Coastal Change Management Areas (CCMAs) – Methodology and Adoption

Work Package 3: Draft CCMA Regions

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Work Package 3: CCMA Draft Regions

Executive Summary

Technical report introducing the second draft of retreat and inundation lines to be used as evidence for the generation of CCMA areas for the Taw Torridge estuary and the East Devon coastline.

The report provides details of the digital GIS files supplied in support of this document. Some discussion on the specific regions is provided, however, the focus is on an explanation of different files that are provided to delineate the short (20 yr) medium (50 yr) and long term (100 yr) likely coastline positions as generated following the methodology outlined in WP2 Version 2 report. For erosion dominated coastlines three epochs are predicted and associated 'buffers' for each coastline are also supplied. For inundation/flood dominated coasts the 1:200 yr level (including sea-level rise) is used to generate a single region with additional 'buffer' lines also provided to accommodate coastal paths and mapping accuracy.

It is envisaged that the proposed areas will be refined by the Local Planning Authorities, for each region, to best reflect the needs of each district. The files provide each local authority with supporting evidence from which the development of CCMA regions can be generated.

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1. Introduction

This report is the third work package (WP3) of the SWEEP Coastal Change Management Area (CCMA) project, intended to present an optimised methodology for determining the extents of a CCMA. This document presents the final retreat lines/future inundation extents developed using the methods outlined in WP2 that can be used to define a CCMA.

Version 1 (V1) of this report presented changes and additions to the original agreed methodology. These changes have now been incorporated into Version 2 (V2) of the WP2 report and are not contained within this document. The purpose of this report is to present a summary of the regions that have been mapped and highlight any specific areas of interest. The report is broken down into the two regions although there is overlap between the two areas in terms of how the areas are mapped and subsequent naming conventions for the files provided.

Following discussions of WP2 V1 report there were some clear guidelines on the output expected and a request for further clarity on the GIS techniques used which have now been incorporated into WP2 V2 report. It was agreed:

- For erosive coastlines we would provide three predicted retreat lines delineating three epochs (short = 20 yrs, medium = 50 yrs and long term =100 yrs) in line with the Shoreline Management Plan (SMP).
- We would apply the High Emissions (HE) 50 %ile sea level rise scenario to the retreat calculations, as projected by UKCP18, in-line with Environment Agency (EA) methods. This is the mid-range of the HE scenario and so considered a ‘precautionary’ rate upon which future planning is aligned.
- For tide dominated coasts (e.g. estuaries) a single 1:200 yr return event sea level anomaly, combined with projected sea-level rise, would be mapped for a long term scenario in line with existing strategic flood risk assessments (SFRA) undertaken at most established coastal towns. This ensures existing SFRA can be adopted/incorporated into this CCMA method.
- For all areas an additional ‘buffer’ would be provided to each line which allows for variability in retreat rates, mapping accuracy and the southwest coastal path, where necessary.

Discussion Points

It important to be clear what the lines presented in this report represent, with respect to potential CCMA designations. This is a technical report, supporting digital files, which provides an overview of the evidence-based predicted retreat position of future coastlines and/or predicted inundation extents. It is expected that this information will be used, as the evidence for subsequent designation of CCMA areas.

We do not provide any suggestion of the specific polices that may surround CCMA adoption or how they are applied by the respective LPAs.

Where sea defences exist the current policy is that a CCMA is not required by the LPAs. We have therefore provided retreat/inundation extents in these areas as separate GIS layers that can be included or omitted from the wider CCMAs. As discussed in WP2, predicting response at a site with a sea defence is very complex and predicted lines are based on a response without a structure in place- which is unrealistic given existing infrastructure.

The lines have been provided will sometimes appear to cross 'through' a property. This often reflects the resolution or the accuracy (e.g. how recent the data is valid) that has been used. In such cases it is up to the LPA to make a judgement on which side of the property the boundary should fall, although it is suggested a pre-cautionary approach should be taken.

For some areas where flood inundation has been mapped the presence of 'dry-islands' will occur where elevated topography results in areas mapped above the flood extent while they may be surrounded by lower lying ground. For these locations (see examples in Section 1.1), depending on their location, the LPA should decide on how best to incorporate them into the CCMA or allow them to stand alone following consideration of further flood defence infrastructure.

