Disappearing **coasts**

Understanding how our coasts are eroded is vital in a future of climate change and sea level rise, writes Catherine Poulton.

England has some of the fastest retreating coastlines in Europe. Along some of the coasts in the south and east, the cliffs are made up of soft sediments that are easily eroded. Whole villages have been lost to the sea over the years and many more may be on the brink of joining them.

For local people, erosion is a serious issue. They have become accustomed to watching houses teeter dangerously on the cliff edge. They have seen whole streets topple into the sea. The consequences to the environment, and people's assets and lives can be enormous – especially as home-owners do not usually receive compensation for the loss of their homes and livelihoods.

How can people most effectively plan to live and work in such a changeable environment? And how will climate change and sea level rise affect the rate of coastal erosion? What's the best way to tackle the problem?

At the British Geological Survey (BGS) we've been studying the process of coastal erosion and cliff retreat as part of our Stability of Cliffed Coasts project. By studying 12 study sites on the 'soft rock' coasts of Dorset, Kent, Sussex, Norfolk and North Yorkshire, we're trying to find out how the nature of the rocks and climate change influence coastal erosion.

Standing on a specific point on the beach, we scan the cliffs and beach with a low power laser to monitor and measure change along the coast. The laser measures the distance and relative position between our survey point and a set grid of points on the cliff face. We then feed our many thousands of measurements into a computer to generate models of the shape of the cliff face. This shape changes constantly so we repeat the laser scan every year. We can then analyse the results, calculate the rate of cliff retreat and model the way the cliffs collapse.

The eroding coast and BGS test site at Happisburgh, facing north. The relative strengths of different sediments in the cliff can be seen in the slope angle - the stronger the sediment, the steeper the angle before it collapses.

The southern end of Happisburgh in 2003.

Mike Page

Environment Agency (Anglian Region)

A 1992 aerial photograph with a line showing the top of the cliff measured in 2003 by BGS.

On fast-retreating coasts it is not just the position of the cliff face that is important. The entire system of coastal erosion is complex. We must also look at the on- and offshore environment, the weather and climate, the strength and variability of the rocks and materials making up the coast and the influence of man-made structures such as groynes and sea walls. To do this we survey the coastal sections by geological mapping and aerial photograph analysis. We also test rock samples for strength to try to understand why the cliff is eroding so quickly.

Understanding how the offshore environment influences coastal erosion is particularly important. These influences include wave energy and wave direction, the distribution of sediments moved by wave scouring and changing sea level. One critical factor is the rate that sediment is moved away from the cliffs and beaches. Coarse materials, such as gravels, may stay put in local beach systems, but finer materials, such as clays and silts, are readily washed offshore and may end up on coasts on the other side of the North Sea.

One of the main interests in our research is the mechanism by which the cliffs collapse. Understanding this is essential in both predicting how coasts will recede and how they will be affected by climate change and sea level rise. Coastal slopes fail in a number of ways. Steep-faced slopes can topple and fall once the sea has eroded the base of the cliff back far enough. Other shallower slopes ooze their way down towards the sea as part of a mud or debris flow or slumps. Some coasts comprise very large landslides that slide along a deep spoon-shaped surface and these are called 'deep-seated rotational' slides. Many cliffs may fail in a combination of all these mechanisms, either as a domino effect where one failure causes another, or as a constant cycle of events involving over-steepened slopes and the erosive power of the sea.

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We are trying to understand why particular types of landslides occur in different geological settings and how fast coasts are likely to retreat given various factors. These include the geology, the nature of the wave power along this section of coast, the climate and storm frequency and the influence of coastal defences and offshore dredging. Through the Stability of Cliffed Coastlines project, we are studying and comparing the behaviour of different types of coastline to gain a better and more accurate understanding of the processes of coastal erosion and landslides.

One of the 12 sites in the project includes a section of cliffs next to Happisburgh (pronounced Haiz-borough) on Norfolk's North Sea coast. This is a pretty country village with a notable stone church, an impressive manor house, listed buildings and a famous red and white striped lighthouse. These assets may be threatened, as the receding cliff line claims the loss of a property every year or so.

In the past, coastal defences built at Happisburgh slowed down the rate of retreat. Today, however, large sections are in disrepair. Sea-level rise and climate change, including increased storminess, are likely to increase the rate of erosion.

So far, we have monitored the rate of erosion at Happisburgh in 2001, 2002 and 2003, using the laser scan system. Where there are defences, the surveys have shown an average erosion rate of approximately 2m per year, but elsewhere in more exposed parts, the erosion rates are 8-10m per year, and about one house a year is disappearing.

So, why is the coast retreating so fast? It's largely down to the composition and structure of the rocks and deposits that make up the land. The exposed coast at Happisburgh is made up of sands and clays, mostly deposited in glacial conditions about 430,000 to 630,000 years ago. These deposits are highly variable, weak and easily eroded.

There has also been considerable work done to defend parts of the Norfolk coast against the sea. In 1983, about 70% of the East Anglian coastline was defended.

But these defences may have had a detrimental effect on unprotected stretches of coast, such as at Happisburgh, where erosion rates are relatively high. This is because the defences trap sediments, which would normally get washed along the coast and replace those that are eroded. Therefore, in managing erosion, the entire coastal system must be taken into account in order to balance priorities.

In a highly developed island nation such as Great Britain, the coastal infrastructure and resources are critically important. We need to develop methods to accurately monitor and predict coastal change to protect these assets and manage them in the most cost-effective way. Our research will improve everyone's understanding of the complexities of cliffed coast erosion and coastal retreat.

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