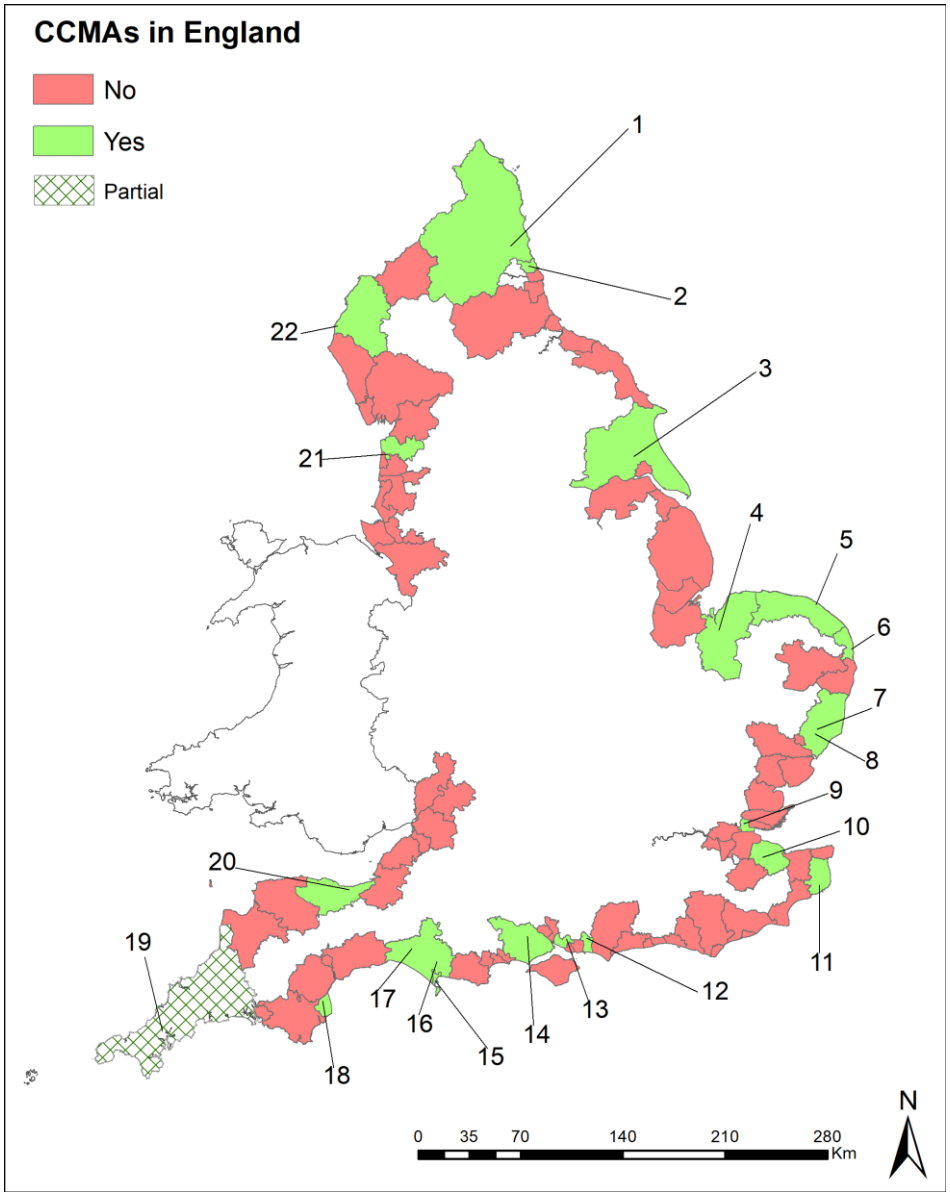

Figure 2-1. Geographical distribution of Coastal Change Managament Areas within England, 2019. Coastal planning authorities have been catogorised depending on whether they have implemented a CCMA. Red is no CCMA; green is CCMA; and checked green is a CCMA within a small region but not for the whole district. Numbers cross-refer to Table 2-1 (below) to provide area name and methodology used to implement the management areas. The figure is based on searches, at the time of writing, and the authors acknowlegde may not reflect the complete distribution.

Table 2-1. Systematic review results of Coastal Change Management Areas within England. The table provides the Coastal Planning Authorities which have considered a CCMA, if it is adopted or planned, and the method used to designate the area. The number column cross-references to Figure 2-1.

Number (corresponding to Figure 2-1)	Coastal Planning Authority	Adopted or Planned	Method of CCMA development
1	Northumberland	Yes	CCMAs currently in draft but will be defined as the area between the shoreline and the 100-yr predicted erosion line, plus a 30 m buffer.
2	North Tyneside Council	Yes	CCMA defined between St. Mary's headland to the border of Northumbria, based on the SMP, but then no development allowed within 30 m of CCMA.
3	East Riding of Yorkshire Council	Yes	CCMAs implemented in regions of NAI, using the SMP 100-yr erosion scenario in 2016. The SMP has been used as the primary basis of the CCMA extent, with additional information obtained from East Ridings coastal change management programme. As such, some NAI regions are exempt from CCMA classification where the management programme show that no erosion is taking place.
4	King's Lynn & West Norfolk Council	Yes	CCMAs were adopted for Hunstanton to Deringham region in 2016. The landward boundary extent was defined using the SMP and EA Flood Zone 3 maps.
5	North Norfolk District Council	Yes	CCMAs were defined using the adopted SMP, whilst recognising the impact of climate change and other specific locally derived evidence.
6	Great Yarmouth Borough Council	Yes	CCMAs adopted in the 2018 (part 2) LDP, around the Scratby region. The CCMA has been defined using the SMP 100-yr erosion extent.

7	Suffolk Coastal District Council	Yes	A CCMA has been defined within the Waveney region based on the 100yr erosion rate from the SMP. However, application within 30 m of the CCMA need to undertake an additional Coastal Erosion Vulnerability Assessment.
8	Waveney District Council	Yes	CCMAs have been adopted between Kessington to Southwold and Corton to Lowestoft (2013 planning docs). CCMAs are defined based on the 100-yr erosion rate from the SMP. However, applications within 30 m of the CCMA need to undertake a Coastal Erosion Vulnerability assessment.
9	Castle Point Borough Council	Yes	CCMAs defined within the 2014 LDP between Canvey Island, Hadleigh Marshes, and South Benfleet. No further details on the methodology supplied.
10	Swale Borough Council	Yes	CCMAs have been defined in the Swale region (incorporating cliffs, inter-tidal mudflats, and beaches) using a combination of approaches, including EA flood maps which includes sea-level-rise scenarios, Swales strategic flood assessment, and the 50-to-100-yr SMP.
11	Dover District Council	Yes	CCMAs adopted with the 2015 LDP based on mapping guidance by Herrington Consulting in 2010. There are seven CCMAs within this region, from Kingsdown to Capel-le-Ferne. CCMAs have been defined using the cliff-top line, plus the 100-year SMP (EA) predicted erosion. Note, they acknowledge the foot of the cliff but only use the cliff-top for classifying CCMAs.
12	Havant Borough Council	Yes	CCMAs have been proposed between West Hayling and Hayling beach front, however, we are unable to obtain information in relation to the applied methodology.
13	Fareham Borough Council	Yes (2017/18)	Unable to obtain information in relation to the applied methodology.

