PROTOTYPE
FACULTY OF ENGINEERING AND APPLIED SCIENCE
Journal of Undergraduate Engineering Research and Scholarship

PT-2013: Coastal and Ocean Engineering ENGI.8751 Undergraduate Student Forum
Faculty of Engineering and Applied Science, Memorial University, St. john's, NL, Canada March, 2013

Paper Code. (PT-2013 - Hogan)

Erosion Management on the Holderness Coast

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ABSTRACT

The Holderness coastline is located on the east coast of England, facing the North Sea. The coastline consists mainly of till deposits, boulder clays and glacier clays and contains very little woodland. It is the fastest eroding coastline of Europe, losing approximately 1.5 m per year, or two million tonnes of land. This is caused by several factors including its geology and its exposure to long waves from the North Sea.

The loss of this much land area has a significant impact on the residents of the area, with many roads and structures at risk of erosion. Preventative measures have been taken to slow the erosion rate such as groynes, sea walls and off-shore breakwaters.

Due to factors like global warming and decreasing sea ice, coastal erosion will be a significant future issue in many parts of the world. As sea levels rise waves begin to affect parts of coastlines farther inshore and with less sea ice to protect them, northern coastlines will feel erosion more strongly. The extreme case of erosion of the Holderness coastline can be used to help predict the patterns of cost lines in the future. Its accelerated erosion rate allows data to be collected that would have to be over a longer period of time in most areas.

This paper will outline the environmental and economic advantages to maintaining and observing the Holderness coastline. It will discuss the challenges and current solutions to slow erosion and show future possibilities for the coastline.

1 INTRODUCTION

Holderness is located along the eastern coast of England facing the North Sea. It is 61 kilometres in length, extending from Flamborough to Spurn Point [1]. The area is affected by westerly winds which bring unsettled weather and can cause depositions [2]. There is a layer of Cretaceous chalk deep beneath the area but it is covered in a thick layer of glacial deposits and so it has very little influence on the landscape. The deposits that make up the landscape mainly include boulder clays, glacial lake clays and till. Other effects of glaciation in the area include drumlin mounds, kettle holes and ridges. The area has very little woodland and is flat and exposed in most places with cliff of 20 to 30 metres extending from the sea.

Several methods of erosion management have been put into place, but in many cases these have caused further damage in other areas. Due to the high rate of erosion in this particular area lessons like these can be observed over a shorter period of time and new solutions can be discovered for future coastal erosion problems.

2 EROSION UP TO DATE

2.1 Causes of Erosion

The extremely high erosions rate of the Holderness coast can be attributed to many different factors. The coast faces the harsh waves of the North Sea and is subject to strong winds that have created a longshore drift. The geology of the area also has a significant impact on the erosion rate. There are several key geological factors that can be examined.

The cliffs along the most Northern parts of the coast, mainly in Flamborough, are composed of chalk and glacial till, shown in Figure 1 [1]. The weakness of the chalk allows the strong waves from the North Sea to create caves and arches along the coast. As the erosion progresses even further arches can be separated from the cliffs and become stacks (Figure 1).

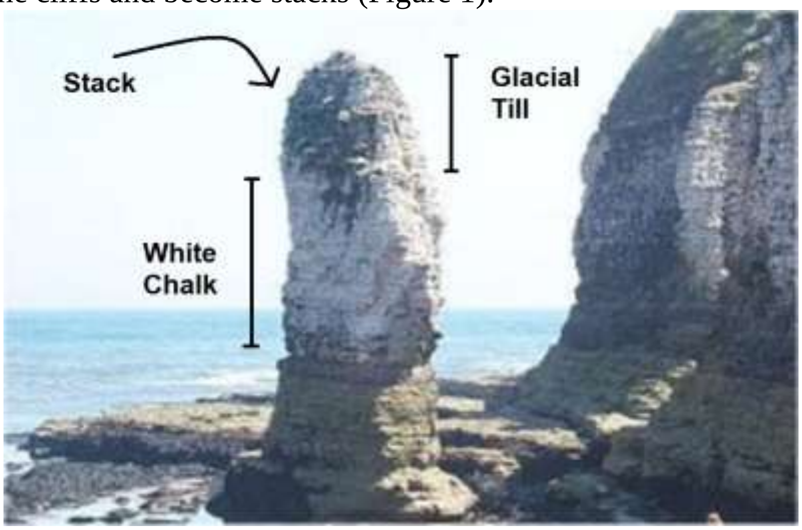

Figure 1: Chalk Cliffs at Flamborough

In other areas of the coastline the underlying boulder clay has begun to erode, further showing the weakness of the material and the strength of the waves of the North Sea.

