Explanatory notes

The actions of the sea and the weather are the major causes of changes to the coastal landscape in the South West of England, leading to erosion, where material is worn away, and accretion, where it is deposited.

A major cause of coastal erosion is the power of waves. When a wave hits a cliff face or sea defence, any weaknesses can be gradually expanded, destabilising the structure. Waves also carry sand and pebbles, and these can wear away cliffs and man-made defences. The stormier the weather, the bigger the effects. In calmer weather, the small waves can deposit sediment, causing beaches to grow.

Beaches themselves are a strong defence against erosion: put simply the further a wave has to travel up a beach the weaker it becomes.

South West Coastal Monitoring (SWCM) is the data-gathering arm of the Nation Network of Regional Coastal Monitoring Programmes (NNRCMP), which was founded in 2006 to provide a standard, repeatable and cost effective method of monitoring the coastal environment in the region.

The programme operates from Portland Bay in West Dorset to Beachley Point in Gloucestershire on behalf of the region's maritime local authorities and coastal groups, as well as the Environment Agency and Defra, and is managed by Teignbridge District Council.

Porlock Bay lies on the Somerset coast, facing northwest into the Bristol Channel. As such it experiences a large tidal range (~9 m) as well as storms which penetrate up the channel from the Atlantic. The beach itself is predominantly comprised of a long, steep shingle barrier formed over many thousands of years, moving landwards as sea level increased after the last ice age (and still showing signs of movement). The upper shingle section of the beach is steep due to the impact of storms waves which remove smaller material from the bottom of the beach. The beach provides important protection for the low-lying land behind.

In October 1996 a large storm surge coincided with the already high tide raising the sea level enough to wash the top section off the barrier and allow the sea to flow into the fields behind. As the tide receded the flood water had to escape, creating a breach in the barrier. This section of beach is now of great interest to many scientists due to its uniqueness. Measurements are taken to observe how the beach is changing over time with the hope that the knowledge can be applied to other examples around the UK and the World. Since the breach in 1996 no effort has been made restore the beach to its former shape. Instead, the area behind the beach now floods on a regular basis as the tide rises, creating new saltmarshes. Exmoor National Park's vision for the areas is that of minimal intervention where the beach, marshes and land are left to develop naturally. Not interfering with the natural processes is a very rare case with most areas around the coast having to take into consideration the needs of many different stake holders.

