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# Baseline Study and Gap Analysis of Coastal Erosion Risk Management NI

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# Acknowledgements

This report has been prepared by Amey Consulting with HR Wallingford for the Department for Infrastructure (DfI) and the Department of Agriculture, Environment and Rural Affairs (DAERA).

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# Executive Summary

The value of the Northern Ireland coastline for tourism, recreation, nature conservation and heritage is an inarguable fact. Equally the occurrence of coastal erosion and its potential implications cannot be ignored especially in the context of climate change, sea level rise and increased storms.

The primary aims of the baseline study were to:

- Undertake a gap analysis of the data currently held, or available, which could be utilised to inform coastal erosion risk management, and identify key considerations regarding data collation to inform a Coastal Erosion Risk Management strategy;
- Using the data currently available undertake a preliminary high level assessment of the vulnerability of the Northern Ireland coastline to coastal erosion;
- Identify those areas where it is considered that coastal erosion may pose a significant risk that requires to be managed based on the potential impact to land, property and infrastructure, and if necessary, identify where there are gaps in information required to complete this exercise;
- For the areas where coastal erosion is considered a potentially significant risk identify existing coastal defences, both public and privately owned, including defences associated with highways and transportation infrastructure;
- Identify the operational needs of both government bodies and local authorities in terms of information required to inform coastal decision making and identify key considerations to inform the development of policy on coastal erosion;
- Identify future areas of work required to inform the next steps in addressing Coastal Erosion Risk Management in Northern Ireland.

A high-level preliminary vulnerability assessment of coastal erosion along the Northern Ireland coast has been undertaken utilising the data which is currently available.

# Executive Summary

The initial results of this preliminary assessment do identify areas at potential risk of erosion coinciding with areas of high physical asset value as well as high historic and natural asset value. However, because of the lack of consistent and comprehensive coastal erosion baseline data in Northern Ireland, the risk ranking of assets is preliminary and by association the veracity and reliability of the vulnerability mapping is low and must be approached with a high degree of caution.

As a consequence, as identified in the Gap Analysis, consideration should be given to the establishment of a coastal erosion baseline for Northern Ireland encompassing the quantification of long-term coastal erosion through review of historic maps and photos. This baseline information can subsequently be utilised to prioritise more detailed, geographically specific data collation and assessment requirements.

In addition, the stakeholder consultation confirmed that across central and local government, having regard to climate change, there is a need for data on coastal erosion to inform local development planning and development control and allow for informed decisions with regard to the long-term management of coastal assets.

In order to address this need, a number of further interconnected areas for consideration have been outlined as part of a Needs & Opportunities discussion. Within the discussion, it is recognised that coastal erosion risk management in Northern Ireland must be considered as a shared responsibility. To this end the Coastal Forum could play a key role in informing the development of policy and strategy in this area including the delivery of a prioritised and coordinated monitoring programme to empower local decision makers.

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# Introduction

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# Introduction

## 1.1 Introduction

**1.1.1** The Northern Ireland coast extends from Londonderry on Lough Foyle in the north to Warrenpoint in Carlingford Lough to the south. It is a recognised national asset that contributes to the quality of life for residents, underpins the tourism industry which relies on the high quality scenic environment and sustains both commercial and recreational activities alongside its nature conservation and heritage value.

**1.1.2** Unlike other parts of the UK, Northern Ireland has not experienced large-scale or catastrophic coastal erosion events. Historically, therefore, coastal erosion has not been considered to be a major issue or management problem that warrants the investment on the scale of that seen in England and Wales. As a consequence, Northern Ireland has both a legislative and policy void in this regard and a lack of systematic data collection on the occurrence of coastal erosion.

### Bateman Formula

**1.1.3** The Coast Protection Act 1949 does not extend to Northern Ireland and there is to the present day no legislation in place in Northern Ireland to specifically address the issue of coastal erosion or assign responsibility for it. Instead, for the past 51 years, coastal erosion in Northern Ireland has largely been addressed by means of the 'Bateman Formula.'

**1.1.4** The Bateman Formula was an approach endorsed in 1967 by the then Permanent Secretary of the Ministry of Finance Sir Cecil Bateman. Bateman ruled that assets along the coastline would be looked after by the respective government department whose responsibilities most closely coincided with the property or asset at risk from erosion.

**1.1.5** This approach is essentially a coastal protection policy rather than a coastal erosion risk management strategy. The objective is simply the protection of property with no requirement to consider the consequences of implementing and maintaining coastal protection.

**1.1.6** Bateman also doesn't require a joined up or strategic approach. As a consequence, there is a lack of leadership on coastal erosion risk management and no coordinated strategy to consider and address coastal erosion in NI.

### Increased Awareness

**1.1.7** The impact of damage caused to land, property and infrastructure, including roads and transportation infrastructure, in recent years, has raised public and political awareness of the issues around the need for coastal erosion risk management, especially in areas affected such as Outer Ards and East Antrim. The sequence of storms in January 2014, when tidal surges and

high winds combined to cause damage in coastal areas along the east coast, brought the issue of coastal erosion and coastal protection to the fore. This has led to ongoing calls for an urgent review and updating of the current arrangements. It has also strengthened the conviction of coastal land and property owners and managers that the current arrangements to manage coastal erosion are deficient. The growing consensus amongst stakeholders is that Northern Ireland needs to move toward a coastal erosion risk management strategy which provides for informed decision making and allows for more than hard engineered coastal protection.

**1.1.8** The National Trust's recent Shifting Shores Wave 2 seminar (2018) brought together representatives from Department of Agriculture, Environment and Rural Affairs (DAERA), Department for Infrastructure (DFI), the National Trust, consultants, Local Councils and community groups. As well as highlighting the proactive work and research being undertaken by the National Trust and the University of Ulster, amongst others, the seminar also demonstrated the current level of interest and concern on the issue of coastal erosion across the spectrum of landowners, coastal councils, central government and politicians. It also highlighted the lack of current information and understanding in Northern Ireland when compared against the approach taken by other countries.

**1.1.9** The National Trust Shifting Shores Report was quoted during a parliamentary debate (Hansard – UK Parliament 2018) with the MPs from Strangford and East Londonderry raising their concern for coastal erosion in Northern Ireland and how it has worsened in recent years. It was suggested that a strategic approach was required for shoreline management.

## 1.2 Aim of the Baseline Study

**1.2.1** It is generally accepted that climate change will result in sea level rise and increased storminess and that this will impact current coastal protection practices.

**1.2.2** England & Wales and Scotland have already moved to a coastal erosion risk management approach; in England & Wales Shoreline Management Plans (SMPs) are widely applied whereas Scotland via the Dynamic Coast research has applied vulnerability mapping alongside SMP on eroding coasts. SMPs are a non-statutory tool which can help manage the risks of coastal erosion and coastal flooding in the specific plan area. It comprises a detailed map of existing coastal defences, protected areas and historic features; examines the likelihood of short-term, medium-term and long-term coastal change and can propose the following variant coastal defence policies:

- do nothing,
- hold the line,
- advance the line, or
- managed retreat.

**1.2.3** Under the UK Climate Change Adaption Programme 2017 Evidence Report it has been recognised by the UK Adaptation Sub-Committee that there is currently no system in place in Northern Ireland to decide if a section of the coast should be protected or when other more appropriate measures should be used. The report also recognises that there is planning guidance on flood risk but no equivalent guidance on coastal change planning. The Sub-Committee determined that coastal erosion risk management in Northern Ireland is an area where 'more action is needed' and 'research' is required.