14	New Forest District Council	Yes	CCMAs adopted between Barton on Sea and Milford on Sea. The CCMAs have been defined using the SMP for Hurst Spit to Durlston Head (Poole and Christchurch Bays, SMP15, 2011).
15	Weymouth & Portland Borough Council	Under prep (2018/19)	CCMAs are currently proposed, with the policy under preparation (2018/2019). CCMAs will be applied using the SMP supporting local evidence.
16	West Dorset District Council	Yes	CCMAs to be developed using the SMP and guidance from coastal planning documents for West Dorset/Weymouth
17	East Devon District Council	Yes	Introduction (2016-2018) of CCMA at Sidmouth. Not yet applied and no information regarding methodology.
18	Torbay Council	Yes	Unable to obtain information in relation to the applied methodology.
19	Cornwall Council	Proposal passed (2019)	Newquay have defined their CCMAs on the basis of the SMP 100-yr erosion rate, plus a 10 m buffer exclusion zone, and a 30 m coastal vulnerability zone (landward of the exclusion zone). In addition, if the coastal path passes through the exclusion zone, an additional 2 m buffer is applied to allow for rollback of the SW coastal path.
20	West Somerset District Council	Yes	CCMAs have been proposed for Sedgemore, Steart peninsula, and the Berrow to Brean Down, however, an explicit methodology has not been defined.
21	Wyre Borough Council	Yes	Four CCMAs have been defined around the Wyre Estuary, defined on areas of NAI using the SMP and NCERM, in addition to using the Environmental Agency Tidal Zone 2 plus a 10 m buffer.

22	Allerdale Borough Council	Within 2018/19 LDP which is currently under review.	CCMAs have been defined within the Allerdale Borough Local Plan (part 1), and adopted in July 2014. However, we have been unable to obtain information in relation to the applied methodology.

2.1. CCMAs in England: Method

Of the 22 regions who have adopted CCMAs, the vast majority used the SMP in connection with NCERM to define the area extent. As mentioned above, each region varied with the area covered, as some LPAs implemented CCMAs along the full stretch of coastline, whilst others selected particularly vulnerable segments. In addition, with an exception of Havant Borough Council, CCMAs have only been imposed where the SMP reflects NAI for the 100-yr epoch.

CCMAs are typically demarcated using one erosion line, with certain regions applying an additional buffer. For example, Wyre Borough Council defined their CCMA region based on the EA Flood Zone 2 maps with an additional 10 m buffer. The SMP and NCERM 100 yr worst case scenario was applied, which equated to a 6.6-m long-term rate of erosion, and was rounded up to 10 m to incorporate a buffer region (Wyre Council, 2019). Similarly, Newquay have applied three different zones to their CCMA. There is an absolute CCMA boundary, defined on the basis of the SMP 100-yr erosion rate, plus an exclusion zone (10-m buffer) and a coastal vulnerability zone (30-m buffer). In addition, if the coastal path passes through the exclusion zone, an additional 2-m buffer is applied to allow for rollback of the SW coastal path (Newquay Neighbourhood Plan, 2019). There is little information regarding the methodological application of the exclusion and vulnerability zones, and both have varying rules regulating development, and additional steps are required to develop buildings within these zones. As previously mentioned, the majority of LPAs require planning applications to complete Coastal Vulnerability Assessments as a pre-requisite for development within the CCMAs. Therefore, the review has shown the complexities and regional differences in developing and applying CCMAs as there is no broad brush approach to tackling coastal erosion and vulnerability.

2.2. The role of the Shoreline Management Plan

The review of LPA development plans has revealed a range of methodological approaches to defining CCMAs. Each approach incorporates the SMP 100-yr erosion rate, and other variables are region-specific with guidance from the EA, buffers based on climate change scenarios, and local beach management plans.

A SMP is a large-scale assessment of the risks associated with coastal processes "including tidal patterns, wave height, wave direction, and sediment transport processes", and presents a long-term policy framework to reduce the risks to people and the environment (SCOPAC, 2019). To date, there have been two SMPs; the first was produced in the 1990s, and the more recent (SMP2) review completed in 2006 came into practice in 2010. The SMP covers the entire English and Welsh Coast, which has been divided into 22 policy units (see: https://www.gov.uk/government/publications/shoreline-management-plans-smps/shoreline-management-plans-smps). Each region SMP has been implemented by different Local Authorities, but are broadly composed using the same methodology. A SMP defines the coastal boundary extent per policy unit for each National Coastal Erosion Risk Mapping (NCERM; discussed below) erosion scenario: short term (0 to 20 yrs), medium term (20 to 50 yrs), and long-term (50 to 100 yrs). There are four policy options available for SMPs, which are (1) Hold the Line (HTL): policy to maintain or upgrade the level of protection provided by defences or natural coastline (2) Advance the Line (ATL): policy to build coastal defences seawards of the existing defence line where significant land reclamation is considered (3) Managed Realignment (MR): Shoreline management plan policy to realign the 'natural' coastline configuration, either seaward or landward, in order to create a future sustainable shoreline position, and (4) No Active Intervention (NAI): policy to not invest in providing or maintaining defences or natural coastline (Figure 2-2).

2.3. SMP Method

The aim of the SMP is to provide a consistent approach to flood and coastal erosion risk management around the English and Welsh Coast. The SMP erosion rates are generally site-specific, calculated by conducting erosion risk analysis per sub-cell region. For example, SMP 14 has divided the Isle of Wight into 7 zones (Isle of Wight Council and Royal Haskoning, 2010). Each zone consists of varying coastal features, from cliffs, estuaries, dune systems, coastal engineering structures, and beach frontages backed by settlements (Isle of Wight Council, 2010). An analysis occurred within each zone to identify the current coastal processes acting on the coastline, sediment transport sources and pathways (SCOPAC, 2010), and historic changes (e.g. via topographic analysis). Using additional resources including the NCERM and

FutureCoast data sets the future shoreline position is then mapped; however, this does not incorporate any change in sea level rise or climate change impact which are predicted.

Therefore, the coastal management approaches of ATL, HTL, MR, and NAI are site-specific by incorporating the above analysis, and evaluate the impact of erosion from the surrounding environment. Areas that have sea defences are typically defined at HTL or MR. However, current defences have a life expectancy of 20–25 yrs, and, therefore, they would not be able to be defined as HTL for all three epochs as they are expected to fail before the end of the last scenario. For example, Figure 2-2 demonstrates the short-term 20-yr scenario, medium-term 50-yr scenario, and long-term 100-yr scenario for each classification. In addition, Figure 2-2D shows the change in designation from HTL in epoch 1 (0-20 yrs), to MRI or NAI in the 50–100 year scenarios. This is an important map which highlights shifts in the adopted SMP for each area – and therefore may have implications for CCMA designations. An additional map showing assigned funding to meet SMP designations would be equally informative and likely a significant component of any CCMA consideration.