2.2 Effects of Erosion

The Holderness coastline has been eroding at a rate of approximately 1.5 metres per year for the last century. Since Roman times it is estimated that about four kilometres of land has been lost [3], along with many settlements (shown in Figure 2) [4].

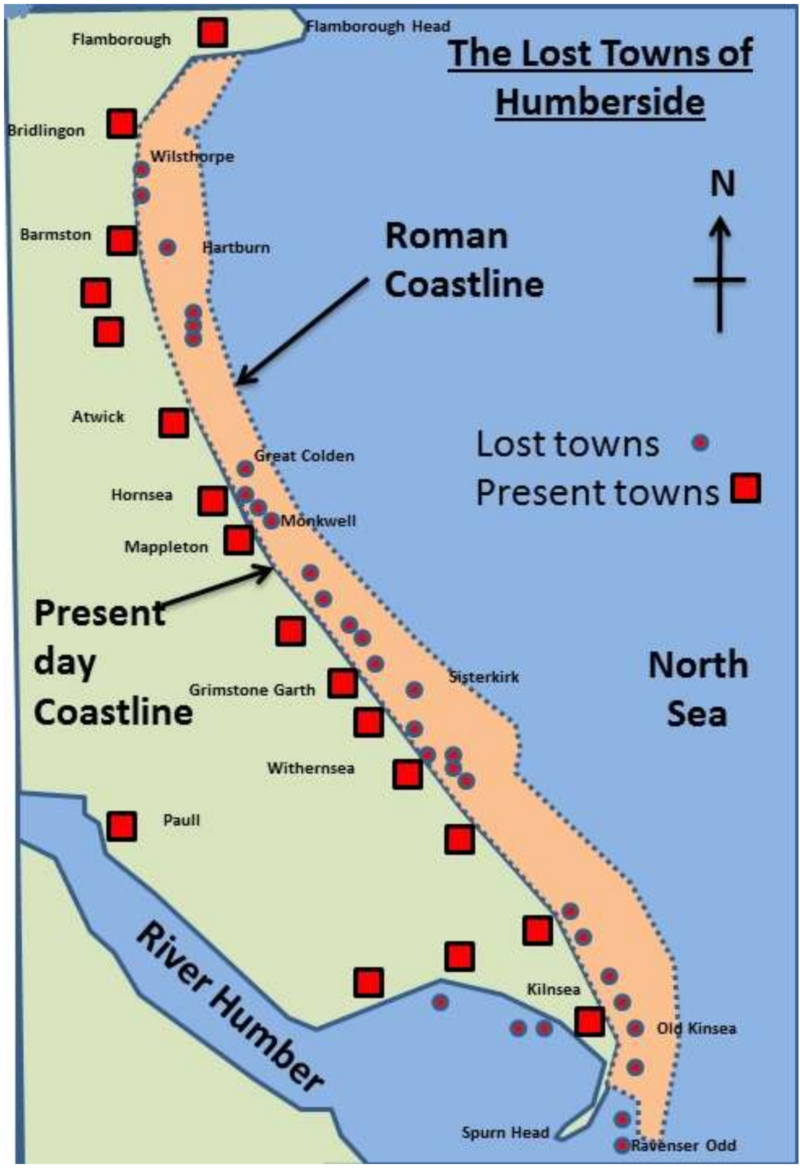

Figure 2: Lost Coastline Since Roman Era

Aside from the large amounts of infrastructure and farmland that has been lost from the coastline to erosion, additional effects have been seen along the southern part of the coast. An example of this can be seen in Spurn Head, which has been identified as a spit. A spit is a landform that occurs from a process of longshore drift. It develops from sediment deposit, building from a head (in this case, Spurn Head) and extending to a nose. While most of the lost sediment moves out to sea, about 3 percent of the total deposits end up at the spit at Spurn head, which can be seen at the bottom of Figure 2 and more closely in Figure 3.

Figure 3: Spit at Spurn Head

3 PRESENT EROSION MANAGEMENT

3.1 Groynes

Groynes are structures, most commonly made of wood, that extend perpendicularly into the ocean to help prevent sediment from being washed away by longshore drift. Groynes must be the right length – too long will rap too much sediment and too short will be ineffective in trapping any sediment. They can help to build beaches (seen in Figure 4) or prevent them from being lost. They can also help absorb some of the wave energy.