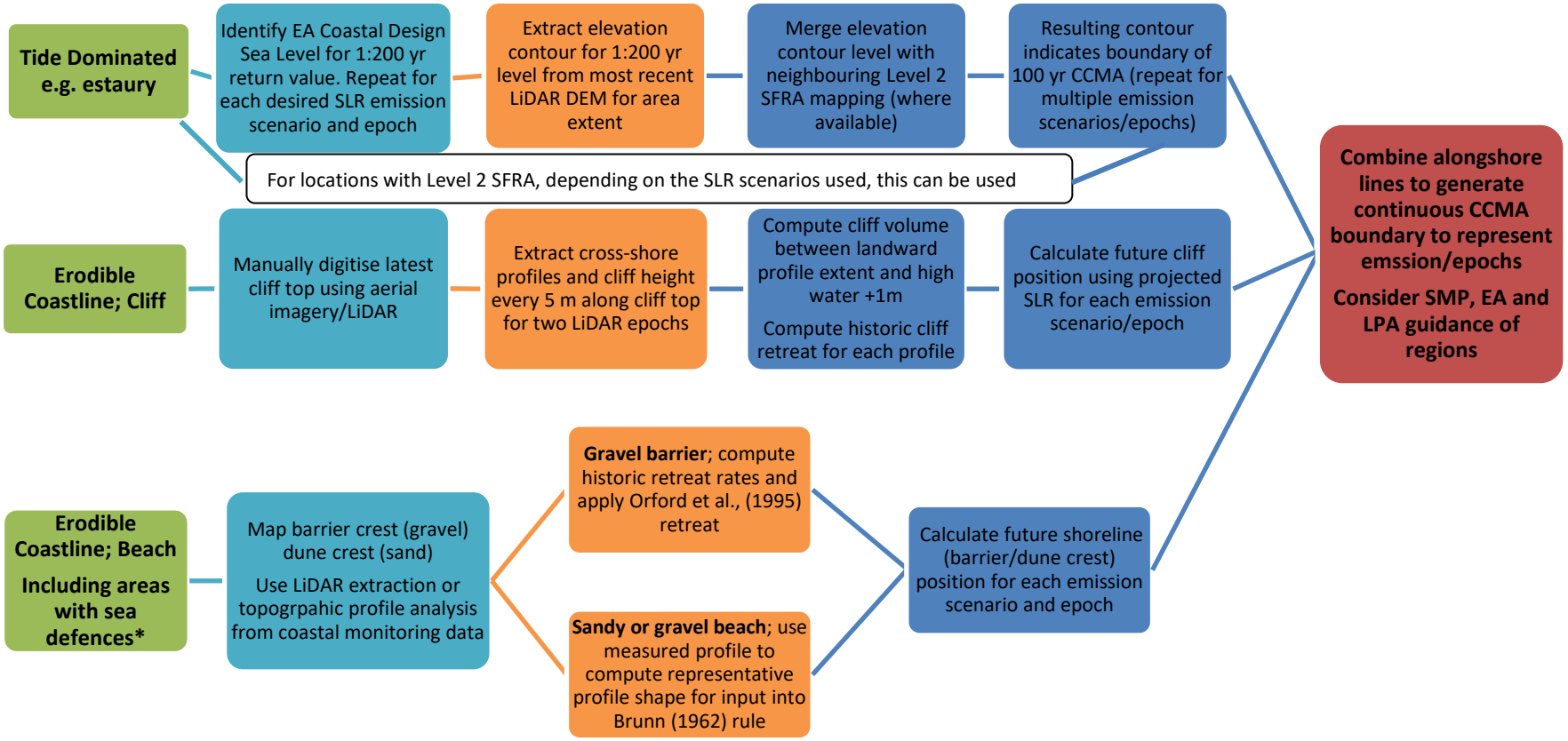

Figure 1-1. Schematic workflow of the main steps required for CCMA generation for different coast types. The final stage would involve detailed assessment of existing SMP and discussion with the LPA, EA and other relevant experts. The reader is referred back to Sections 2 (Cliff Backed Coastline), 3 (Floodable Estuaries), and 4 (Beaches and Defences) for details of the methods described.*As per Section 4 beaches backed by defences are treated as natural beaches as no method exists to incorporate defence structures.

2. North Devon Taw Torridge Estuary

Following the development of the CCMA methodology in WP2 it was agreed that the draft CCMA analysis extent, for the Taw Torridge estuary, would extend from Westward Ho! and Saunton Beach, at the estuary mouth, up to the tidal limit of both rivers (Figure 2-1).

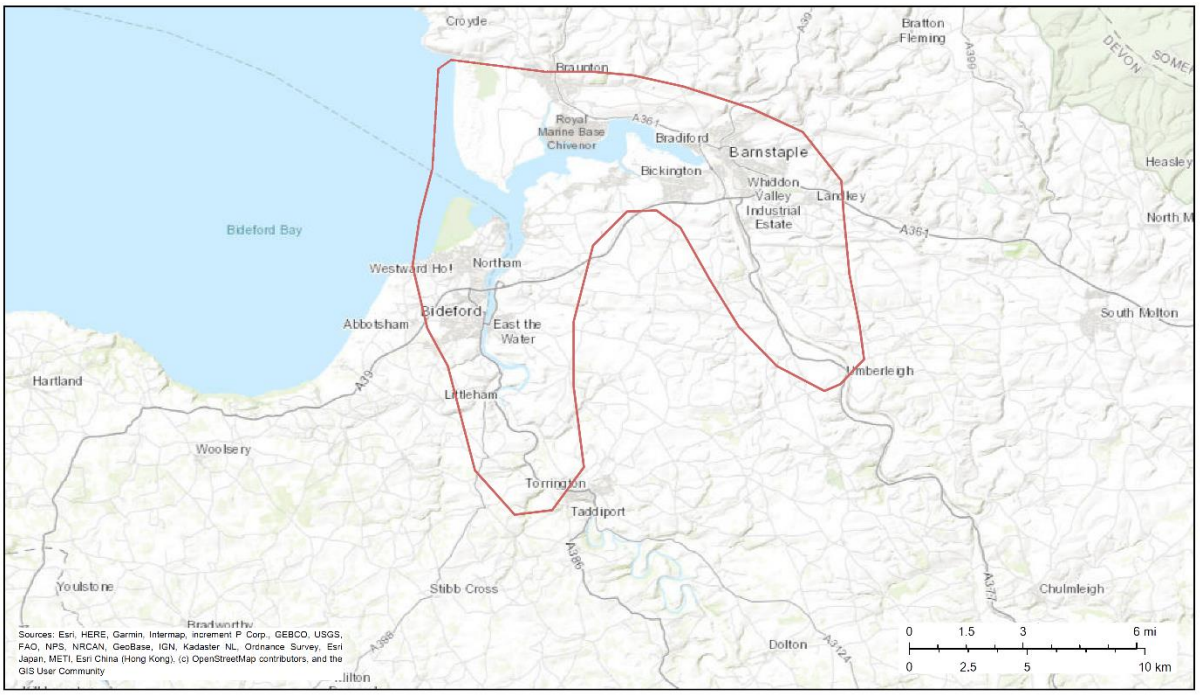

Figure 2-1. Relief map of North Devon with a bounding box (red) highlighting the area covered by the draft CCMA. The region extends up to the tidal limits of the rivers Taw and Torridge. Figure courtesy of Plymouth Coastal Observatory.