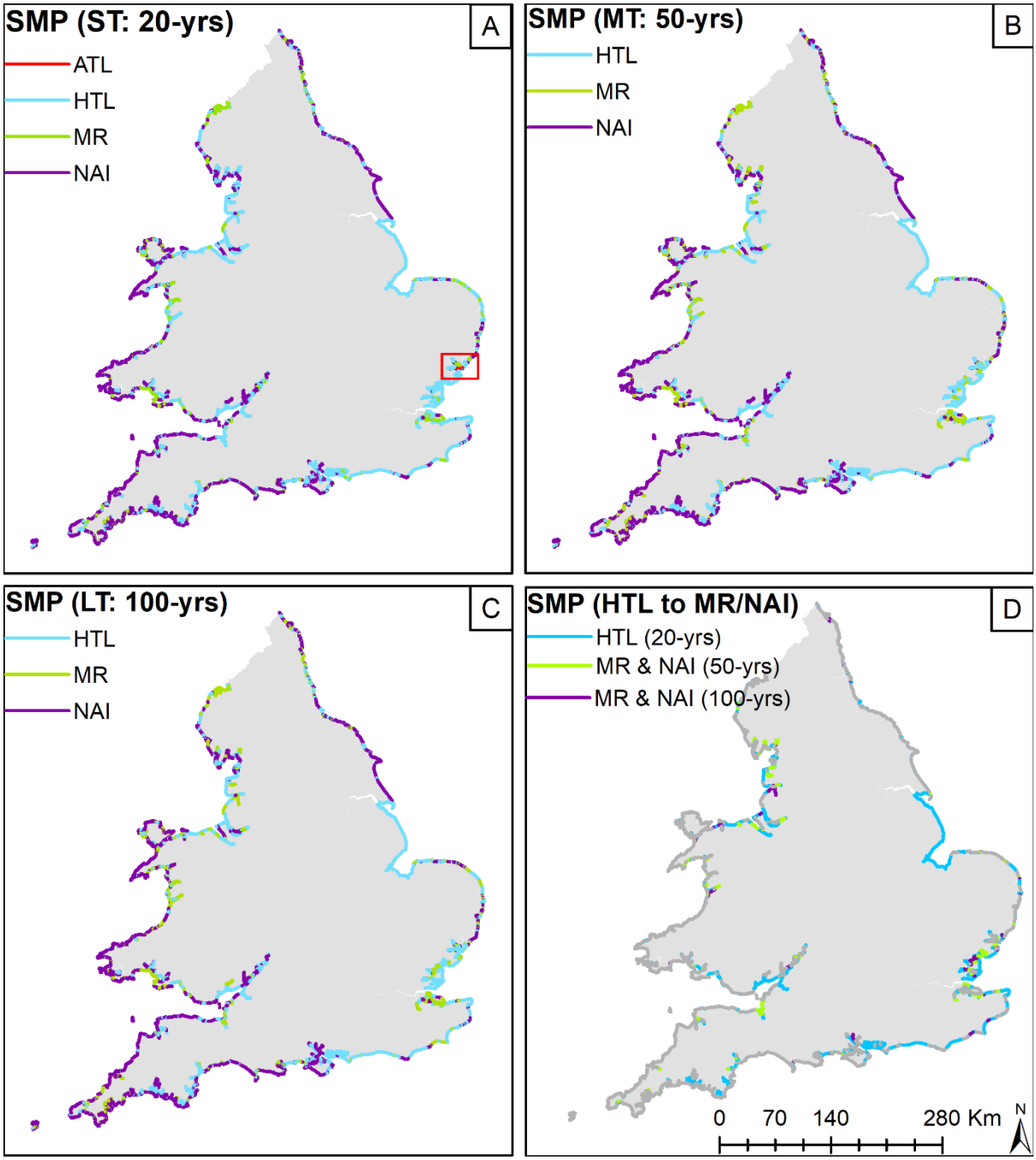

Figure 2-2. Shoreline Management Plans (SMP) for each epoch around England and Wales. (A) Short-Term (ST) 20-yr scenario (B) Medium-Term (MT) 50-yr scenario (C) Long-Term (LT) 100-yr scenario. The SMP consists of advance the line (ATL), hold the line (HTL), Managed Realignment (MR) and no active intervention (NAI). (D) Shows shorelines where the SMP designation changes from HTL after the first epoch. (Data available from: https://environment.data.gov.uk/DefraDataDownload/?mapService=EA/ShorelineManagementPlanMapping&Mode=spatial)

2.4. National Coastal Erosion Risk Maps

National Coastal Erosion Risk Maps (NCERM) demonstrate the coastal baseline position alongside projected flood risk/erosion zones. The maps are used to inform the development of the SMPs and, as such, outline CCMA regions. The NCERM coastal positions were developed as part the Risk Assessment of Coastal Erosion (RACE) project by adopting the 'source-pathway receptor risk model'. The model combines the erosive forces (source), where they become a hazard (pathway), and the magnitude of impact (receptors). This approach allowed the EA to propagate the magnitude of risk from coastal erosion; including the future efficacy of coastal defences and natural erosion at the coast (Halcrow, 2007). The combination of analysis (e.g. on engineering structures and natural coasts) allowed for a better risk assessment of change and contributed towards the primary development of NCERM (Halcrow, 2007).

RACE calculated erosion profiles with a propagated uncertainty based on the probability of erosion, alongside the future shoreline positions based on coastal retreat (Figure 2-3).

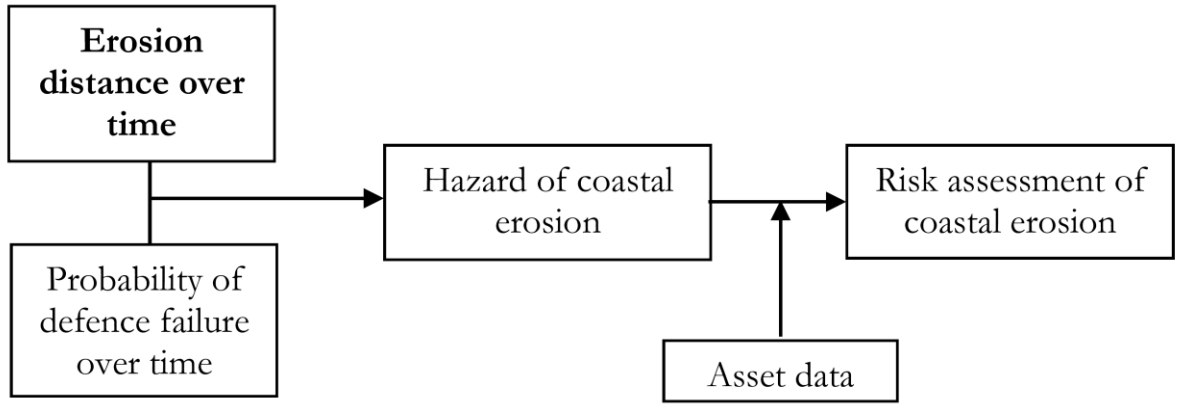

Figure 2-3. The Methodology For Risk Assessment Of Coastal Erosion (RACE) developed and applied to the NCERM project.

Erosion rates are difficult to predict due to the number of unknown variables (e.g. climate, geology and geomorphology) which influence erosion. RACE, therefore, applied three erosion risk boundaries, known as the best case, most likely, and worst-case scenario to outline the

minimum and maximum rates of erosion. These boundaries were based on cross-shore erosion profiles at 5%, 50% and 95% percentile confidence limits (Figure 2-4). For example, the worst-case scenario would represent high magnitude and frequency of cliff-erosion over a sustained period of time, rather than a large-scale episodic event.