**1.2.4** DfI and DAERA are committed to addressing the recommendations of the Sub-Committee and the Baseline Study is considered the next step in this regard. With all of the above in mind the brief for the study, as suggested by the title Baseline Study and Gap Analysis of Coastal Erosion Risk Management are:

- Undertake a gap analysis of the data currently held, or available, which could be utilised to inform coastal erosion risk management, and identify key considerations regarding data collation to inform a coastal erosion risk management strategy;
- Using the data currently available undertake a preliminary high level assessment of the vulnerability of the Northern Ireland coastline to coastal erosion;
- Identify those areas where it is considered that coastal erosion may pose a significant risk that requires to be managed based on the potential impact to land, property and infrastructure, and if necessary, identify where there are gaps in information required to complete this exercise;
- For the areas where coastal erosion is considered a potentially significant risk identify existing coastal defences, both public and privately owned, including defences associated with highways and transportation infrastructure;
- Identify the operational needs of both government bodies and local authorities in terms of information required to inform coastal decision making and identify key considerations to inform the development of a policy on coastal erosion;
- Identify future areas of work required to inform the next steps in addressing Coastal Erosion Risk Management in Northern Ireland.

## 1.3 Structure of the Report

**1.3.1** To address the brief compiled by DfI and DAERA, as set out above, the report is structured as follows:

- **Chapter 1:** Introduction

**1.3.2** Sets out the current approach to and awareness of coastal erosion in Northern Ireland and reviews the aims of the Baseline Study.

- **Chapter 2**: Coastal Erosion – a review

**1.3.3** Defines coastal erosion and the factors that influence same; undertakes a brief review of coastal erosion across the UK and Ireland and through benchmarking, provides a comparison of the extent of coastal erosion between Northern Ireland and the other countries.

- **Chapter 3**: Coastal Erosion – Northern Ireland

**1.3.4** Provides a review of coastal erosion in Northern Ireland as currently reported in available research papers. The intention of this chapter is to provide the reader with an overarching understanding of coastal erosion and to inform the areas for consideration arising from the study.

- **Chapter 4**: Coastal Erosion Risk Management – in Practice

**1.3.5** A brief review of the differing approaches to Coastal Erosion Risk Management across England & Wales, Scotland and Ireland. The review provides background information to inform the potential way forward for Northern Ireland.

- **Chapter 5**: Assessment and Gap Analysis of Existing Data

**1.3.6** Addresses the first aim of the Baseline study – review currently held information and identify prioritised data requirements.

- Chapter 6: Preliminary Vulnerability Assessment of the NI Coastline

**1.3.7** Introduces vulnerability indices and completes a preliminary, high level assessment utilising the existing available data.

- Chapter 7: Current Governance and Stakeholder Consultation

**1.3.8** Reviews the current responsibilities across central and local government and, through analysis of the stakeholder consultation exercise, considers their operational needs in terms of information required to inform coastal decision making.

- Chapter 8: Conclusion

**1.3.9** Sets out a brief review of the report findings and presents a discussion on the potential way forward for Northern Ireland to achieve a strategy to address coastal erosion risk management.

# 2.0

# Coastal Erosion - a Review

# 2.0

# Coastal Erosion - a Review

## 2.1 Defining Coastal Erosion

**2.1.1** Coastal erosion can be defined as "the removal of material from the coast by wave action, tidal currents and/or activities of humans" (McKibbin, 2016). It typically results in landward retreat of part of the coast and can be caused by natural and human activities (Van Rijn, 2011).

**2.1.2** Coastal erosion includes a range of processes such as water currents, wind, and wind-induced waves (Rangel-Buitrago, 2018) and is one of the greatest challenges for coastal management. The rate of erosion is dependent on the type of coast (Van Rijn, 2011). Climate change is predicted to further exacerbate coastal erosion as a result of sea level rise combined with an increase in the frequency and severity of storm events (Cooper & Jackson, 2017).

**2.1.3** Factors which affect an area's susceptibility to coastal erosion are listed and discussed briefly below:

- Elevation and Topography
- Location
- Geology and Geomorphology
- Coastal Defences
- Marine Activities
- Climate Change

### Elevation and Topography

**2.1.4** Low lying areas are generally more susceptible to coastal erosion and fluctuations in sea level. For example, the high cliffs along Northern Ireland's north coast are less affected than the lower lying areas such as the banks of Lough Foyle and the eastern coast along the Ards Peninsula.

**2.1.5** Sub surface features and topography also affect wave action and sediment transport which can have both a protective or erosive impact upon the existing coastline.

### Location

**2.1.6** The more exposed coastline and headlands are likely to be subject to greater forces and experience the impacts of erosion when compared to sheltered areas and sea loughs, where wave energy is significantly lower than the open sea. Orientation, prevailing wind and swell direction as well as tidal fluctuations all impact the force and energy which affects the coastline.

### Geology and Geomorphology

**2.1.7** Geology is a key factor affecting the susceptibility of the coastline to coastal erosion – the harder the geology the less susceptible to erosion it is.

## Coastal Defences

**2.1.8** The use of hard engineering coastal defences can often result in negative or unforeseen impacts on sediment transport and coastal geomorphology having an effect on natural ecosystems and local ecology. For example, large sea defences at Newcastle (fronted by a seawall) and around Cranfield Point caravan site have led to a reduction in sediment supply by preventing cliff recession reducing the amenity value of the beach as it narrows and the sand disappears.

**2.1.9** Hard engineered coastal defences can also exacerbate coastal erosion elsewhere. It has been recognised that engineering works along the coast often impacts other locations by cutting off sediment supply to other stretches of the coast.

**2.1.10** Soft defences in the form of dunes and salt marshes are present at various locations along the Northern Ireland coast, and play a key role in defending certain areas. Such systems are dynamic and in the case of saltmarshes, may represent important reservoirs which can protect against flooding as well as being important habitats in their own right.

## Maritime Activities

**2.1.11** Other activities that can also have an impact upon coastal erosion include removal of sand from beaches, dredging to maintain navigation and manage drainage, as well as wash from boat traffic.

**Photograph 1.** Coastal Protection at Newcastle, County Down

### Climate Change

**2.1.12** Climate Change is leading to increasing temperatures and in turn higher sea level (Climate Change Risk Assessment [CCRA], 2017). Rising sea levels pose a significant threat for the coast of NI (Dodds et al., 2010; Cooper & Jackson, 2017). Rising sea level is beginning to cause a re-shaping of the NI coastline (CCRA, 2017). Climate change could also contribute significantly to beach erosion because of the predicted increase of storm activity and intensity.

## 2.2 Comparing Coastal Erosion across the British Isles

**2.2.1** The relative rates of erosion in the different areas of the British Isles comes down to three main factors:

- Geology
- Relative sea level rise and
- Wave climate.

**2.2.2** A simplified geological map of the UK is presented in Plate 2.1. Note that this is a map of the underlying rock and does not include the superficial sediments, such as the sand at Magilligan Point. In general, younger sedimentary rocks are expected to erode more quickly than older sedimentary rocks. Metamorphic and igneous rocks erode more slowly.