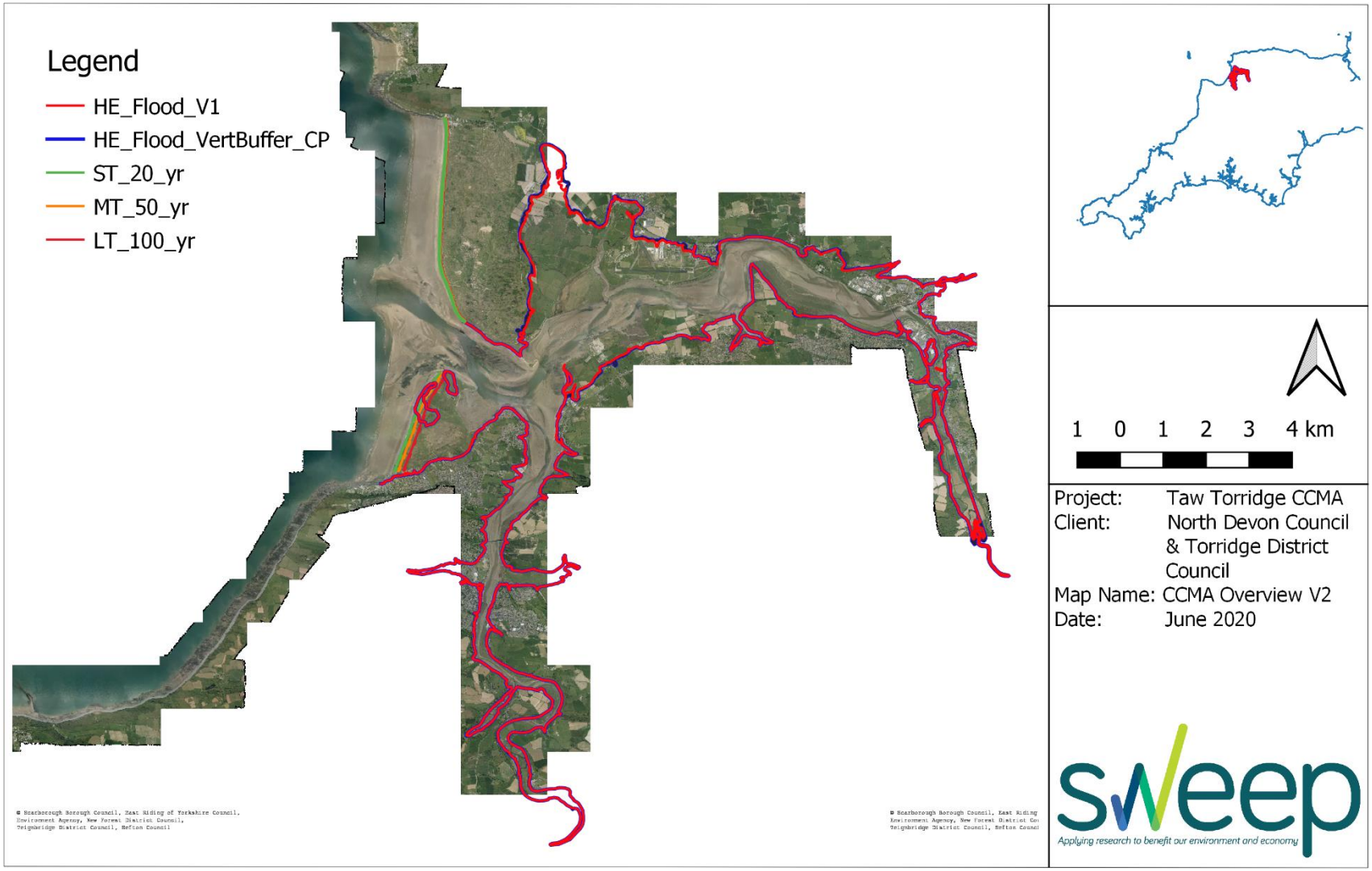

Figure 2-2. Overview map showing the full extent of the CCMA for the Taw Torridge region.

2.1. Taw Torridge Estuary CCMA

As with any GIS based spatial mapping it is far easier to explore and digest the output within a GIS platform rather than in a report. The full overview of the area mapped is shown in Figure 2-2. The scale of the overview map means it is hard to differentiate between the different layers that are presented. Table 2-1 summarises the layers that we have provided digitally (TawTorridge_CCMA_V2.zip) as well as those which have been presented within the overview map in Figure 2-2.

Table 2-1. Layer names and descriptions that are provided, as digital files (TawTorridge_CCMA_V2.zip), and used to generate the overview map in Figure 2-2.