Figure 4: Rock Groyne

The groynes used along the Holderness coast are built from rock like the one in Figure 4 [5]. While they help to prevent some of the beach sediment from moving down the coast they can also cause issues in other areas. One major problem with groynes is known as terminal groyne syndrome which occurs after the final groyne in a series along a coast. The buildup of sediment near the groyne will cause even more acceleration of the downdrift beach. The downdrift beach would normally receive sediment from longshore drift but the series of groynes can prevent this.

3.2 Breakwaters

Although breakwaters can be used for other purposes, along the Holderness coastline they are used for lessening the effects of waves. They are normally built out of rock, like in Figure 5, and can be anywhere between 100 to 300 feet offshore [6].

Figure 5: Breakwater

The breakwaters along the Holderness coastline have fewer disadvantages than groynes but still struggle to protect the entire coast.

3.3 Seawalls

Seawalls help to reflect the incident wave energy back into the sea so that less of the energy goes towards erosion and deterioration of the coast [7]. They can be constructed in various forms including curved, vertical and mound shaped or sloped (seen in Figure 6).

Figure 6: Seawall

Like the other structures, seawalls also come with disadvantages. The reflected energy from the waves can sometimes cause scouring at the base of the wall. Also, the disturbed sediment flow can cause accelerated erosion down drift from the wall.

3.4 Revetments

Revetments are very similar to seawalls in their functions and the way they are constructed. They are a sloping structure, usually built up along a dune, commonly out of rock, concrete or both, as seen in Figure 7 [8]. A revetment should be built up higher than waves normally reach to be effective in more intense sea states.

Figure 7: Revetment

The disadvantages found with revetments are similar to those of seawalls. The main issues tend to occur at the ends of the revetment which should be feathered to provide less dramatic erosion effects.

4 PRESENT CONDITIONS OF THE COASTLINE

The majority of the coastal management that has been completed to date is near the town of Mappleton. In 1991 approximately 2 billion pounds were spent on coastal defences in the area of Mappleton [1]. The defences consisted of two stone groynes and a rock revetment. The groynes have been successful in preventing erosion and building up the beach south of Mappleton. Towards the North however, there is very little sediment. This can be seen in Figure 8.

Figure 8: Coastline Near Mappleton South(left) and North(right) of the Groyne

The groynes and revetment have for the most part stopped or greatly slowed the erosion in the area of Mappleton but have had negative effects south of the area. Due to the disturbance in the natural movement of the sediments, the beaches south of Mappleton have become narrower, accelerating erosion rates to almost 10 metres per year in some areas [3].

5 LESSONS LEARNED

The main lesson to be taken from this case should be that protecting human infrastructure can come at a price. Almost all attempts at coastal management, while succeeding in preventing erosion, have also caused negative effects. The case of the Holderness coastline provides a useful example to learn from these effects due to its fast erosions rate. Erosion occurs along many coastlines facing harsh ocean conditions but the geology of Holderness causes the erosion to progress faster than in most other areas. This allows the effects of coastal management to be seen over a shorter period of time. The results of coastal management here can be used to evaluate solutions for other coastal areas experiencing erosion problems.

6 FUTURE RECOMMENDATIONS

Although the cliffs in the coastal area of Mappleton are no longer at risk because of coastal management using groynes and revetments, management techniques should be continually developed. The structures preventing the coastline near Mappleton from eroding are also causing faster erosion of southern areas. Most existing coastal management structures do not come without downsides. With the risk of rising sea levels, more areas are likely to experience erosion problems similar to that of the Holderness coast, if at a slower rate. The negative effects of coastal management structures need to be minimized in the future so that those areas can be preserved more effectively.

7 CONCLUSIONS

Much of the Holderness coast has already been lost and it may be out or the reach of humans to try to preserve the rest of the coastline in its present state. The coastline’s location and geology make certain amounts of erosion inevitable. The many advantages and disadvantages of coastal management need to be examined and this is an excellent case to do so. The management of erosion in attempts to protect human settlement and infrastructure can have significant negative effects on surrounding areas and the areas environmental and ecological systems. The knowledge and experience in coastal management gained in this case will be vital in the future, particularly in areas at risk to rising sea levels.

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