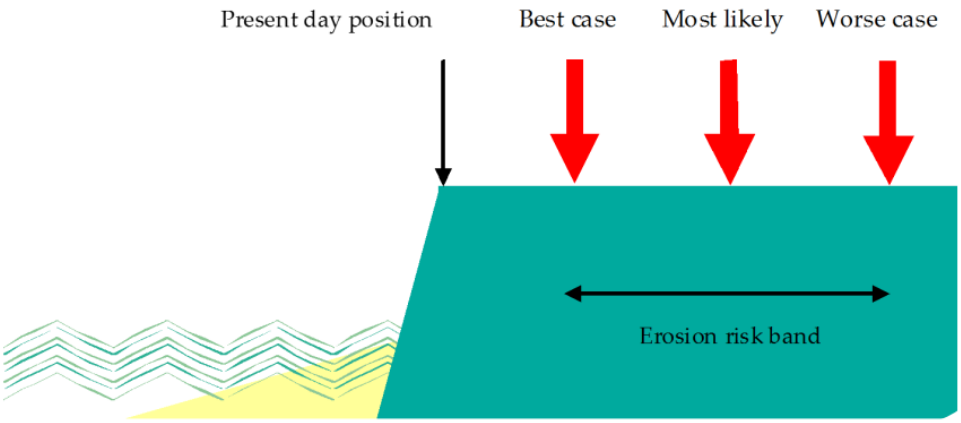

Figure 2-4. NCERM and EA erosion risk bands, examples of the best case (5%-ile), most likely (50%-ile) and worst case (95%-ile) erosion bands (Frampton and Hardiman, 2017).

RACE applied complex techniques to analyse the potential future condition of the coastline for cliffed regions and engineered structures (Table 2-2). The impact of coastal change has been assessed through: (1) the extrapolation of historical data; (2) expert judgement (e.g. from cliff behaviour models); (3) probabilistic simulation modelling; (4) process-response simulation modelling; and (5) empirical modelling (Halcrow, 2007). The following table obtained from Halcrow (2007) provides detailed information regarding the above techniques used to determine erosion potential.

Table 2-2. Techniques implimented by RACE for determining erosion potential, from Halcrow, 2007.

Technique		General Description	Main Points
1	Engineering Judgement	Experienced based assessment for use with minimal data.	Quick and easy method. Crude approximation.
2	Qualitative Assessment	Uses data from the Futurecoast cliff database	Consistency of available data lends itself to national application Imprecise output.

3	Broad Numerical Analysis	Combines data from Futurecoast with real data (e.g. more up to date aerial photographs)	More accurate than Technique 2, although some aspects remain imprecise. Some Local Authorities may already have such studies available
4	Detailed Calculation of Failure Potential	Uses purely real data and methods recommended by the Soft Rock Cliffs manual to calculate single recession rates.	Very robust method that will deliver reliable results. Data requirements exceed Techniques 1 to 3. Methods require extensive data and expert input.
5	Probabilistic Models	Uses purely real data and methods recommended by the Soft Rock Cliffs manual to calculate single recession rates.	Likely to provide most accurate output. Methods require extensive data and expert input.

Importantly, all of the above approaches require a historical retreat rate for future predictions and validation, and RACE used the historical retreat rates from Halcrow's Futurecoast model. DEFRA commissioned Futurecoast in 2002 which provides approximate estimations of future coastal change (DEFRA, 2002, Environmental Agency 2018). Futurecoast utilised available data on coastal evolution, both past and future to determine the future shoreline position. For example, historical cliff recession rates were derived from digitising historical (1:10,560 scale) and current (1:10,000 scale) OS maps, alongside expert guidance. Shoreline positional change was then classified into retreat, advance, oscillation, and no change in shoreline position, with the magnitude of change categorised into:

- Extreme: > 200 m in 100-yrs
- Very high: 100 – 200 m change in 100-yrs
- High: 50 – 100 m change in 100-yrs
- Moderate: 10 to 50 m change in 100-yrs
- Negligible: < 10 m change in 100-yr
- Breakdown: morphological change, for example, the formation of a new inlet

RACE then extrapolated the calculated historical retreat rates using a random sampling linear regression, to predict future rates of recession (Crowell et al., 1997). The simulation occurred multiple times to "establish a probability distribution for the position of the coast at any year in the future" (Halcrow, 2007). More recently, LiDAR data have become freely and easily

available around the UK which can be used to accurately quantify historical retreat rates and beach change over time (e.g. Earlie et al., 2014; Burvingt et al., 2016).

Despite the complex methodology deployed by RACE to model future coastal erosion (Figure 2-3), both RACE and NCERM are limited in their approach as they are spatially coarse and do not incorporate future sea-level rise scenarios (e.g. UKCP09/18). In summary; NCERM have developed their erosion scenarios for the short-term, medium-term, and long-term at the 5th, 50th, and 95th percentiles based on four types of data:

(1) Spatial data: coastline position (e.g. cliff top, defences etc) plotted using OS MasterMap and aerial photography.
(2) Historical recession data: obtained from Futurecoast
(3) Defence data: obtained from National Flood and Coastal Defence Dataset (NFCDD)
(4) SMP2 policy: SMP2 policy acted as a main driver towards NCERM.

(Rogers et al., 2015).

Moore et al. (2010) validated the NCERM outputs against predicted recession rates under UKCP09. The results showed that the NCERM model provides comparable rates of change to recession rates under SLR to the medium-term scenario (e.g. 50 yrs), with few NCERM outputs predicting comparable change under the long-term scenario (e.g. 100 yrs). As such, the future development of coastal retreat models ought to incorporate sea-level rise parameters to accurately predict the recession rates under a 100-yr scenario.

2.5. Environment Agency Flood Zones

The EA provide a "Flood Map for Planning" as an online tool for the public, which allows an area of interest to be explored with regard to its flood potential. The information provided can then be used as part of a flood risk assessment for a planning application. The maps provide different "Zones" which refer to modelled flood extents resulting from fluvial and tidal waters. The Flood Zones refer to the probability of river and sea flooding, which have been categorised into Zone 1 (low probability: 1 in 1,000 annual probability of river or sea flooding), Zone 2 (medium probability: between 1 in 100 and 1 in 1,000 annual probability of river flooding; or between 1 in 200 and 1 in 1,000 annual probability of sea flooding), Zone 3a (high probability: 1 in 100 and 1 in 200 (or greater) probability of river or sea flooding, respectively), and Zone 3b (the functional flood plain), Table 2-3.

Table 2-3. Environemnet Agency Flood Maps For Planning definitions for the Flood Zones used.

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding.(Land shown in dark blue on the Flood Map)
Zone 3b The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