Layer Name	Description
HE_Flood_V1	The 2100 1:200 yr flood boundary elevation location using the High Emissions (HE) 50 %ile output
HE_Flood_VertBuffer	The 2100 1:200 yr flood boundary elevation location using the High Emissions (HE) 50 %ile output plus 0.25 m (**vertical buffer**)
HE_Flood_VertBuffer_CP	The 2100 1:200 yr flood boundary elevation location using the High Emissions (HE) 50 %ile output plus 0.25 m and a 2m **horizontal buffer** to allow for the coast path
ST_20_yr	The 2040 cliff/coastline position using the High Emissions (HE) 50 %ile output
MT_50_yr	The 2070 cliff/coastline position using the High Emissions (HE) 50 %ile output
LT_100_yr	The 2100 cliff/coastline position using the High Emissions (HE) 50 %ile output
ST_20_yr_Buffer	The cliff/coastline position (for each epoch) using the High Emissions (HE) 50 %ile output plus the **horizontal buffer** (10 m or 10 % of projected retreat distance)
MT_50_yr_Buffer	
LT_100_yr_Buffer	

By highlighting small areas of the region we can explore some of the detail that gives an indication of the CCMA lines and any aspects of their location. Figure 2-3 gives a simple representation of the proposed flood extent (red line) and the difference in the line position when a vertical buffer and a horizontal buffer are added. This figure clearly shows how a standard horizontal buffer, not linked to the terrain, would not match the extent as presented.

As outlined in the WP2 methodology the approach adopted is to take the worst case extent i.e. most landward. For areas where a Level 2 Strategic Flood Risk Assessment (SFRA) has been undertaken we would incorporate this area as necessary (Figure 2-4). This figure also highlights the complexities of extracting elevation data from LiDAR mapping where hedgerows/treelines may create artificial barriers when in fact they 'hide' the true flood extent. For such regions some 'interpolation' across areas is the most pragmatic way forward.

Figure 2-3. Aerial image showing Velator and parts of RMB Chivenor with the CCMA extent overlaid. Red line is the projected 1:200 yr line and the blue line is the projected position including the vertical and horizontal buffer.

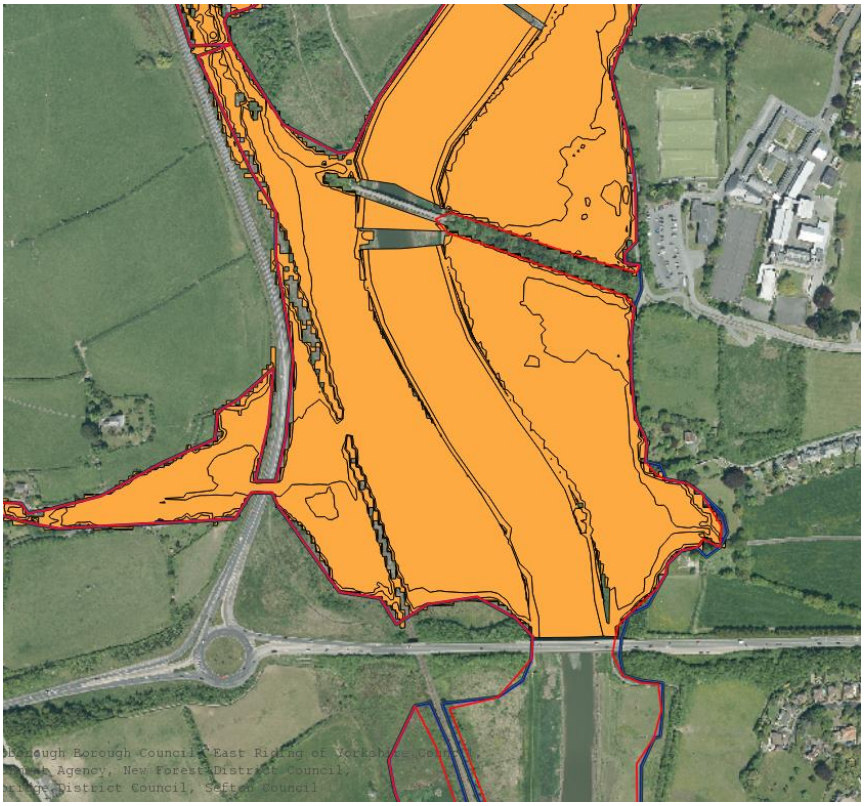

Figure 2-4. Aerial view of the River Taw as the A 361 crosses it. This marks the extent of the Level 2 SFRA that was undertaken and also highlights the need for manual input to "refine" the CCMA around woodland and roadways etc. Note the lines presented represent ground level and therefore pass under bridges etc.

At the mouth of the Taw Torridge estuary Westward Ho! is dominated by a unique gravel barrier spit that extends north from the town (Figure 2-5). Again, following WP2 we have incorporated three likely future barrier positions based on gravel barrier roll-back predictions. As these positions all lie seaward of the flood area we would imagine the whole of the Northam Burrows would be incorporated into the CCMA (Figure 2-5). The presence of 'dry islands' on the Northam Burrows – reflecting the elevated position of the dune system – would also be classed as within the CCMA area.

