P.G. TIPS OVER THE EDGE

A line of homes stood between Cliff House (circled) and the sea

Now everything in front of the dotted line has gone. Cliff House (circled) is clinging on

Anyone for tea

By **James Tozer**

TEA drinking is not normally considered a precarious pastime.

But as Diana Wrightson sips her Ceylon at Cliff House in Happisburgh, Norfolk, she may be forgiven for feeling a little uneasy.

For a couple of steps in the wrong direction would take her over a sheer drop to the beach below.

This was not a problem when Miss Wrightson bought the tea shop-cum-guesthouse in 1980. Back then guests needed to peer over a row of bungalows to catch a glimpse of the sea.

Twenty-five years on, coastal erosion has reduced the bungalows and the road on which they stood to just a memory, and the distance between her back door and the cliff edge is now less than 60ft.

Yesterday Miss Wrightson said this summer would almost certainly be the last for Cliff House before its situation becomes simply too perilous to remain open.

'I expect that once the cliff advances to within about 30ft of the house, we will have to close down,' she said. 'And it will only take one chunk to fall into the sea over the winter and that will be it.

'We've known this was coming since 2002. At least it means the sea views are getting better and better!' When Miss Wrightson and her

'It will only take one chunk'

friend Jill Morris bought the four-bedroom house in a Victorian terrace, no one in Happisburgh envisaged large chunks of the village being washed away in a couple of decades. The distance to the 40ft drop was more than three times what it is now.

But successive governments refused to foot the bill for repairs to the village's crumbling coastal defences that would now cost an estimated £10million. Instead the policy has been 'managed retreat'.

Since then the coastline has been one of the most badly hit in the east of England. 'Everybody in the village felt that when the erosion reached a certain point the Government would step in,' said Miss Wrightson. 'But they seem to be perfectly happy for the whole village to go into the sea.'

Like the homes on either side of it, Cliff House is now effectively worthless. With all their money tied up in the property the pair will have few options once it finally goes. 'We may run an ice-cream kiosk, or something like that,' said Miss Wrightson.

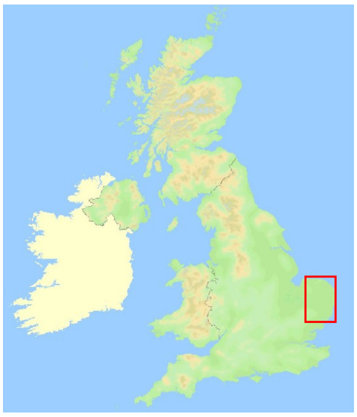
Sally Brown

PhD Student,

School of Civil Engineering and the Environment,

University of Southampton.

On Saturday 2nd July 2005, the Daily Mail published an article on the forthcoming loss of Miss Wrightson's Cliff House tea shop in the village of Happisburgh, Norfolk. Coastal erosion is nothing new; its action has been changing the shape of our island for thousands of years. There are a few unfortunate people who lose their homes to this process every year, but for Miss Wrightson, she is not only losing her home, but her livelihood.



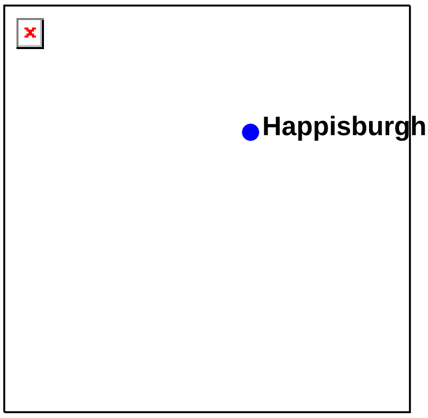


Figure 1 – Location of the village of Happisburgh on the Norfolk coast
www.ordnancesurvey.co.uk/getamap

Figure 2 – Miss Wrightson's Cliff House tea shop positioned dangerously near the cliff edge at Happisburgh. Photograph taken by Mike Page, 12th September 2005. http://www.happisburgh.org.uk/gallery/mikepage

Figure 3 – Coastal erosion forming a bay at Happisburgh, Norfolk. The blue line indicates the position of the cliff before the defences started to fail in 1996. Miss Wrightson's tea shop (circled in red) is dangerously near the cliff edge. Photograph taken by Mike Page, 15th February 2005. http://www.happisburgh.org.uk/gallery/mikepage

Norfolk's coastline is vulnerable. To understand why, we have to take a journey back over ten thousand years to the last Ice Age. Known as the Pleistocene Epoch, great volumes of ice covered the country. Soft, erodable boulder clay was deposited creating the cliffs we see today along parts of the Norfolk coastline (North Norfolk District Council, 2005a). Where cliffs are not present, sand dunes have formed.