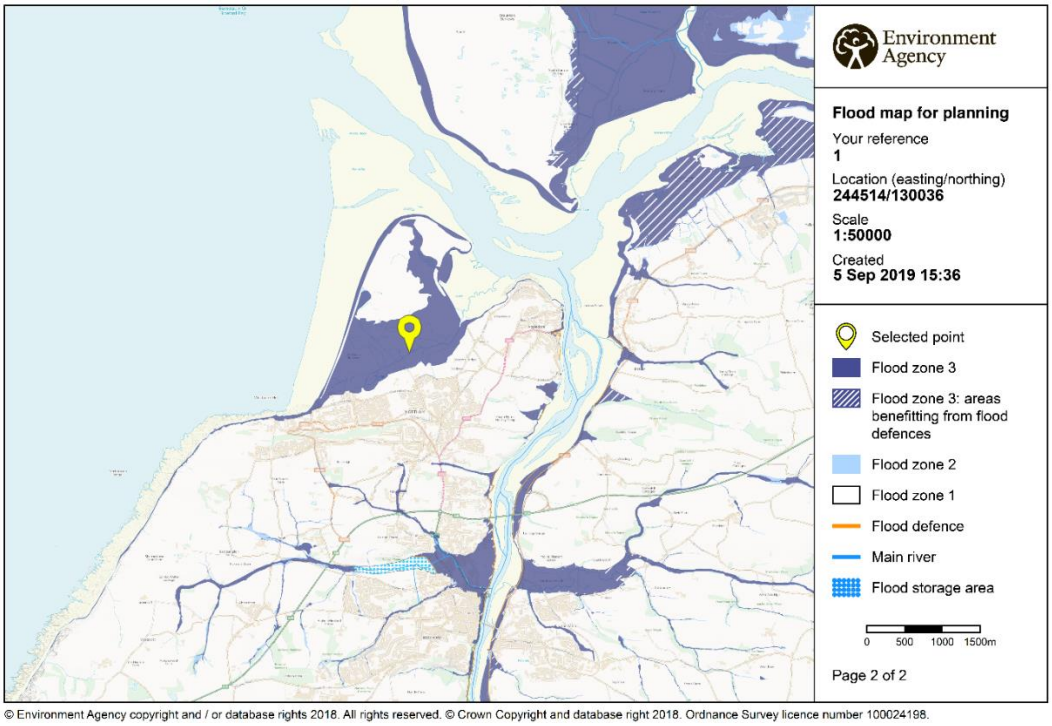

Figure 2-5. Example Flood Zone map as generated via the Environment Agency Flood map For Planning service (https://flood-map-for-planning.service.gov.uk/).

An example of the publicly available flood maps is given in Figure 2-5 which shows the area surrounding Westward Ho!. Importantly, the established publicly available flood zone maps do not account for the possible impacts of climate change projections (i.e. sea level rise, possible increases in storminess) in the future probability of flooding.

As part of long-term investment and strategic planning councils are obliged to undertake a Strategic Flood Risk Assessment (SFRA), of which there are two levels; Level 1 is used to identify potential development sites located in areas of low flood risk. These are usually completed using the information contained within the publicly available Flood Zone Maps for Planning. Where development is required/necessary in areas of greater flood risk, a Level 2 SFRA is usually required. A level 2 SFRA aims to identify the risk to an area from flooding from all sources, now and in the future by taking into account the impacts of climate change, and the impact land use changes and development will have on the flood risk. The climate change allowances are predictions of anticipated change for:

- peak river flow by river basin district
- peak rainfall intensity
- sea-level rise
- offshore wind speed and extreme wave height

While the EA flood zone maps do not consider future climate change, such considerations should be part of any Level 2 SFRA. Any consideration of climate change impacts discussed within a Level 1 SFRA often follows a similar approach to that stated in the SFRA for North Devon where;

- *Fluvial maps - For a rough guide, areas that are currently Flood Zone 2 will become Flood Zone 3 if climate change is accounted for.*
- *Tidal Maps – Similar to the above, but sometimes in flat areas, e.g. Pottington, flood zones could extend further, perhaps 20m or more beyond current Flood Zone 2. Further information should be sought on the flood risks from the Councils or the Environment Agency.*

This approach is underpinned by Table 2-4, which is the Governments national policy for land use and planning produced in 2010 (Planning and Policy Statement 25: Development and Flood Risk, 2010), the precursor to NPPF. Using Table 2-4, for the South West, between 2019 and 2100 a total SLR of 0.83m is forecast, which is within the bounds of the latest UKCP18 forecast (low emissions = 27 cm – 69 cm, high emissions = 51 cm – 113 cm).

Table 2-4. Recommended contingency allowances for relative sea-level rise, for each epoch in millimetres (mm) per year with cumulative sea level rise for each epoch in brackets, from Planning Policy Statement 25, Annex B.

Area of England	1990 to 2025	2026 to 2055	2056 to 2085	2086 to 2115	Cumulative rise 1990 to 2115 / metres (m)
East, east midlands, London, south east	4 (140 mm)	8.5 (255 mm)	12 (360 mm)	15 (450 mm)	1.21 m
South West	3.5 (122.5 mm)	8 (240 mm)	11.5 (345 mm)	14.5 (435 mm)	1.14 m
North west, north east	2.5 (87.5 mm)	7 (210 mm)	10 (300 mm)	13 (390 mm)	0.99 m

These allowances account for slow land movement. This is due to 'glacial isostatic adjustment' resulting from the release of pressure after ice that covered large parts of northern Britain melted at the end of the last ice age. The northern part of the country is slowly rising and the southern part is slowly sinking. This is why relative (net) sea level rise is less for the north west and north east than the rest of the country. Sea level can be estimated by adding the allowances for the appropriate geographical area from Table 2-4 to the 1990 base sea levelyear.

For a Level 2 SFRA far more detailed modelling is employed to look at a range of scenarios incorporating fluvial and tidal flood events and output providing detail on water depth, flow rates and flooding risk (Figure 2-6).

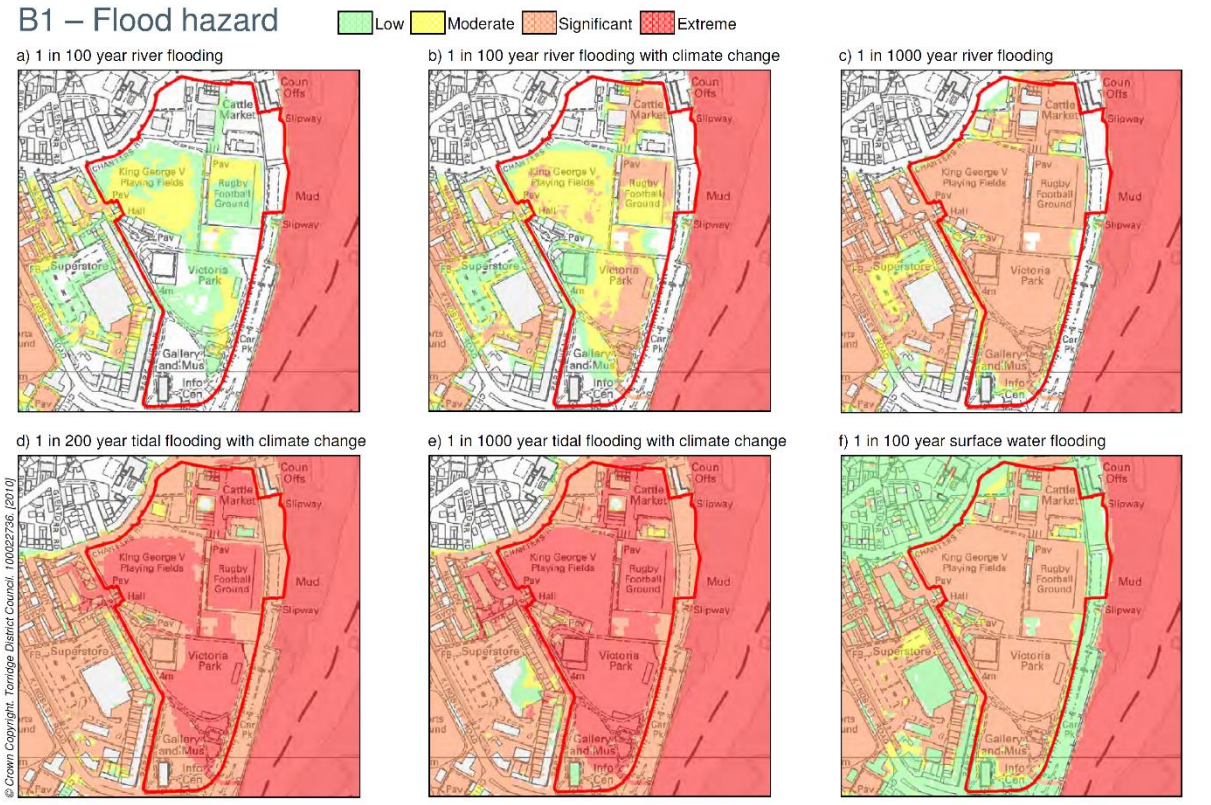

Figure 2-6. Example model output from the Level 2 SFRA undertaken for Bideford with a range of flooding scenarios classed into different Flood Hazard levels.