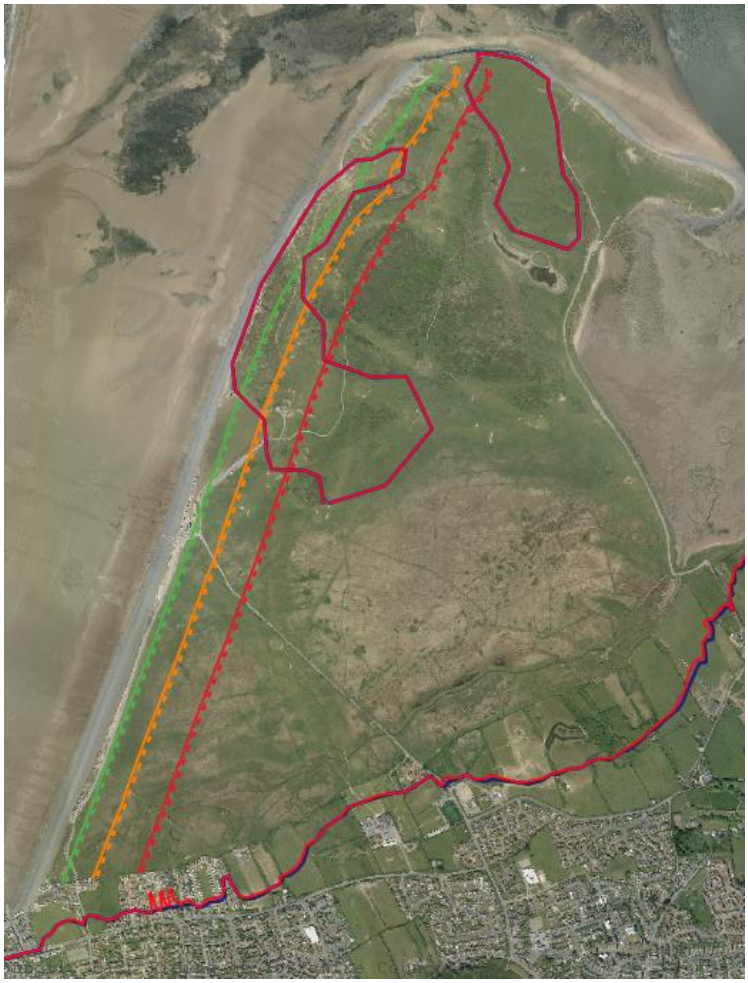

Figure 2-5. Aerial image of Westward Ho! showing the predicted barrier rollback positions for three epochs; short term (green line); medium term (orange line); long term (red line). The buffer lines for each epoch are demoted by the dashed lines. Flood extent 'dry islands' are also plotted over Northam Burrows.

On the northern side of the Taw Torridge estuary mouth lies Saunton Sands backed by Braunton Burrows (Figure 2-6). This region is represented in a similar approach to Westward Ho! with three future retreat lines (plus buffers), representing each epoch, generated using the sandy beach methodology.

Figure 2-6. Close-up aerial image of Saunton Sands showing the predicted beach positions for three epochs; short term (green line); medium term (orange line); long term (red line). The buffer lines for each epoch are demoted by the dashed lines.

3. East Devon

For the East Devon coastline it was agreed that we would provide a draft CCMA region for the area extending from Pennington Point, Sidmouth, in the west to the eastern boundary of East Devon at the edge of Lyme Regis (Figure 3-1);.

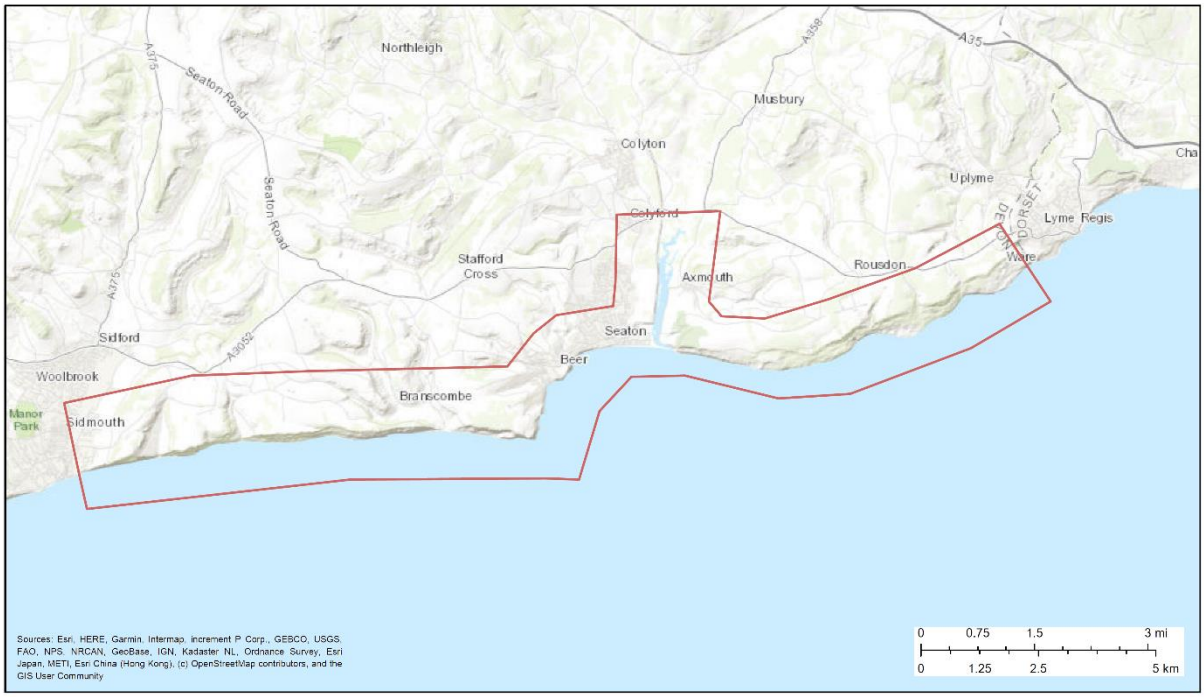

Figure 3-1. Relief map of East Devon with a bounding box (red) highlighting the area covered by the draft CCMA. Figure courtesy of Plymouth Coastal Observatory.