**2.2.3** The Office of Science and Technology's Flood and Coastal Defence Foresight project (Evans et al., 2004) estimated potential unconstrained shoreline evolution for England and Wales under four future climate change scenarios. Evans et al. (2004) used basic assumptions on relative sea level rise, surge activity, wave height, littoral drift and shoreline movement. Average erosion rates were predicted at a national level. These results are mapped in Plate 2.2 (reproduced from Evans et al., 2004).

**2.2.4** A comparison between the rock types (shown in Plate 2.1) and the potential future erosion rates for England and Wales in Plate 2.2 shows that the two highest categories of erosion risk are associated with the two youngest ages of sedimentary rocks. In Northern Ireland, these ages of rock are only present on the coastline from Cushendall to Belfast.

**Plate 2.1** Simplified geological map of the UK. (© UKCRI)

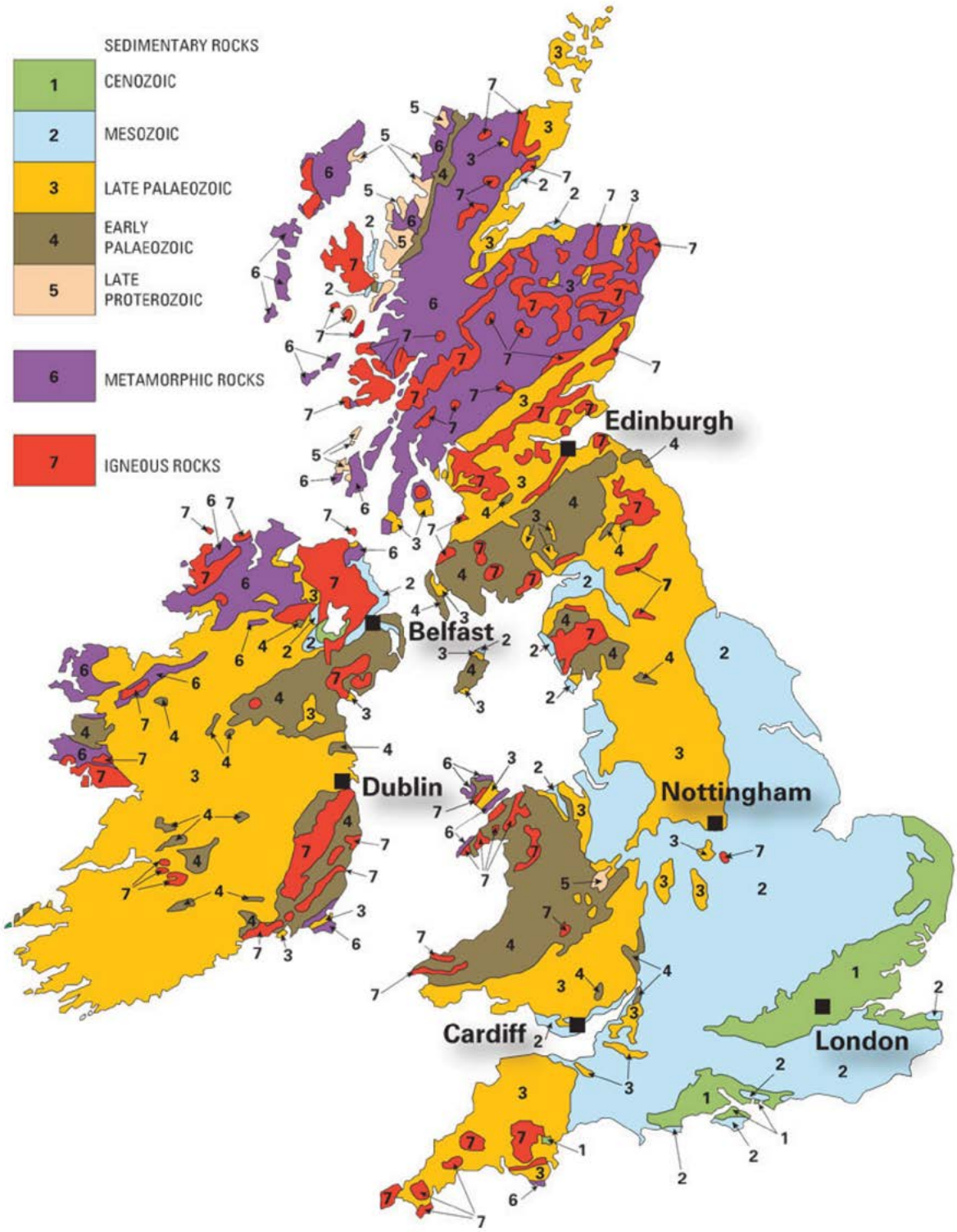
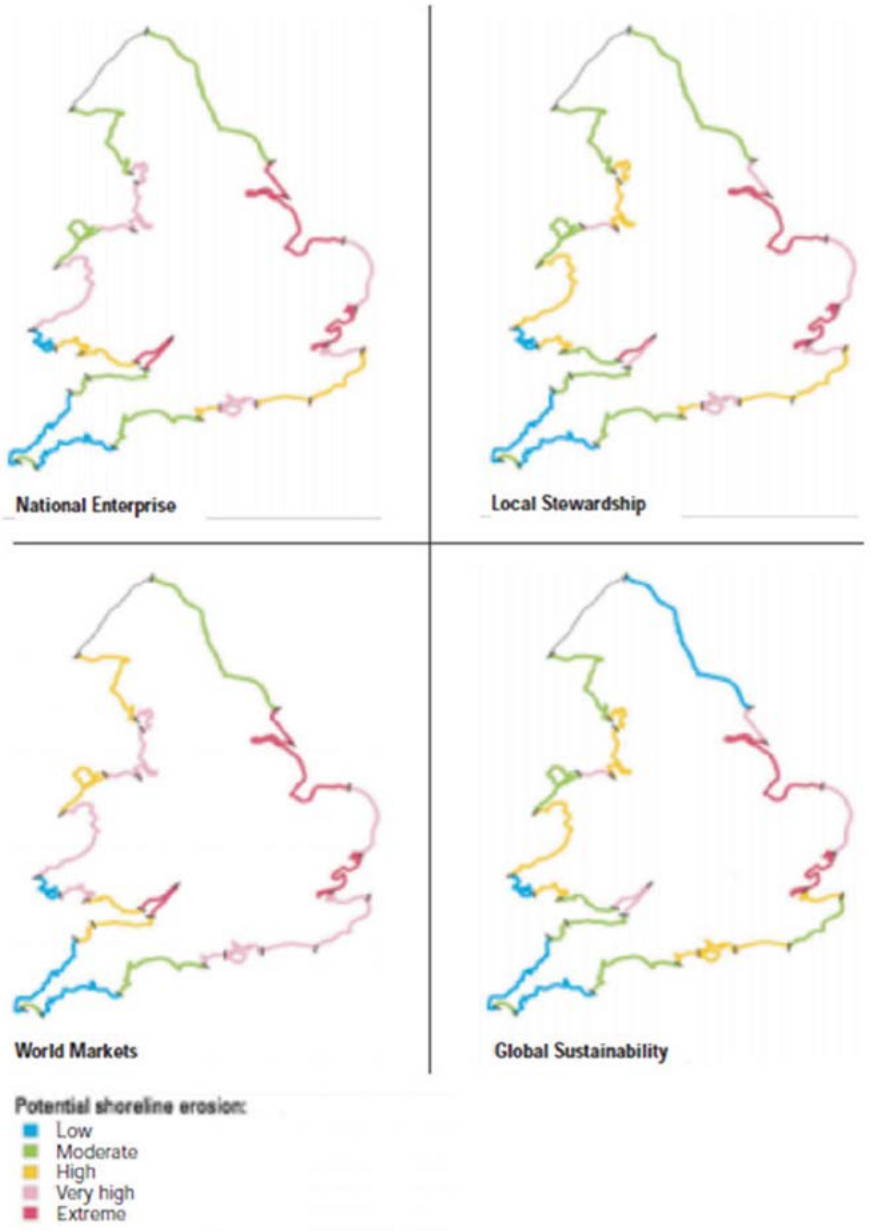