3. Case studies

3.1. CCMAs within England

The following section presents different case studies from UK LPAs where CCMAs have been adopted. The examples aim to provide an overview of existing methods that have been used for three key types of coastal environment – cliffs, estuaries and beaches.

Case Study 1: Defining CCMAs on cliffs - Dover District Council

Figure 3-1. Dover District Coastal Change Management Areas (Herrington Consulting Limited, 2019).

Region: Dover District Council

Coastline Type: Cliff

Year of adoption: 2015

Summary: In Dover District Council, seven CCMAs were identified between Kingsdown and Capel-le-ferne in 2010, based on the Shoreline Management Plans for (a) South Foreland to Beachy Head and (b) Isle of Grain to South Foreland Figure 3-1. The implementation and designation were reviewed in 2018 to update the approach to account for newly available information regarding CCMAs (Herrington Consulting Limited, 2018).

Method: CCMAs were implemented, in consultation with Herrington Consulting Limited, where the SMP defined areas as NAI or MR for the 100-year epoch, with an exception of Folkstone Warren where the policy was defined as HTL for the short-to-medium term, but NAI for the long-term. The CCMAs were defined using the digitised 2010 cliff-top and the EA 100-year erosion epoch; with a caveat that the spatial distribution of erosion rates may be over-or-under estimates. For example, retreat rates were applied per SMP segment which resulted in CCMA width variations of between c.7 m to 97 m along the Dover District coast. In addition, the SMP did not define 100-year erosion rates along the full coast due to complex cliff geology, for example at Capel-le-Ferne.

Case study 2: Defining CCMAs around Estuaries - Wyre Council

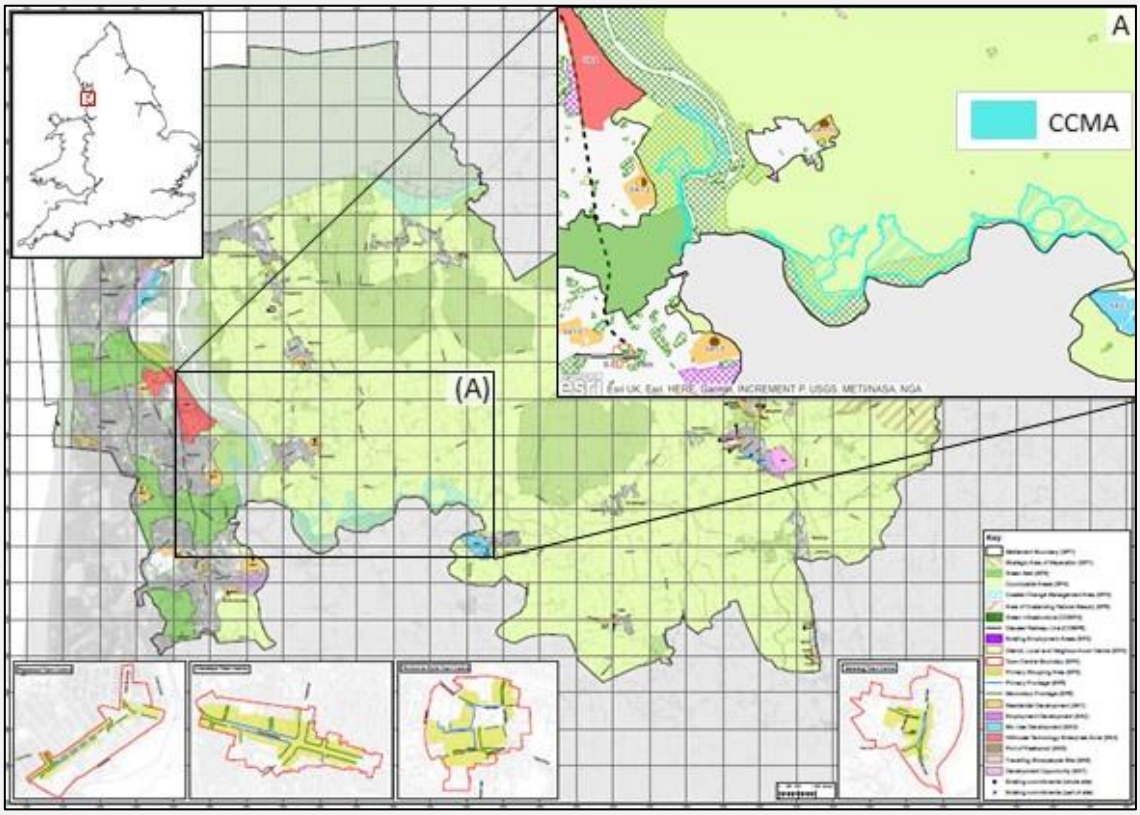

Figure 3-2. Wyre Adopted Local Plan Policy Map (available from https://wyre.maps.arcgis.com/apps/View/index.html?appid=b6a4363819334deba9158f4672cdc0f1) with the CCMA region highlighted in box (A) and enlarged in A.

Region: Wyre Council

Coastline Type: Estuarine

Year of adoption: 2019

Summary: In the Wyre District, four CCMAs were identified, one along the north of Piling, and three along different sections of the Wyre Estuary where the SMP policy is not hold or advance the line (Figure 3-2).

Method: The CCMAs have been defined on areas of No Active Intervention or Managed Realignment, based on the SMP, in addition to using the EA's Tidal Zone 2 plus a 10-m buffer (Wyre Council, 2019). The EA flood zone map is based on "land assessed as having between 1 in 100 and 1 in 1,000 annual probability of river flooding (1% - 0.1%) or between

a 1 in 200 and 1 in 1,0000 annual probability of sea flooding (0.5% - 0.1%) in any year" (Environmental Agency, 2015). In addition, the Tidal Zone 2 acknowledges the impact of climate change by calculating 100-yrs of sea-level rise. The additional buffer was derived by using the NCERM long-term (50–100 yr) erosion rate at the 95th percentile, which equated to 6.6 m and was rounded up to 10 m to be conservative.