Much like the work for North Devon, there are some aspects of the method adopted for East Devon that have been further refined during the process of developing the draft CCMA for the proposed area. While the general workflow, as detailed in Figure 1-1, remains the overall approach, as described in WP2 V2 the method was updated to describe the inclusion of coastal 'Sections' which help break the coast down into manageable extents and allows us to consider varying geological makeup and exposure. This is principally driven by the use of the Coastal Vulnerability Dataset from the British Geological Survey (BGS).

As discussed in WP2 V2 report and repeated here this dataset has been compiled by geologists (engineering and coastal) and the BGS to provide a range of GIS layers that identify areas susceptible to flooding and coastal erosion for Great Britain within 1 km of the coast. It is expected that this dataset would be available to councils, or the Environment Agency and so be of relevance for future CCMA work. Of primary interest to us is the 'Backshore (Erosion Susceptibility)' layer;

"The erosion susceptibility assessment considers a number of geological engineering properties of cliff sections around the GB coastline using the discontinuities and excavatability datasets (part of the BGS Civils data suite), and the BGS Permeability dataset".

BGS used a scoring system to capture the range of geological and engineering properties to be applied to the various rock layers within the cliff. The scores were summed and used to produce an overall level of erosion susceptibility. The output that has been adopted within our region includes five different classifications:

1) *Cliff with relatively strong, massive geological formations.*
2) *Layered cliff with moderate to strong geological formations and moderate structural discontinuities.*
3) *Multi-layered cliff with relatively weak geological formations and abundant structure discontinuities.*
4) *String rick cliff composed of igneous, metamorphic or well-lithified massive rocks.*
5) *Weak, unlithified (superficial depositions), low or no cliff.*

The above classification scheme and a 'manageable' lengths of coast were the primary parameters used to split the East Devon region into 13 sections shown in Figure 3-2.

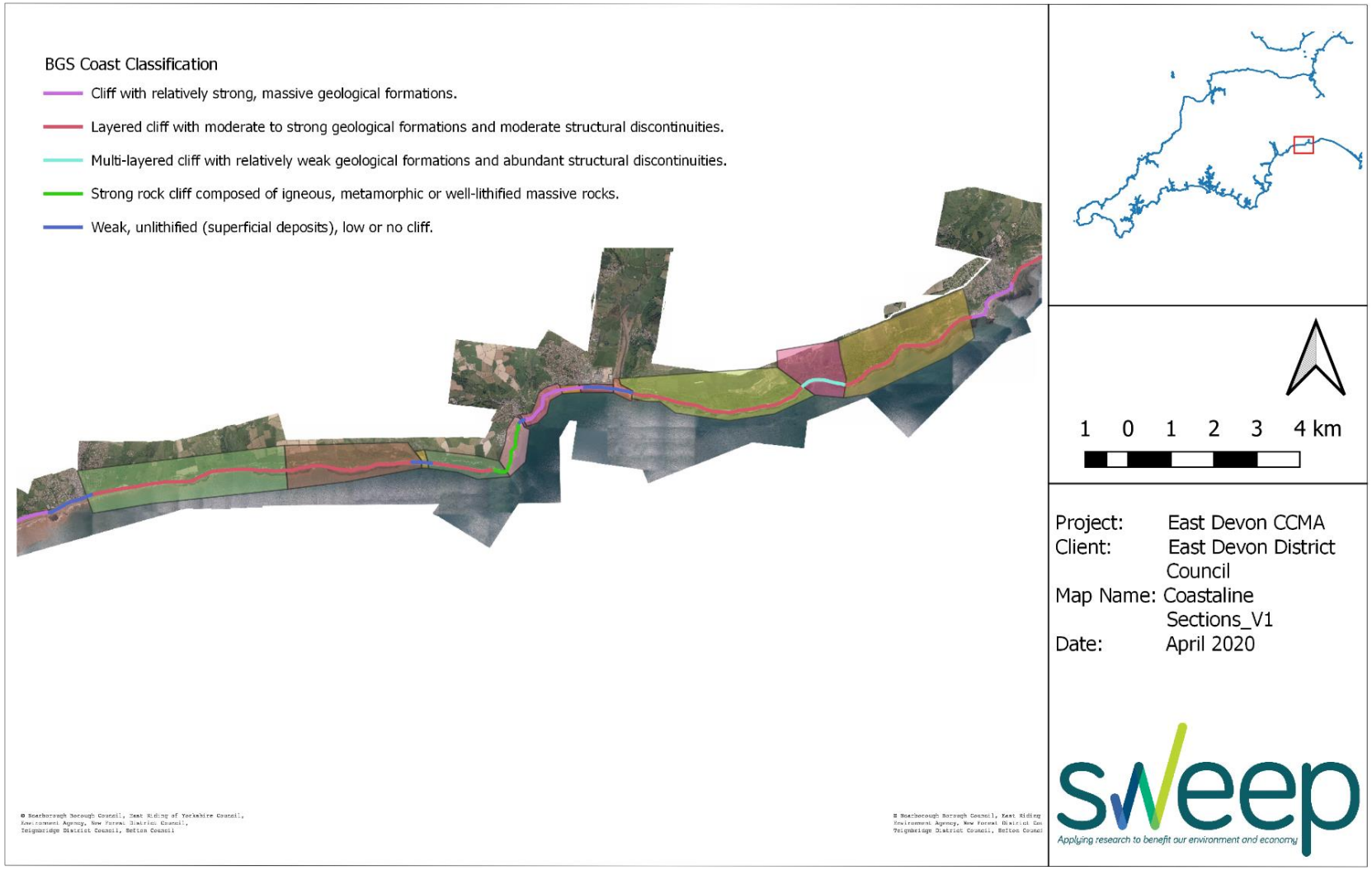

Figure 3-2. Overview map of East Devon showing the 13 sections (from west to east) overlaid with the BGS Coastal Classification scheme used, in part, to define the sections.