Together, they are the land's natural protection against the potentially hazardous sea. These natural defences were broken in 1953 when the North Sea spilled into Norfolk, large parts of Eastern England and low-lying parts of the Netherlands. Fierce stormy seas caused by a violent north-westerly storm together with a spring tide forced the sea level to rise and caused the subsequent erosion. In the U.K. and the Netherlands, over two thousand people died and many more were left homeless (Delta Project leaflet, undated).

Understanding the physics and nature of storms plus the behaviour of the sea is an important aspect in protecting land for the future. The solution? To initiate a new battle with the sea: to provide a line of hard defences covering a large portion of the coastline of Eastern England. If scientists could understand why the event took place, engineers could design defences to protect the adjacent land. Studies and consultations were untaken and scientists and engineers collaborated. During the 1950s, defences were developed (North Norfolk District Council, 2005b), and residents' awareness increased to the potentially devastating phenomena. Today, wooden groynes and other hard defences cover much of the coastline that was affected by the 1953 storm. Similarly, in the Netherlands, the Delta Scheme was developed – giant dams and storm surge barriers that stop the sea entering the low lands. But with the advent of these defences, why is the coastline at Happisburgh still eroding today? Why will the Cliff House tea shop be lost to the sea?

The answer comes in the form of DEFRA's (Department for Environment, Food and Rural Affairs) coastal policy. 860km of the U.K.'s coast is defended (Lee and Clark, 2002). These defences are costly to maintain. With the demand for coastal protection increasing, DEFRA's money pot is being stretched further and further and something has had to give. The answer has been to defend and maintain stretches of coastline where it is cost effective or prudent to do so. As a result, larger towns, such as Cromer and the North Sea Gas Terminal at Bacton in Norfolk can protect and maintain their defences. Other smaller towns and villages are left to the perils of nature. Not rating high enough on DEFRA's Priority Scoring policy for the development of defences and the maintenance of existing ones, these communities are left in nature's hands. Gradually, as in the case of Happisburgh, the defences originally designed to protect the coast are in their demise, allowing the sea to regain its destructive force on the coastline. Each year, the degrading defences lose a little of their strength through the annual battering of storm waves, resulting in more land slipping into the sea. Erosion rates average 2m/year, but in some areas rates of 8-10m of cliff loss each year are recorded (Poulton, 2004). Within the next year it could be the turn of Miss Wrightson's tea shop.

So what can be done to support communities such as Happisburgh? A campaign was launched by the residents for a greater awareness of their plight. Villagers were worried their whole community would disappear, including their 12th century Church and the lighthouse which stands a few hundred metres away from the cliff edge. Whilst there is acceptance of the sea as a hazard, it was felt more could be done to support those who have been ill affected by the current policy. For many years, scientists have studied the East Anglian coastline to establish how and why this coastline changes. Studies include Clayton's (1989) study of Norfolk sea defences, Thomalla and Vincent's (2003) study of beach response to breakwaters, and Wallkden and Hall's (2005) models into shore profile development. Some new schemes have been engineered where it is feasible to do so. Perhaps the most visual is that of the Sea Palling reefs, an area down-drift of Happisburgh. Here, instead of land disappearing, sediment has been accreting due to offshore reefs being created in the nearshore (Thomalla and Vincent, 2003). Some feel that it is unfair that one part of coastline is defended, whilst an adjacent stretch is allowed to erode. Attempts to educate Happisburgh residents on the financial and environmental implications of coastal protection is certainly a challenging task whilst their village is being lost to the sea.

But can anything be done to save Happisburgh from further devastating land loss? The construction of new groynes could possibly save the village, but these are deemed too costly. Rock armouring has been placed parallel to the cliff toe, thus hindering incoming waves from attacking the cliff, thereby slowing erosion. This provides the residents some extra time to enjoy their cliff-top views before their houses succumb to the fate that others know all too well. However, rock armouring is not a long term solution. Under the current situation, will Happisburgh be lost forever?

Perhaps not. Another form of defence, known as a crenulate shape bay is being constructed and tested in the U.K. One of the most recent designs has been at

Folkestone (Channel Coastal Observatory, 2005). These bays utilise two artificial barriers known as headlands as a form of defence.