Case study 3: Defining CCMAs on mixed environments - Swale Borough Council

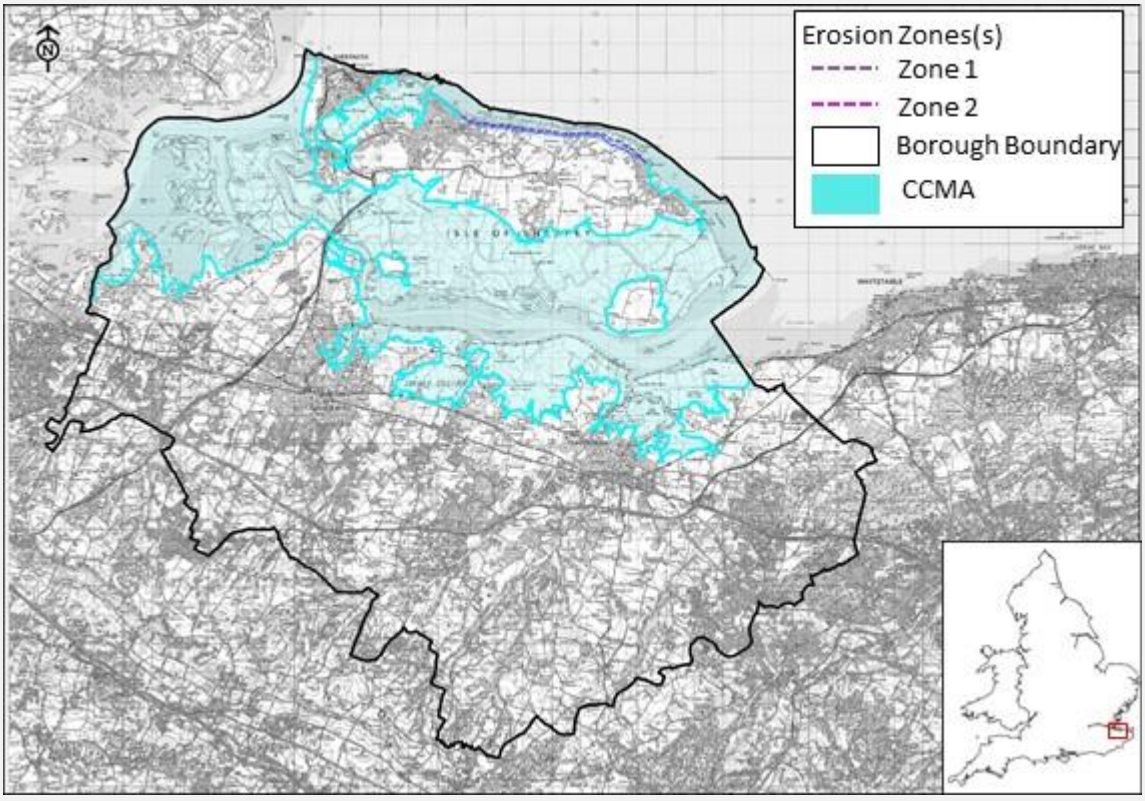

Figure 3-3. Swale Borough Coastal Change Management Area (Swale Borough Council, 2013)

Region: Swale Borough

Coastline Type: Mixed cliffs, dunes, estuarine & town

Year of adoption: 2013

Summary: Swale Borough implemented a CCMA along the 111-km shoreline around the Swale Estuary and the Island of Sheppey in 2013, to protect the surrounding environment from coastal flooding (Swale Borough Council, 2013; Figure 3-3). Swale region has applied the CCMA to a range of environments; including cliffs, inter-tidal mudflats, and beaches, making it an excellent case study to draw from. Built up areas within Swale were defined within the SMP as hold the line or advance the line over the 100-yr scenario; therefore, these

areas have been excluded from the CCMA as existing strategies are thought to adequately mitigate future risk.

Methodology: The CCMA was defined using a combination of approaches, which included a pre- coastal adaptation study for North Sheppey (Canterbury City Council Engineering Services, 2011), Environmental Agency flood maps, Swales strategic flood assessment (Halcrow, 2015), and relevant guidance from the SMP. The EA flood map zone 3 was adopted as the land is predicted as having a "1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year" (Environmental Agency, 2015). The EA flood zone maps also incorporate sea-level rise scenarios over a 100-yr period. All of the above investigations were reviewed and assessed to appropriately define the extent of the CCMA.

3.2. International Coastal Change Management Strategies

Coastal management, in response to climate change predictions and increasing population pressures is a global issue. As evident in the previous sections, tyring to understand the detail of management approaches, in particular the methodology used to derive management policy is often complex and opaque. While our research has identified some comparable work overseas, much of it falls under broader coastal zone management rather than more specific CCMA methods that we are focusing on.

In France the Natural Risk Prevention Plans (PPRn) focuses on development control in coastal regions, reinforced by the Grenelle of the Environment bill. The plans were developed in 1995, and by 2008 the PPRn had been approved in 270 coastal communities (Deboudt, 2010). In Nord/Pas-de-Calais regions, shoreline management strategies were developed based from the PPRn, for example, the Coastal Actions for Erosion Management Plan (PLAGE) which provides guidance for the decision making process (Deboudt, 2010). The PPRn reduced the vulnerability of coastal zones via the ban of settlements in dangerous zones, prioritising human life and spreading costs from potential disasters. The plan established three zones, based on flooding, within the coastal regions; red zone, blue zone and white zone (Deboudt, 2010). Within the red zone no planning permission is permitted, this rule was enforced by the 1982 Predictable Natural Risk Exposure law forbidding construction in natural risk prone areas. Within the blue zone planning permission is subject to conditions and within the white zone planning permission is subject to local planning regulations (National Trust, 2015).

In the Canadian Great lakes have adopted a similar SMP that were developed in the Great Lakes area to minimise threat to life and property from flooding and erosion. The SMP requires developments to account for shoreline hazards, following regulations under section 28 of the provincial Conservation Authorities Act allowing authorities to control shoreline works (Lawrence, 1995). Hazards have been assessed by calculating Ontario's shorelines recession rates, erosion prone areas, maximum wave uprush and floor levels (Lawrence, 1995).

Iran has also adopted a similar SMP approach. The Iranian Integrated Coastal Zone Management (ICZM) was established by Port and Marine Organisation between 2005 and 2007. The SMPs defines and conveys risks from flooding and erosion within the area, sets out regulations and policies for planning and land use and has procedures in place for the monitoring of policies (Dibajnia, et al., 2012). Historic erosion and accretion rates were used to aid in the forecast of future shoreline positions and definition of setbacks (Dibajnia et al., 2012).

4. Discussion and Summary

This document has sought to provide an overview of CCMA use in England with examples of similar approaches adopted further afield. The CCMA process, from conception and development through to adoption, is multi-faceted both in terms of the partners/organisations involved, but also in the data used to underpin the decisions made. Projecting coastal change into the future, including climate change considerations, adds to the complexity of designating future CCMAs. However, few would argue that development of a CCMA is not a worthwhile process, as it provides a much-needed framework for local planners to implement sustainable development at the coast.

The review of CCMAs within England (Sections 2 - 3.1), has shown that, broadly speaking, CCMAs are designated as required for regions considered NAI/MR and rarely for HTL, in-line with NPPF guidance. While there is some variability in "buffers" applied to CCMAs, the underlying approach is to adopt the most recent SMP guidelines. The SMP is a comprehensive body of work, and makes use of multiple previous large-scale coastal studies. While the SMP is limited in terms of projecting climate change impacts and spatial resolution, it does incorporate a sound body of work with respect to historic changes and coastal processes.

While it is the intention of the SWEEP CCMA project to try and identify a more consistent, scientific method that can address some of the shortcomings (e.g. climate change impacts) in the use of SMPs for CCMA designation, it is fully recognised that the detail contained within the SMPs is of significant benefit and importance. Equally, while an objective and repeatable methodology is being sought throughout this project, the inclusion of "expert consultation" is still of importance and should be maintained to ensure the most up-to-date, site-specific information is utilised.

From the outset, the CCMA designations are viewed as a working document and planning guidance rightly states that planners should use the "best available information" in consideration of any development proposals. Therefore, as SMPs and NCERM data are

intermittently reviewed, CCMAs that are based on a SMP can equally be updated and revised accordingly.