**Plate 2.2** Regional differences in potential shoreline erosion in England and Wales over the next 100 years




Source: Evans et al., 2004, © Crown Copyright, 2004

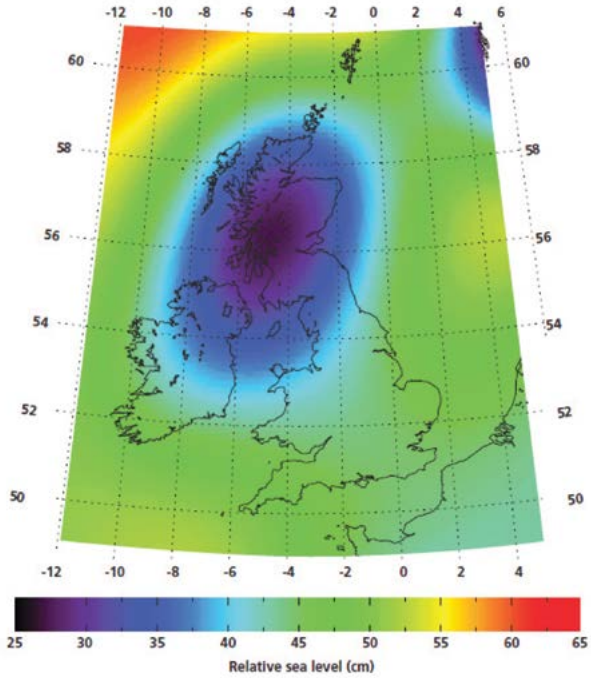
**2.2.5** The relative rate of sea level rise is affected by global changes, regional changes in water level and the isostatic rebound from the last ice age. Predicted rates of relative sea level rise are shown for the British Isles in Plate 2.3. This shows that Northern Ireland is experiencing relatively low rates of relative sea level rise compared to much of the British Isles, particularly the south-east part of the UK, which is predicted to have the highest erosion rates.

**2.2.6** Higher extreme waves have greater energy and erosion potential than lower waves. Comparisons of the average winter significant wave height around the British Isles (e.g. Lowe et al., 2009, Figure 5.2) shows that the highest predicted mean wave heights occur west of Ireland and around the north-west of Scotland. The north coast of Northern Ireland is less exposed to storms than the west of Ireland or the northwest of Scotland. Within Northern Ireland the north coast is more exposed to waves than the east (see also the wave climates presented at points 1 to 5 in Plate 3.1, Section 3.8).

**2.2.7** A comparison between underlying geology, relative sea level rise and wave exposure indicates that Northern Ireland will be relatively less affected by coastal erosion than Scotland, Ireland or England. The south-east of England (in particular) suffers from relatively high rates of sea level rise and relatively young (and generally erodible) rocks, compared to Northern Ireland. However, this applies to the underlying bedrock. Areas where there are beaches of sand and/or shingle overlying the bedrock are still vulnerable to erosion by storms.

**2.2.8** For example, Magilligan Point is a large sedimentary feature that is subject to coastal erosion in places (Westley, 2018) although it lies on top of igneous rock which would erode slowly if exposed to the prevailing waves (refer Figure 5.1 which presents a more detailed geological map)

**Plate 2.3** Relative Sea level rise in the British Isles to 2095




Source: Fig 3.7 of the Lowe et al., 2009.
Reference: Lowe et al., 2009. UK Climate projections science report: marine and coastal projections. Met Office Hadley Centre, Exeter, UK.

**2.2.9** Coastal erosion on the cliffed and other rock coasts of Northern Ireland is slow and sporadic (McKenna et al., 1992). This can still cause local damage that can have wider consequences (such as the closure of a coastal road).

**2.2.10** Northern Ireland is therefore faced with two distinct types of coastal erosion:

- The erosion of beaches due to wave action, potentially exacerbated by changes in sediment supply and sea level rise. Note, however, that not all beaches are eroding – a beach can remain stable (with small fluctuations about the mean) where there is a balance between sediment supply and sediment loss.
- The sporadic and local erosion of bedrock due to a range of potential erosion mechanisms.

**2.2.11** The monitoring and management of the two types of areas should reflect the different nature of the processes causing erosion.

### England

**2.2.12** It is clear from the above comparison that England is the most affected by coastal erosion in the UK. In 2012, approximately 1,800 km of the 4,500 km of the coast of England was at risk of coastal erosion (approximately 340 km of which is defended). Also, approximately 200 properties are currently vulnerable to coastal erosion but by 2029, up to 2,000 residential properties, and 15 km of major road and railway may become vulnerable (Environment Agency, 2012).

**2.2.13** Low-lying and soft-sediment coasts will be the most vulnerable (e.g. in the east of England) because they are most easily eroded, for example Suffolk and north Norfolk face widespread coastal erosion with property and natural habitats being threatened. It is reported that the county of Suffolk has had the greatest loss of coastline than any other county in England.

**2.2.14** However, in England there are examples of coastal erosion across the country from Norfolk in the east to the Sefton Coast in the west near Liverpool.

**2.2.15** The risk of coastal erosion is expected to increase due to climate change causing rising sea levels and changes in weather patterns. Coastal areas in the UK are at risk of being effected, with some areas already experiencing extreme storms or floods.

### Wales

**2.2.16** The geology of the Welsh coastline provides an explanation for the contrast in erosion rates between Wales and the east coast of England. The high-relief and mainly rocky coastline is more resistant to erosion than the low-lying soft geology on the east coast of England. Cliff erosion is controlled by the strength of the geology; typical erosion rates on hard and soft rock are 0.1-1cm per year and 10-100cm per year.

**2.2.17** In Wales, it is estimated that coastal erosion is occurring along 23% (346km) of the coastline. If there was no active intervention, it is estimated that by 2114 there would be 2,126 properties at risk of coastal erosion; of these 1,944 would be residential.

### Scotland

**2.2.18** In 2016, a national coastal erosion susceptibility model for Scotland was produced by Dynamic Coast highlighting areas where erosion can occur (Fitton et al., 2016; Dynamic Coast, 2018). The National Survey split Scotland's coastline into 11 coastal cells and examined the extent of erosion in each cell.

**2.2.19** Since the 1970s 12% of Scotland's soft coast can be classified as erosional, 11% accretional and 77% stable or showing insignificant change. Comparing these recent national figures with the historical period, there has been a 39% increase in the extent of soft coast experiencing erosion and a 22% fall in the extent of soft coast experiencing accretion.

**2.2.20** Greater amounts of erosional change occur within the open and mobile soft coasts of the east, compared with the rock-enclosed coastal cells of the west and north which show greater stability within their soft coast sections (Dynamic Coast, 2018).