3.1. East Devon Coast

As outlined above, the coastline was split into 13 sections to reflect the geomorphology or to make the coastline a manageable size to work with. Additionally the River Axe which reaches the sea at Seaton is dealt with separately and this is covered in Section 3.2.

An overview map for the East Devon coastline is shown in Figure 3-3. The scale of this makes it hard to see the detail but it does give an indication of how the proposed retreat lines differ in some areas compared to the existing SMP (Figure 3-3; black line). We have discussed this previously in WP2 and it is clear that **the baseline position of the cliff line used in the SMP differs from our approach and therefore the two methods should not be combined.**

In line with WP2 we have provided three predicted retreat lines to represent the short term, medium term and long term likely position of the coastline/cliff based on the most recently mapped position (2017). The predicted retreats are based on the high emissions 50 %ile scenario as stated in the Introduction. A summary of the layer names (in the .zip file East_Devon_Coast_CCMA_V2.zip) are provided in Table 3-1.

Table 3-1. Layer names and descriptions that are provided, as digital files (East_Devon_Coast_CCMA_V2.zip), and used to generate the overview map in Figure 3-3.

Layer Name	Description
ST_20_yr	The 2040 cliff/coastline position using the High Emissions (HE) 50 %ile output
MT_50_yr	The 2070 cliff/coastline position using the High Emissions (HE) 50 %ile output
LT_100_yr	The 2100 cliff/coastline position using the High Emissions (HE) 50 %ile output
ST_20_yr_Buffer	The cliff/coastline position (for each epoch) using the High Emissions (HE) 50 %ile output plus the **horizontal buffer** (10 m or 10 % of projected retreat distance)
MT_50_yr_Buffer	
LT_100_yr_Buffer	
ST_20_yr_SD	The cliff/coastline position (for each epoch) using the High Emissions (HE) 50 %ile output, for areas backed by a sea defence (**SD**)
MT_50_yr_SD	
LT_100_yr_SD	
ST_20_yr_SD_Buffer	The cliff/coastline position (for each epoch) using the High Emissions (HE) 50 %ile output, for areas backed by a sea
MT_50_yr_SD_Buffer	

LT_100_yr_SD_Buffer	defence (**SD**), plus the **horizontal buffer** (10 m or 10 % of projected retreat distance)
SMP	
Line20yr_upper_final	South Devon and Dorset Shoreline Management Plan (2) short term shoreline position
Line50yr_upper_final	South Devon and Dorset Shoreline Management Plan (2) medium term shoreline position
Line100yr_upper_final	South Devon and Dorset Shoreline Management Plan (2) long term shoreline position