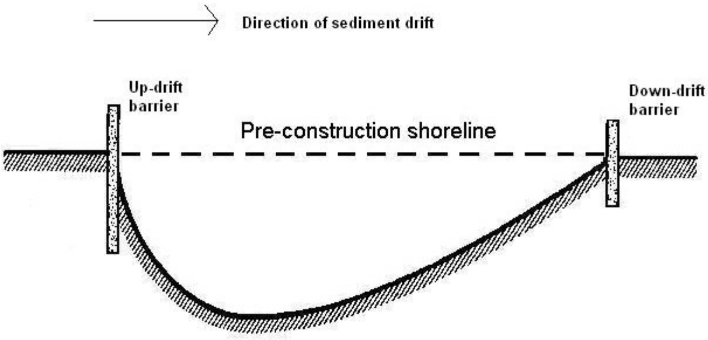


Figure 4 – An example of a crenulate shape bay. The up-drift headland blocks sediment transport, causing erosion down-drift. However, this erosion is checked by the second headland down-drift. The final shape in between the headlands is described by a mathematical log-spiral curve. Based on Everts (1983), Figure 1, page 675.

The headlands, constructed from large natural or man-made boulders, form two promontories a set distance apart. The up-drift headland blocks sediment transport. At first this causes rapid cliff erosion between the headlands. However, as the eroded sediment is limited in longshore transport beyond the down-drift headland, a beach is gradually constructed and protects the cliff from erosion. In turn, this slows the cliff erosion, and eventually leads to a near stable coastline. The final shape of the coastline resembles a log-spiral curve described by the following formula:

$$\frac{r_1}{r_2} = e^{\theta \cot \alpha}$$

Where r_1 and r_2 are radii from a common centre, separated by an angle, θ.
α is equal to the radius vector and a tangent to the curve at that point.

Using conceptual and numerical models, the final equilibrium coastline may be mapped prior to the construction of the headlands. Knowing the ultimate equilibrium position of a coastline has its benefits as a scheme can be designed to a known set-back distance, avoiding important buildings or ancient monuments. Although costly at the beginning, in the long term there would be lower maintenance costs as nature is allowed to defend the land.

The U.K. Government's 2004 Foresight Report (Evans et al., 2004) into future erosion and flooding in light of climate change and sea level rise recommends new research to be completed into crenulate shape bays. The concept of crenulate shape bays itself is not new (Silvester, one of the prime scientists researching crenulate shape bays published some initial ideas in Nature in 1960), and many studies have investigated the form and the mathematical behaviour of naturally occurring crenulate shape bays. However, much less research has been undertaken on the design of man-made crenulate shape bays and the role of the bays as a form of defence.

Engaging with environmental physics is rewarding; understanding the principals behind the formation of bays can lead to a greater understanding of how man can construct defences that harmonise with nature. The beauty of physics is that it may be applied in many different ways. Examples range from scientific analysis, civil engineering and the design of coastal structures, to equipment such as DGPS (Differential Geographical Positioning System) and GIS (Geographical Information System) that may be used to measure and present results. The significance of crenulate shape bays cannot be underestimated, as their design could change the morphology of our coastline for hundreds of years to come. Benefits include lower maintenance costs compared to existing sea defences. The future of crenulate shape bays is bright.

So what of Happisburgh, its seaside views, houses, lighthouse and tea shop? With Cliff House a matter of metres from the cliff edge, its fate is clear. Next summer may be the last season for the happy tea-drinkers and tourists who have made their annual pilgrimage there for many years. However, the lighthouse may fare better. Whilst placing rock armouring at the cliff toe, the local authority has created a man-made headland. The area down-drift of this headland is continuing to undergo rapid erosion but in time this erosion will slow, and it is possible that the lighthouse could be saved. However, with no second down-drift headland to control the longshore transport, the exact position of the final cliff top remains unknown.

The value of environmental physics and coastal research to predict coastline position certainly has significance at Happisburgh, in other parts of the U.K. and wherever coastlines are eroding world-wide. By understanding the science behind natural phenomena there is a greater awareness of how and why these processes work. Designs of coastal engineering works are becoming more holistic as civil engineers and scientists work with nature rather than against it to protect our nations beautiful coastline. This can reduce costs and unnecessary work, allowing us to enjoy our coastal sceneries, making our time near the sea even more special. For those living near the sea, perhaps the benefit is most poignant, with the knowledge that their homes are safe and that happy memories may blossom there for generations to come.

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