**2.2.21** The changes identified by the national survey of falling accretion extent, increasing extent of erosion and faster rates of change are consistent with the anticipated coastal impact of climate change.

**2.2.22** Erosion occurrence adjacent to coastal defences was noted as common within every cell. The defences were inserted in response to an erosional event, however, there are cases where erosion has been exacerbated by these defence structures either on-site or down drift of the site.

### Northern Ireland

**2.2.23** Coastal erosion has historically been a minor concern in Northern Ireland compared to that in England and Wales. This is illustrated by only 32% of NI's coastline being fronted by man-made structure and 68% natural compared to 44% in England and Wales (Cooper et al 2016).

**2.2.24** According to Eurosion (2004) 89km of NI's coastline is eroding – this represents 19.5% of the total NI coastline. The geology of NI is compared to the high-relief, mainly rocky coast of Wales, Scotland and the west coast of England by Masselink and Russell (2013).

### Ireland

**2.2.25** Currently, approximately 20% of Ireland's coast is at risk of coastal erosion. The coasts most susceptible to coastal erosion are those composed of soft sediment. These areas are most common on Ireland's eastern and southern coasts and also in sedimentary bays on western and northern coasts including; the Shannon estuary, Donegal, Clew, Tralee and Dingle Bays.

**2.2.26** Most of the Irish Sea coast is experiencing long-term recession, beaches and dunes are retreating. The rate of recession is highly variable in time and space. Sediment deficit and "coastal squeeze" are noticeable on Ireland's coasts (Climate Change Post, 2018).

**2.2.27** The Atlantic west coast of Ireland is storm dominated (Orford et al., 1999) and in Ireland, storms have been identified as one of the significant drivers of coastal erosion. These types of storms can cause substantial dune erosion and scarping, barrier retreat and lowering of beaches as they impact the sediment budget (Kandrot et al., 2016).

**2.2.28** The National Irish Coastal Protection Strategy Study commissioned in 2013 investigated the potential for erosion along the Irish coast. The study divided the coast of Ireland into six areas. The analysis of coastal erosion along each section of the coast indicated that there was generally little potential risk associated with coastal erosion particularly in the urban areas, primarily due to the fact that these areas are either naturally resilient or protected by man-made defences.

# 3.0

# Coastal Erosion NI: Current Status

# 3.0

# Coastal Erosion NI: Current Status

## 3.1 Introduction

**3.1.1** At present, there are no ongoing coast wide programmes of data collation / research being undertaken along the Northern Ireland Coast, although some small-scale studies, e.g. Beach profiling, are being undertaken at selected locations often as academic studies. As a consequence, our understanding of coastal erosion across the whole of the Northern Ireland coastline is limited.

**3.1.2** What research is available has primarily been delivered by the two main academic institutions within Northern Ireland; Queens University and Ulster University. Professors Andrew Cooper and Derek Jackson from the Centre for Coastal and Marine Research at Ulster University are recognised as a key source of local expertise and have published many papers on the topic. In recent times research on coastal erosion has been commissioned and supported by the National Trust.

**3.1.3** These organisations have a wealth of expertise and knowledge on issues relating to the Northern Ireland coast, however the results of many of the studies are not currently widely available.

**3.1.4** Recent notable local research includes:

- Shifting Shores Living with a changing coastline (National Trust, 2007)
- Shifting Shores playing our part at the Coast (National Trust, 2015)
- Northern Ireland Coastal Data: Current Status and Future Options (Cooper & Jackson, 2017)
- Shifting Shore Wave 2 Seminar: Summary Report (National Trust, 2018)

**3.1.5** A brief summary of these papers is presented in Appendix A.

**3.1.6** The following review of Coastal Erosion in Northern Ireland is based upon local research papers on coastal erosion which are currently published and available.

## 3.2 Summary of Northern Ireland's Coastal Geomorphology

**3.2.1** Different studies have provided varying estimates of the extent of coastal defences in Northern Ireland and it is currently difficult to be definitive. Cooper and Jackson (2017) consider that about 20% of the coastline is armoured; however, Cooper et al. (2016) report that a quarter of all sandy beaches in Northern Ireland are backed by sea defences. According to Cooper et al. (2016) and Defra (2010), 32% of the total coastline (including sea loughs) is subject to some form of coastal protection. When this analysis is conducted excluding sea loughs, 20% of the shoreline is subject to some form of coastal protection according to CCIP (2009). As part of this the Department for Infrastructure - Rivers maintains 26km of sea flood defences and two tidal barriers. Other defences consist of those

maintained by DfI Roads and Translink and private land owners. A recommendation in this regard is made in Section 5.5: Data Recommendations.

**3.2.2** The coastline of Northern Ireland is highly diverse and is comprised of sandy beaches, dunes, tidal inlets, sea loughs and cliffs (Cooper, 2010). Carter (1990), following a detailed study of 16 beaches along the coast of Northern Ireland, suggests that all of the Northern Ireland soft coast, except a stretch ~4km around the mouth of the River Bann, is receding at varying rates. Cooper & Jackson (2017) estimate that about 30% of the coast is at risk from erosion, while McKibben (2016) estimates that almost 20% of the coast of Northern Ireland is at risk of erosion, compared to almost 30% in England. Further studies of the north and north east coast of Northern Ireland by Carter and Bartlett (1990) have indicated that erosion rates of the soft coast range between 0.03 and 2.56 m/yr. However, changes to hard coastline are harder to detect as they are typically sporadic. McKenna et al. (1992) summarised the erosion of the 'hard' coastline. The construction of roads along the coast, such as the Antrim Coast road, has led to the cutting off of much of the sediment supply to the littoral zone, contributing to erosion along those coastlines (McKenna, 1992).

**3.2.3** The main reason for erosion on this northeast part of the coastline is wave attack along with temporary rises in the sea surface (surges) and vulnerability in areas of poor sediment supply (Carter,1990).

**3.2.4** Cooper (2016) reports the coastline as divided into five sections, consisting of the North Coast, Antrim Coast, Outer Ards Coast, South Down Coast and Sea Loughs. This has been reported predominantly in Cooper (2010) and Cooper et al. (2016) which form the basis for the following summary.

- North Coast

**3.2.5** This length of coastline runs from Magilligan Point in the west, encompassing Portrush, Portstewart and Portballintrae stopping at Ballycastle. At Ballycastle the coastal orientation changes to run north-south.

- Antrim Coast

**3.2.6** This section of the coast extends from Ballycastle in the north to Larne. Key settlements along this stretch include Cushendun, Cushendall and Ballygalley. This section is characterised by the glaciated valleys of the Antrim Glens, with headland-embayment beaches at the mouths of the valleys.

- Outer Ards Coast

**3.2.7** This length of the coast runs from Larne to Dundrum Bay, encompassing Bangor and Donaghadee. The A2 Coast Road runs semi-continuously along this rocky section of the coastline.

- South Down Coast

**3.2.8** This section extends from Dundrum Bay to Cranfield Point and includes the towns of Newcastle and Kilkeel. This section is characterised by a mixture of hard rock and soft glacial deposits.

- Sea Loughs

**3.2.9** There are five sea loughs located on NI's coastline; Lough Foyle, Larne Lough, Belfast Lough, Strangford Lough and Carlingford Lough.