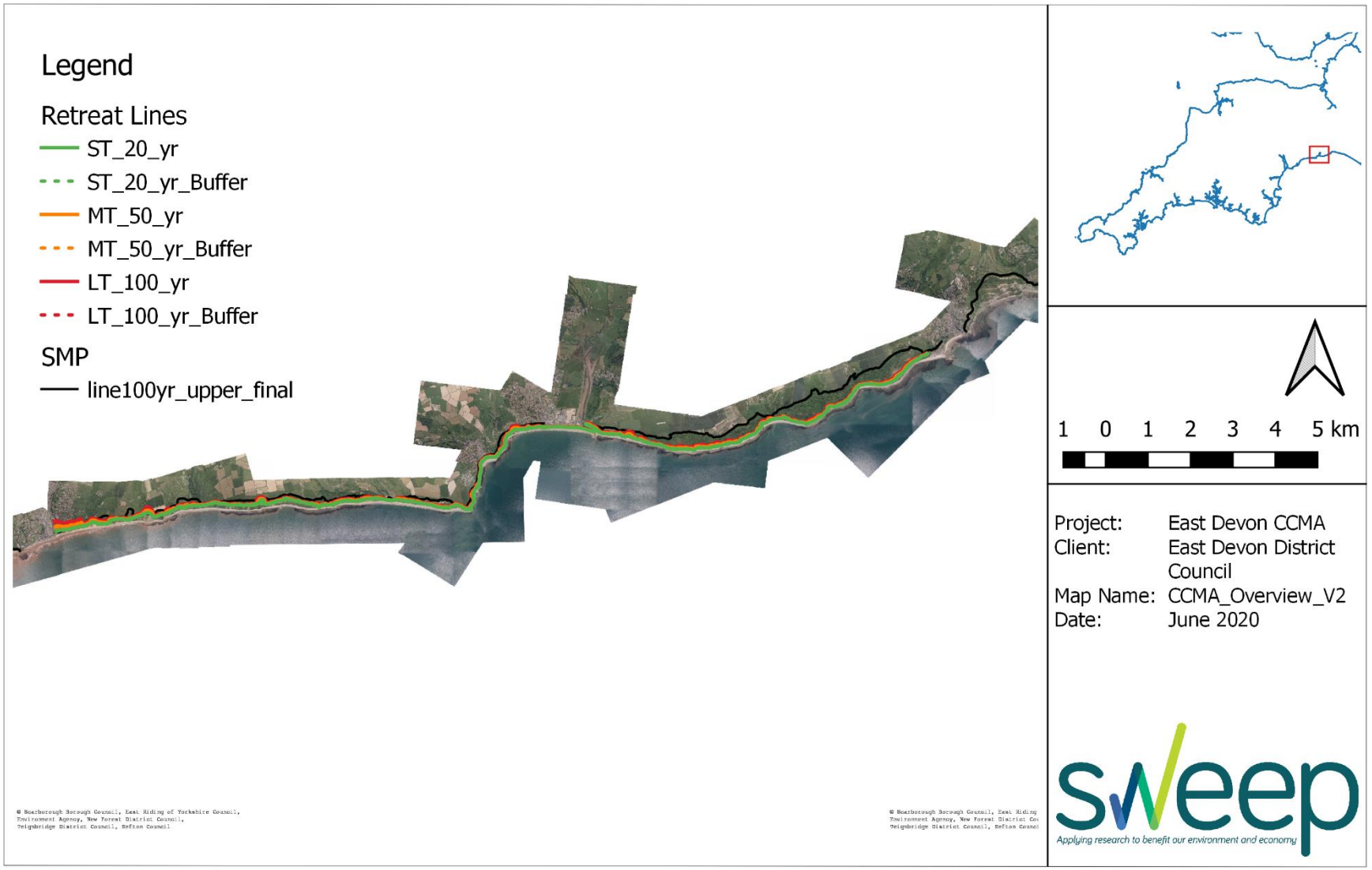

Figure 3-3. Overview map showing the full extent of the predicted retreat lines for the East Devon coastal region. The 100yr SMP line is also shown for reference.

Figure 3-4. Aerial image of a section of East Devon coast with the predicted cliff line positons for the short (green), medium (orange) and long term (red). The dashed lines indicate the 'buffer' for each epoch. The 100 yr SMP line is also shown (black).

You will discover, as you explore the datasets, there are several areas where the SMP long term line is further landward than our predictions (equally many that are not). This is primarily due to the cliff position that the SMP has used as a reference point. The most accurate approach for mapping cliff retreat is to use the "active" cliff i.e. the section exposed to future coastal change driven by wave/sea-level rise (SLR) impacts. Along the East Devon coastline there are some sections of complex cliffs with multiple cliff sections. The SMP has mapped to the inland extent, whereas we have focused on the more seaward position (Figure 3-4).

Figure 3-5. Aerial image of Seaton showing the line positons for the short (green), medium (orange) and long term (red). While the lines are identical (in colour scheme) to the cliff sections they are saved as a separate layer because they represent coastlines backed by sea defences (SD). The 100 yr SMP line is also shown where available (black).

As outlined in Table 3-1, to provide some differentiation between defended coastline and undefended ones we have provided separate lines where a sea defence (SD) backs the beach so that these can be easily 'turned off' within a GIS viewer (Figure 3-5).

3.2. River Axe

The River Axe, which reaches the sea at Seaton has been handled in exactly the same way as the Taw Torridge Estuary outlined above. An overview of the extent mapped is shown in Figure 3-6.

For ease of use the River Axe region has been kept as a separate series of layers to be used and not connected with the coastal section as there is some overlap. A summary of the layer names, used for the River Axe (in the zip file East_Devon_Coast_CCMA_V2.zip) are provided in Table 3-2.

Table 3-2. Layer names and descriptions that are provided, as digital files, and used to generate the overview map in Figure 3-6.

Layer Name	Description
HE_Flood_V1	The 2100 1:200 yr flood boundary elevation location using the High Emissions (HE) 50 %ile output
HE_Flood_VertBuffer	The 2100 1:200 yr flood boundary elevation location using the High Emissions (HE) 50 %ile output plus 0.25 m (**vertical buffer**)
HE_Flood_VertBuffer_CP	The 2100 1:200 yr flood boundary elevation location using the High Emissions (HE) 50 %ile output plus 0.25 m and a 2m **horizontal buffer** to allow for the coast path

Figure 3-6. Overview map showing the full extent of the CCMA for the River Axe area.

4. Discussion and Next Steps

This report acts a technical reference to the digital files provided alongside the report. The report aims to introduce and breakdown the specific files attached and highlight any particular areas of interest.

Following V1 of this report, and subsequent discussions, changes have been made to the lines presented using the updated method outlined in the WP2 V2 report.

It is hoped that the lines provided can be taken forward by the respective LPAs and used to help develop CCMA boundaries in line with their current planning policies. The Taw Torridge estuary is expected to undergo further future flood mapping to fill in gaps between the SFRA work done at Bideford and Braunton. Given the time required for full CCMA adoption it is very likely that the North Devon region can be updated with the latest flood models that are used as part of the study. We have tried to develop an approach that lends itself to utilising the most recent data available to ensure the CCMA lines remain as accurate as possible.

The next stage of the **SWEEP CCMA** project is WP4 which will focus on wider dissemination of the methods developed and greater uptake and implementation of CCMAs nationally. To achieve this the Plymouth SWEEP team shall work closely with the LPAs, who have helped shape WP1-3, to produce a publication that would target local planners e.g. **The Planner.** We also hope, through Natural England, to open a dialogue with the NPPF to further raise the application of CCMAs in England. The development of CCMAs within the southwest will also be the focus of the SWEEP/EA funded PhD being undertaken at Plymouth University by Josie-Alice Kirby. This will ensure further research is undertaken on all aspects of CCMA development that will serve to build on the work by the SWEEP project.

GIS Viewing

For those who are less familiar with GIS but would like to view the datasets then it is very easy to install the latest free QGis (via https://www.qgis.org/en/site/). We would also strongly recommend downloading the template project from the Channel Coastal Observatory via https://www.channelcoast.org/ccoresources/wms/CCO_WMS_v2_cco.qgs which is explained at https://www.channelcoast.org/ccoresources/wms/. This project template will allow you to view the layers and also view other data from CCO without having to download lots of data to your own computer. Please get in touch if you need further guidance.