One of the concerns identified in this report is the omission of sections of coastline deemed HTL. While some sections of coastline define HTL for all epochs of the SMP, there is often little long-term funding streams identified to maintain such designations for the same time period. Given this lack of long-term commitment we would advise a precautionary CCMA designation is used to provide greater checks on development proposals. While the SMP is the standard dataset LPAs are using to underpin a CCMA, trying to establish further method statements, in this respect, is often less straightforward. Equally the historic development of the NCERM and SMP projections is a multifaceted processes with a range of stakeholders and a possible useful output from the SWEEP CCMA project in WP4 would be the development of a summary paper on these topics.

It is recommended going forward, that the NPPF provide a structure for LPAs to adhere to, for example, covering the specific CCMA region, type of coastline, and methodological approach to use. A standardised approach would limit the complexities in implementing and defining CCMAs, alongside enhancing the consistency between councils, ultimately, enhancing the planning policy practice.

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Appendix A

A1. Questionnaire responses from LGAs

East of Riding Yorkshire Council

(1) Which LGA do you work for?

East Riding of Yorkshire Council

(2) Does your LGA have a CCMA in place? If so, for how long? If not, is one in development stage?

Yes. The CCMA formed part of the East Riding Local Plan Strategy Document, which was adopted in April 2016.

(3) Did you undertake the CCMA work yourself or was this outsourced?

Work was undertaken internally between the forward planning, sustainable development and coastal engineering teams.

(4) What areas does your CCMA cover e.g. complex cliff, sandy beach, estuary?

Soft, glacial till cliffs, which are exposed to the average erosion rate of up to 4m per year and isolated cliff losses of over 20m in some locations.

(5) Can you briefly explain the methodology used to define the location of the CCMA (does this differ for the coastline type?), for example have you relied on the regional SMP, the NCERM data, advice from the Environment Agency etc.?

Our approach to identifying the extent of the CCMA was based on the Council's existing approach to defining coastal erosion risk, which had been developed over a number of years through the development of rollback guidance documents for residential properties, agricultural operations and caravan parks, the development of the Flamborough Head to Gibraltar Point Shoreline Management Plan (SMP), and the delivery of the East Riding Coastal Change Pathfinder project.

Specifically, and to comply with the guidance within the NPPF to include ‘any area likely to be affected by physical changes to the coast’, it was decided that a CCMA would be implemented on all areas of coast where:

- There is a No Active Intervention Policy in place within the SMP; and
- The results of the Council's coastal change monitoring programme show that coastal erosion is taking place (e.g. the stable chalk cliffs around Flamborough are not part of the CCMA).

This has resulted in the entirety of the East Riding coast, with the exception of the hard chalk cliffs of Flamborough Head, the sand spit of Spurn Head, and the defended frontages of Bridlington, Hornsea, Mappleton, Withernsea and Easington (Hold the Line areas within the SMP) being defined as a CCMA.

With regards the landward boundary of the CCMA, this is based on the estimated position of the East Riding coastline in 2105. This mirrors the timescales within the SMP and approximately matches the typical lifespan of a development, as defined through the planning process. The projected 2105 cliffline was determined by extrapolating the average recent (since 1989) erosion rates for each 500m stretch of the East Riding coast, as recorded through the Council's coastal erosion monitoring programme. This data is collected twice yearly through aerial LiDAR surveys. These projections do not account for future changes in erosion rates due to climate change.

In order to sustain the economy of communities within the CCMA and to allow time for longer-term planning solutions to be implemented (while still avoiding inappropriate development) some temporary development is allowed within the CCMA. The type and scale of development which will be allowed is dependent on which of the four zones within the CCMA the proposed development is located. The extent of these zones are based on the risk levels developed through the delivery of the East Riding Coastal Change Pathfinder, as described below, along with a very brief description of the types of development which may be considered within each zone:

More examples of appropriate temporary development within each zone can be found in Table 11 within the East Riding Local Plan Strategy Document.

(6) Does your CCMA make any allowance for projected climate change scenarios e.g UKCP09/18 sea level rise predictions? Is there an expectation it will be reviewed periodically and updated as required?

Risk Zone	Extent of zone	Examples of appropriate development
Imminent risk	Land within the maximum cliff loss distance ever recorded for that 500m stretch of coast (this zone is not mapped but is described within the policy statement).	No development is allowed in this zone.
High risk	Land outside of the imminent risk zone, but which is expected to be lost by 2025	Development strictly limited to temporary uses e.g car parks, touring caravan pitches
Medium risk	Land expected to be lost between 2025 and 2055	Replacement / adaptation of essential commercial facilities and infrastructure
Low risk	Land expected to be lost between 2055 and 2105	Extensions to existing properties and temporary developments to replace residential properties at risk from coastal erosion.

As stated above, the CCMA was based on a straight extrapolation of recorded erosion rates, and does not account for future changes in erosion rates due to climate change. It is expected that the CCMA extent and policies will be reviewed alongside the review of the Local Plan. It is possible that climate change may be considered as part of this review.

A Coastal Change Supplementary Planning Document (SPD) is also currently in development, which will provide further advice to developers and planners on the types of development which will be considered for approval within the CCMA. This SPD will be developed as part of the review of the East Riding Local Plan which is currently in its early stages. This review will also provide an opportunity to update the physical boundary of the CCMA based on erosion monitoring data collected since it was originally defined in 2015.

(7) What are the main problems you have faced with defining the CCMA regions?

Concerns were raised during the development of the CCMA that existing properties within the CCMA boundary could be blighted, however as erosion data is publically available, and because the definition of a CCMA is not assigning a particular function for that land, these concerns were dismissed.

North Norfolk District Council

(1) Which LGA do you work for?
North Norfolk District Council / Coastal Partnership East

(2) Does your LGA have a CCMA in place? If so, for how long? If not, is one in development stage?
YES - 2008

(3) Did you undertake the CCMA work yourself or was this outsourced? In house

(4) What areas does your CCMA cover e.g. complex cliff, sandy beach, estuary?
Cliffed frontage

(5) Can you briefly explain the methodology used to define the location of the CCMA (does this differ for the coastline type?), for example have you relied on the regional SMP, the NCERM data, advice from the Environment Agency etc.?
SMP erosion epoch - 2105

(6) Does your CCMA make any allowance for projected climate change scenarios e.g UKCP09/18 sea level rise predictions? Is there an expectation it will be reviewed periodically and updated as required?
Up to adoption of the SMP in 2012 – none after that yet.

(7) What are the main problems you have faced with defining the CCMA regions?

Wyre Council

(1) Which LGA do you work for?
Wyre Council

(2) Does your LGA have a CCMA in place? If so, for how long? If not, is one in development stage?
Yes: Part of Adopted Local Plan (Feb 2019)

(3) Did you undertake the CCMA work yourself or was this outsourced?
In house

(4) What areas does your CCMA cover e.g. complex cliff, sandy beach, estuary?
Estuary (River Wyre) , Open Coast within Morecambe Bay (Low lying land SMP policy managed Realignment epoch 2)

(5) Can you briefly explain the methodology used to define the location of the CCMA (does this differ for the coastline type?), for example have you relied on the regional SMP, the NCERM data, advice from the Environment Agency etc.?
Estuary soft cliffs, NCERM data plus sensitivity allowance.

Open coast alignment based on potential future setback.

(6) Does your CCMA make any allowance for projected climate change scenarios e.g UKCP09/18 sea level rise predictions? Is there an expectation it will be reviewed periodically and updated as required?
No although the timing of the realignment will be heavily dependent on sea level rise.

(7) What are the main problems you have faced with defining the CCMA regions?
Estuary: No significant issue as no infrastructure or property within the zone.

Open coast: definition of the realigned defences and the affordability of the SMP policy.