## 3.3 North Coast

**3.3.1** The North coast is primarily composed of hard basaltic geology which is resistant to coastal erosion. However, the coastline is interspersed with sandy beaches and dunes between headlands. These beaches are prone to erosion. Examples of these include Portrush and Portballintrae. The largest beaches are those at Portstewart and Magilligan, where multiple offshore bars dissipate wave energy which also reduces to the east and therefore erosion is not as pronounced (Cooper, 2010).

**3.3.2** Magilligan Foreland is a large sedimentary feature composed of a series of sandy ridges. To the south Lough Foyle is a large shallow sandy estuary. Both of these areas could be at risk of erosion. Carter et al. (1982) describe the cyclic sediment exchange between the top of Magilligan Point and the ebb delta. Magilligan Foreland is a NNE-facing barrier backed by dune-topped beach ridges and has undergone significant periods of erosion and accretion (Cooper et al., 2004). These periods consist of erosion of 100m between 1839 and 1850, then accretion until 1950, erosion 1950-1980 and then accretion until the present day. These patterns are due to fluctuations in ebb-delta morphology which mediated the wave approach angles (Carter, 1975). Carter (1990) suggest that the most rapid erosion in Northern Ireland occurs along the northwest coast of Magilligan. Westley (2018) analysed shoreline change between the Roe Estuary and Magilligan point using historic maps. Shoreline change rates varied in space and time, but the mean rate of change always showed erosion which varied between 0.6 m/year and 1.0 m/year (depending on the time period considered).

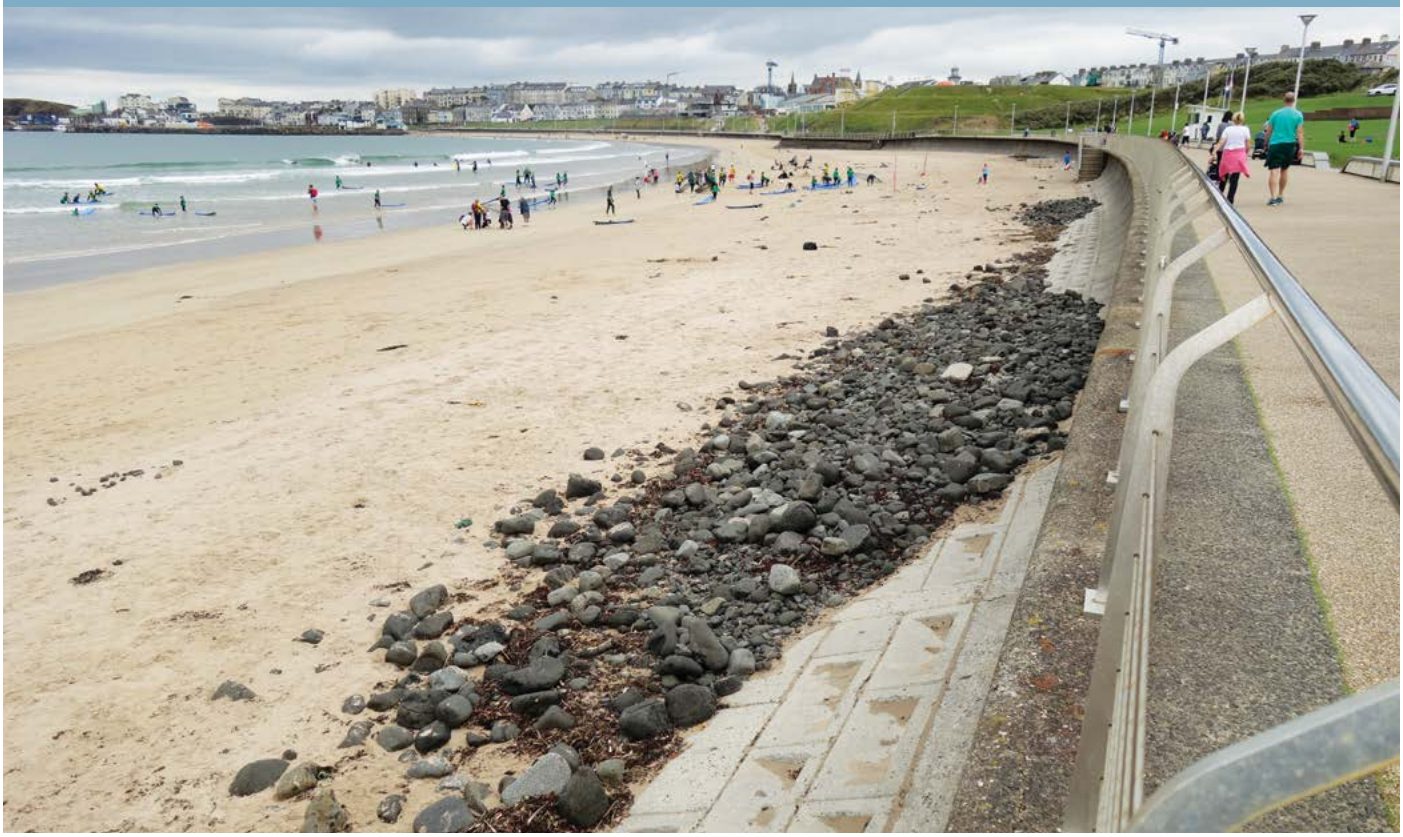
**Photograph 2.** Magilligan Point

**Photograph 3.** White Park Bay

**3.3.3** This coastline is comprised of sandstones and mudstones with overlying softer superficial sediment and is therefore at risk of erosion until past Magilligan Point. After Magilligan Point basalts dominate that are hard and resistant to erosion. However softer superficial sediments dominate in pockets forming sandy beaches at risk of erosion despite the resistant hinterland. Some of these beaches have formed in areas with chalk and sandstone bedrock (Portrush East Strand and White Park Bay) which is softer than the surrounding basalt but still moderately resistant to erosion. Carter and Bartlett (1990) report erosion rates at some of these beaches.

**3.3.4** Typically, during storms sand dune erosion may occur but after storms this sediment is re-deposited on the beach (Cooper, 2010). However due to coastal defences influencing the erosion and redistribution of sediments beach erosion is reported to occur. This is the case at West Strand Portrush where beaches have lowered during storms and narrowed since a seawall built in the 1960s broke the connection between the beach and the sand dunes (Cooper, 2016; Cooper, 2010). Breaking the connection with the dunes means excess energy in storms is not dissipated and is therefore reflected seaward causing erosion (Cooper, 2016). Carter and Bartlett (1990) report erosion rates between 0.08 m/year and 0.14 m/y at East Strand, Portrush.

**Photograph 4.** Sea wall that resulted in lowering of the beach at West Strand, Portrush



**3.3.5** In addition, at Portballintrae several constructions have been built. These at first caused beach lowering and then led to the need to armour the glacial bluffs. The construction of a pier then led to an interruption of longshore drift which has had implications in reducing the width of the beach at Portballintrae. Carter and Bartlett (1990) report erosion rates increasing through time, from an average of less than 0.03 m/year from 1833-1904, 0.15 m/year from 1904-1966 and 0.25 m/year between 1949-1975. Attempts to reinstate the beach with groynes and beach nourishment have been fairly unsuccessful (Jackson, 2013; Cooper, 2010). The hard coastline at Portballintrae is also formed of different materials subject to differing rates of erosion. This can lead to significant crenulation undercutting and collapse (McKenna, 1992).