The SWCM's data is freely available: southwest.coastalmonitoring.org

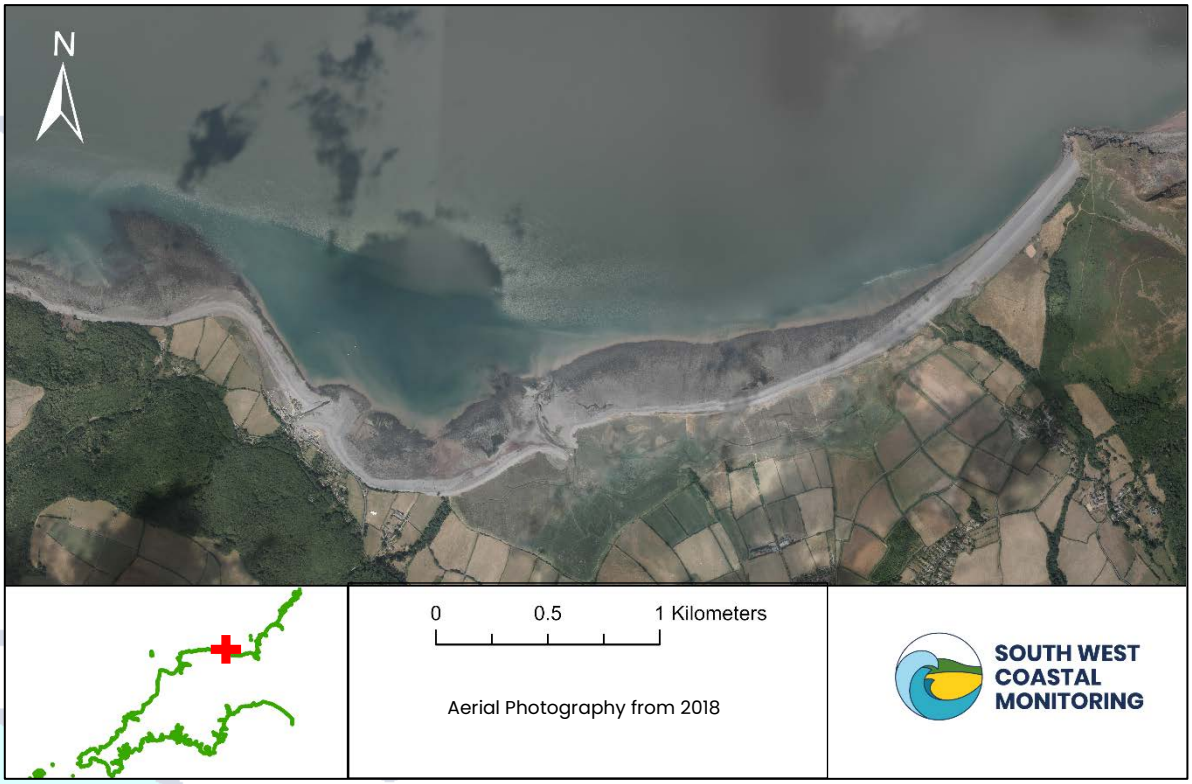

Figure 1 An aerial map of Porlock Bay, Somerset.

1 Porlock Bay is located on the coast of Somerset, facing north into the Bristol Channel. The beach here is made up of shingle which forms a long (5 km), steep, barrier separating the sea from the low-lying land behind (Figure 2). The beach has been built up and evolved over many thousands of years to its current shape. What do you think are the current dominant processes acting on the beach and what may be threatening the beach's current form?

Figure 2 Photography of Porlock beach, depicting the barrier beach.

2 The Bristol Channel and Severn Estuary are known to have some of the largest tidal ranges in the world. Below is a tide chart from a tide gauge located on the Severn Bridge; from the chart below (Figure 3) can you identify when the largest tide occurred and what the tidal range was on that day?

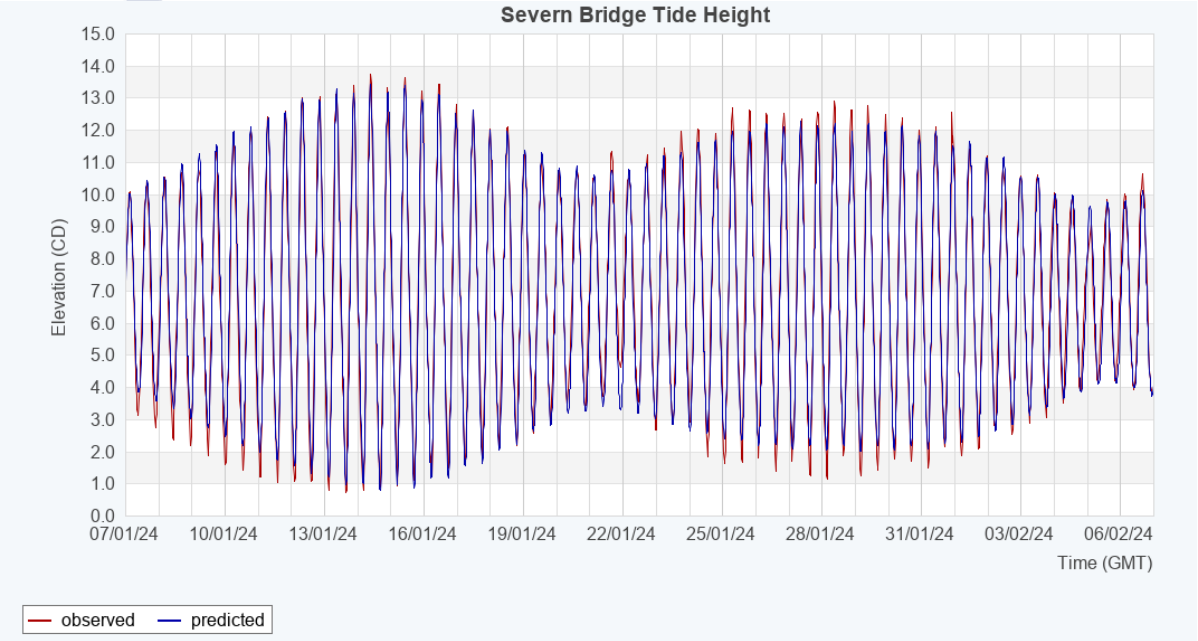

Figure 3 Tidal data for the Severn Estuary gauge between 7th January and the 6th February 2024.