**Photograph 5.** Piers at Portballintrae that have resulted in beach erosion

**3.3.6** Generally, the risk of erosion is low along this stretch of coastline due to the dominance of basalts despite the higher wave energy than the rest of the coastline of Northern Ireland. Erosion does occur in the interspersed beaches. Some of these are not in populated areas. However at Portballintrae and Portrush, the areas coincide with towns. The stretch of coastline between Londonderry and Glebe is also at risk of erosion due to its softer geology. There are settlements here and two airports but these have been defended.

## 3.4 Antrim Coast

**3.4.1** This section of the coast extends from Ballycastle in the north to Larne. Key settlements along this stretch include Cushendun, Cushendall and Ballygalley. This section is characterised by the glaciated valleys of the Antrim Glens, with headland-embayment beaches at the mouths of the valleys.

**3.4.2** At Ballycastle the orientation of the coastline changes to align north to south and in addition the geology changes significantly. The geology along this stretch of coastline is composed of a number of different units. These are small stretches of hard basaltic rocks resistant to erosion in addition to stretches of sandstones, siltstones and mudstones which are moderately resistant to erosion. Cooper (2010) states that the coastline is predominately Mesozoic mudstone and chalk covered by Tertiary basalt. The igneous rocks along this stretch of coastline often do not extend fully to the coastline leaving a relatively low lying platform of sandstones, siltstones or chalk. These platforms are at a moderate risk of erosion and are in many places where the main road is located. Platforms extending offshore however are likely to dissipate wave energy before it reaches the coast.

**Photograph 6.** Waterfoot

**3.4.3** The Antrim coast has a number of sand and gravel beaches in between headland embayments which compartmentalise the coastline separating sediment budgets, restraining longshore drift. The main beaches are all backed by dunes and consist of: Ballygalley, Glenarm, Red Bay, Cushendall and Cushendun (Cooper, 2010). At Cushendun sand removal from the beach caused beach erosion and shoreline retreat although sand removal has now stopped (Carter, 1991).

**3.4.4** Cooper (2010) states that in certain locations with high relief and cliffs there is also a risk of erosion due to rotational slumping of basalt and chalk above underlying clays. However, the locations prone to this type of erosion are not specified and a more detailed analysis of the geology would be required to find these locations. In some places while the geology is that of hard igneous rocks, slowly eroding wave cut platforms have formed. McKenna et al. (1992) summarised the erosion of cliffs and shore platforms along this coast. Erosion is episodic along most of the hard coast, often limited to block falls or sub-aerial slope failures, mudslides and landslips. This makes it difficult to establish an erosion rate.

**3.4.5** Despite the low risk of erosion, the presence of main roads directly on the edge of these platforms could mean that this is still an important hazard. Westley & McNeary (2014) found instances of erosion along the coastline between Larne and Drain's Bay. Sand extraction at Cushendun and Cushendall has contributed to beach erosion rates of ~1m/year (Carter and Bartlett, 1990).

**3.4.6** Ballycastle and Waterfoot beaches have eroded at average rates of 0.17 m/year and 0.26 m/year (Carter and Bartlett 1990).

**Photograph 7.** Outer Ards coastline (Ballywalter)

## 3.5 Outer Ards Coast

**3.5.1** The geology of this stretch of coastline is predominately basalts and mudstones with igneous intrusions between Larne and Greenisland and then Sandstone with igneous intrusions between Greenisland and Dundrum Bay. Superficial geology is mainly composed of glacial tills and raised beach deposits. Along this stretch of coastline beaches are present between embayments and often due to igneous intrusions, are comprised of only a thin layer of sand on top of an irregular rock surface. Beaches with less sand are more constrained by the geology and typically the sediment is more mobile (Jackson and Cooper, 2009). At Ardglass there is very little sandy deposit as there is not much sediment available there (Cooper, 2010).

**3.5.2** Raised postglacial beaches sometimes provide a sediment source for new beaches by coastal erosion and during storms (Cooper, 2010; Cooper, 2016). These beaches will provide more sediment as sea level rises (Cooper,2016). However, in many cases this process has been stopped and therefore the sediments made inaccessible by sea defences.

**3.5.3** Erosion has been reported at Ballyholme beach (Cooper, 2016). Wave energy along this stretch of coastline is typically low. However, erosion does occur in otherwise stable areas during storms (Jackson and Cooper, 2009). At Bangor and Donaghadee coastal defences to protect the glacial bluffs from eroding has restricted the sediment supply of the beach and therefore beach lowering has occurred as installed groynes have been unsuccessful (Cooper, 2016). While the majority of the Islandmagee peninsula is basalt with very little evidence of erosion found by

Westley & McNeary (2014), there are some areas of erosion resulting in vertical scarps where the geology changes to mudstones to the south of the peninsula close to Blackhead.

**3.5.4** Between Blackhead and Belfast, the geology is that of mudstone with occasional rocky outcrops due to igneous intrusions. Predominately this stretch of coastline is armoured due to the presence of railways and roads. However, some narrow beaches are present and could be at risk of erosion. Between Belfast and Helen's Bay there are some long stretches of narrow beach which could be eroded. From Helen's Bay to Donaghadee beaches are typically shorter and confined between rocky headlands which in some places are igneous intrusions.

**3.5.5** From Donaghadee to Strangford Lough beaches become larger but are still constrained by the geology and appear to be a thin layer on top of a rocky surface and are thus at risk of erosion. However, in some places the shallow platform offshore should reduce the wave energy and therefore result in less erosive potential. A similar coastline is seen between Strangford Lough and Dundrum Bay.

**3.5.6** Areas surrounding Belfast and large stretches of the coastline from Belfast to Dundrum Bay are relatively low lying, which makes them more vulnerable to coastal erosion.

## 3.6 South Down Coast

**3.6.1** This stretch of coastline is comprised of sandstones with igneous intrusions and overlain by soft superficial glacial deposits. Again, most beaches are bound by outcrops (Cooper, 2010). Similarly, to the Outer Ards Coast the beaches are often a thin veneer on top of the irregular geology beneath.

**3.6.2** Coastal erosion has been recorded around and extending from Newcastle, where construction of coastal defences caused a reduction in sediment supply by stopping cliff recession. This caused beaches to narrow and disappear (Cooper, 2016). At Ballyhornan the rear of two small beaches is eroding glacial deposits either side of a headland. The beaches in front of the deposits are thin veneers on top of hard geology which dissipates less energy (Cooper, 2010; Jackson and Cooper, 2009). A wide shore platform with occasional patches of sandy beach is present. The extent of intertidal sand increases to Tyrella (Cooper, 2010). Studies by Westley & McNeary (2014) have shown there is erosion at the eastern side of Cranfield Point and the southwestern tip. They also found limited erosion from Cranfield Point to Derryogue due to the cliff being set further back from the active shoreline. Erosion was also found at the cliff at Kilkeel and at isolated spots at Ballymartin.

## 3.7 Sea Loughs

**3.7.1** There are five sea loughs located on NI's coastline; Lough Foyle, Larne Lough, Belfast Lough, Strangford Lough and Carlingford Lough. Sea loughs are usually dominated by low energy features and are generally more influenced by coastal flooding than coastal erosion. However, according to Cooper (2016), storms may have a large influence. Within Strangford Lough, Cooper (2016) reports that beach narrowing is occurring due to coastal defences stopping erosion, which is the sediment source for the beaches. Armouring the coastline within sea loughs has the effect of inhibiting the landward movement of tidal flats causing them to narrow as sea level rises meaning there is less area for tidal energy to dissipate across (Cooper, 2016).