Being not so far into the estuary the tidal range at Porlock is slightly less at around 9 m, although this is still very large. In this graph the blue line is a prediction of tide height, whilst red is the observed height by the tide gauge.

3 In October 1996 a severe storm surge coincided with a high tide to elevate water levels to an extreme height. The top of the beach was pushed backwards and destroyed allowing seawater to flood the low-lying land behind. As the tide dropped the water had to retreat causing a breach in the barrier. Looking at Figure 4, where do you think the material that made up the beach was moved, both by the rising and falling water?

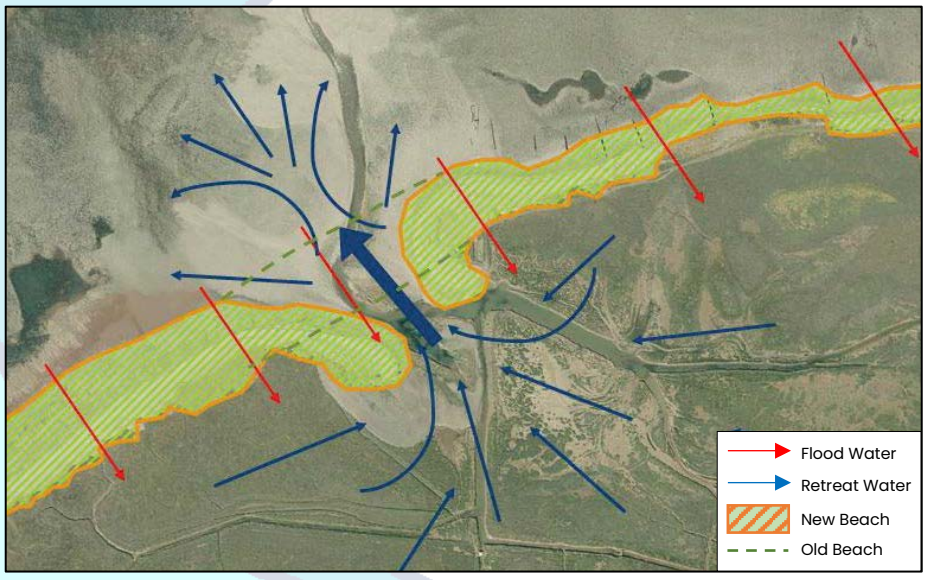

Figure 4 Schematic diagram of Porlock, explaining the movement of water up and down the beach.

Figure 5 Photography of Porlock when flooded (left) and at low tide (right).

4 The storm of 1996 caused a sudden change in the shape of the beach at Porlock. Changes to the beach, however, continue due to the constant rise and fall of the tide, impact of waves and weather. The chart below (Figure 6) is a difference model, created using LiDAR data, which shows the difference in beach height between two dates. Areas in red show a decrease in height, where material has been lost (known as erosion) and areas of blue show an increase in height where material has been gained (known as accretion). Which areas of the beach are accreting, and which are eroding?

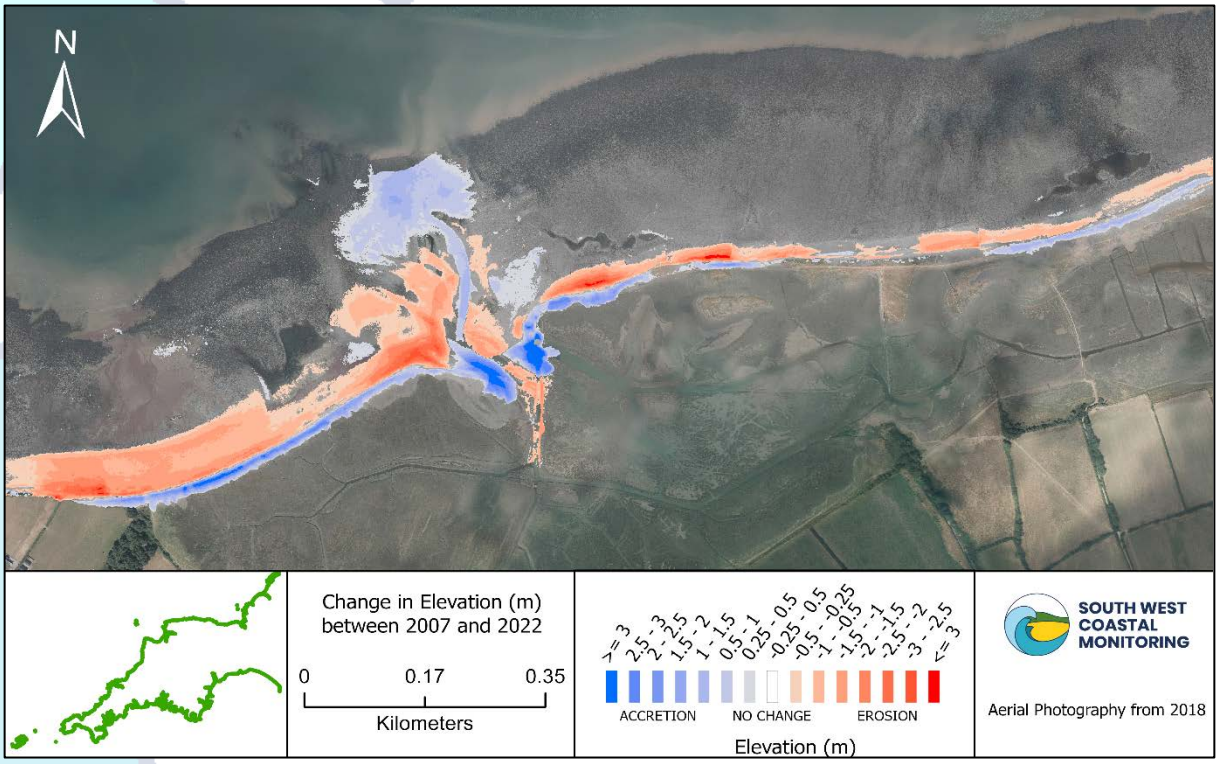

Figure 6 Difference model of Porlock, depicting the change in elevation (m) between 2007 and 2022. Red represents erosion and blue represents accretion.

5 LiDAR (Light Detection and Ranging) is a mapping technique which uses lasers to measure the distance between an aircraft and ground surface. The aircraft flies at around 800m and sends light signals towards the ground; the distance to the ground is calculated by timing how long it takes for the light signal to bounce off the ground and return to the plane. Can you think why LiDAR is a good technique for surveying a beach such as Porlock and which other techniques could be used?

6 Since 2007 South West Coastal Monitoring have conducted regular surveys of Porlock Bay. Two surveys a year, in autumn and spring, have been conducted on foot to monitor the beach shape as well as LiDAR every few years and additional surveys after large storms. Can you think why it is important to collect this information and who will use it?

Surveying on foot is also important. The SWCM team walk the same profiles from the top to the bottom of the beach on each visit (whatever the weather) so that comparisons can be made over time.

Figure 4 The SWCM team surveying Porlock.

Surveying on foot is also important. The SWCM team walk the same profiles from the top to the bottom of the beach on each visit (whatever the weather) so that comparisons can be made over time.

7 Since the 1996 breach, no effort has been made to restore the beach to its previous shape. Instead, the natural processes have been allowed to dominate and the land behind the beach now floods on a regular basis with the rise of the tide. What effect will this have on the land behind the beach and who will benefit from the changes?

Figure 3 A LIDAR image of Porlock Bay. Blue is the lowest height and brown is the highest.

8 Letting the natural processes take over and not intervening is a rare approach to coastal defence. Can you think of anywhere else that this method could be used?