**3.7.2** At Mount Stewart, the National Trust has noticed increasing sea levels and plans are in place to adapt to the rising sea levels of Strangford Lough. The National Trust has enhanced the existing Sea Plantation on the shores of the lough; however recent climate change studies have suggested that the Sea Plantation will struggle to protect the property. Due to this, the National Trust has begun a long-term plan to future-proof the property and in particular the gardens by preparing to allow tidal flats to encroach on what had previously been wetlands. To do this, National Trust have acquired land not at risk from extreme weather events and are preparing to relocate the car park. This site will then be replaced by a dense shelterbelt which will take over some of the role of the Sea Plantation.

**3.7.3** Studies by Orford et al. (2006) found that 50% of intertidal habitat at the northern end of Strangford Lough would be lost by a sea level rise of 1m, however where coastal defences have not been applied this will not occur. Within Strangford Lough erosion rates have been measured to be <1-0.165m/yr by Greenwood and Orford (2008) for unconsolidated cliffs.

**3.7.4** The geology of Strangford Lough is predominately sandstone with igneous intrusions and superficial layers of glacial till and raised beach deposits. Larne Lough has a low risk of coastal erosion due to the low wave energy here. The geology consists of argillaceous rock, mudstone and chalk with superficial glacial till.

**Plate 3.1:** Location of CFSR points analysed around the Northern Ireland Coast


## 3.8 Offshore wave conditions

**3.8.1** The offshore wave climate is dominated by swell, and has been analysed in deep water offshore of Northern Ireland at five points shown in Plate 3.1. This analysis is based on the 30 year hindcast dataset covering 1979-2009 from the United States National Oceanic and Atmospheric Administration's (NOAA's) Climate Forecast System Reanalysis (CFSR) model. Significant wave heights are largest to the North West, where the position is most exposed to Atlantic swell. Wave heights are generally reduced moving around the coast from point 1 to 3, where the coastline is most sheltered from swell from the south and north-west. From point 3 to point 5 significant wave heights increase slightly due to the exposure to waves from the south.

**3.8.2** Most of the coastline of Northern Ireland shelves quite steeply to deep water offering little protection to large swells. However west of Coleraine and along the coastline from Belfast there are shallow shelves which may cause wave breaking and reduce wave energy available for erosive processes.

# 4.0

# Coastal Erosion Risk Management - In Practice

# 4.0

# Coastal Erosion Risk Management - In Practice

## 4.1 Introduction

**4.1.1** This chapter presents a brief review of the different approaches and strategies applied to address Coastal Erosion Risk Management. The practical solutions used to address coastal erosion, from hard defences to managed retreat, are subsequently introduced at the rear of the chapter.

## 4.2 Europe

### Eurosion

**4.2.1** Eurosion (European Commission, 2004) was a European study into coastal erosion at a European scale (including Northern Ireland and the Republic of Ireland). Its outputs were:

- A map-based assessment of European coasts exposure to coastal erosion;
- A review of existing practices and experience of coastal erosion management;
- Guidelines to incorporate coastal erosion into environmental assessment, spatial planning and hazard prevention; and
- Policy recommendations to improve coastal erosion management.

**4.2.2** Eurosion's maps can be used to assess the coastal typography, geology and coastal erosion trends of a region. The maps also include the location of engineering works (whether harbours, jetties, groynes or breakwaters). There is an additional map for regional exposure to coastal erosion.

**4.2.3** Eurosion concluded that a more strategic and proactive approach to coastal erosion is needed for the sustained development of vulnerable coastal zones. It developed the concept of coastal resilience: the inherent ability of the coast to accommodate changes induced by sea level rise, extreme events and occasional human impacts, whilst maintaining the functions fulfilled by the coastal system in the longer term. To promote coastal resilience, Eurosion introduced the concept of favourable sediment status: the situation where the availability of coastal sediments support the objective of promoting coastal resilience in general and of preserving dynamic coastlines in particular. This should be achieved for each coastal sediment cell by designating strategic sediment reservoirs: supplies of sediment of appropriate characteristics that are available for replenishment of the coastal zone, either temporarily (to compensate for losses due to extreme storms) or in the long term (at least 100 years). They can be identified offshore, in the coastal zone (both above and below low water) and in the hinterland.

**4.2.4** A coastal sediment cell is a coastal compartment that contains a complete cycle of sedimentation including sources, transport paths and sinks. The cell boundaries delineate the geographical area within which the budget of sediment is determined, providing the framework for the quantitative analysis of coastal erosion and accretion. Eurosion considered that coastal sediment cells constitute the most appropriate

units for achieving the objective of favourable sediment status and hence coastal resilience (European Commission, 2004). Favourable sediment status is defined as the situation whereby the availability of coastal sediments supports the objective of promoting coastal resilience in general and of preserving dynamic coastlines in particular.

### Integrated Coastal Zone Management

**4.2.5** A European Parliament and Council Recommendation concerning the implementation of Integrated Coastal Zone Management in Europe was adopted on 30 May 2002 (2002/413/EC) (European Commission, 2018).

**4.2.6** It lists eight principles defining the essential characteristics of ICZM. Integration across sectors and levels of governance, as well as a participatory and knowledge-based approach, are hallmarks of ICZM. The eight principles are listed below:

1. a broad overall perspective (thematic and geographic) which will take into account the interdependence and disparity of natural systems and human activities with an impact on coastal areas;
2. a long-term perspective which will take into account the precautionary principle and the needs of present and future generations;
3. adaptive management during a gradual process which will facilitate adjustment as problems and knowledge develop. This implies the need for a sound scientific basis concerning the evolution of the coastal zone;
4. local specificity and the great diversity of European coastal zones, which will make it possible to respond to their practical needs with specific solutions and flexible measures;
5. working with natural processes and respecting the carrying capacity of ecosystems, which will make human activities more environmentally friendly, socially responsible and economically sound in the long run;
6. involving all the parties concerned (economic and social partners, the organisations representing coastal zone residents, non-governmental organisations and the business sector) in the management process, for example by means of agreements and based on shared responsibility;
7. support and involvement of relevant administrative bodies at national, regional and local level between which appropriate links should be established or maintained with the aim of improved coordination of the various existing policies. Partnership with and between regional and local authorities should apply when appropriate;
8. use of a combination of instruments designed to facilitate coherence between sectoral policy objectives and coherence between planning and management.

**4.2.7** Based on these principles, the Recommendation outlined steps which the Member States should take to develop national strategies for ICZM. Given the cross-border nature of many coastal processes, coordination and cooperation with neighbouring countries and in a regional sea context are also encouraged (European Commission, 2018). To support the implementation of the ICZM Recommendations, the Commission facilitated an expert group.

## 4.3 England and Wales

**4.3.1** Department for Environment, Food and Rural Affairs (Defra) has overall national responsibility for policy on flood and coastal erosion risk management (FCERM) in England, whilst the Department for Communities and Local Government (DCLG) are responsible for planning policy, including policy affecting the development of land which is at risk from flooding or coastal erosion.

### Futurecoast

**4.3.2** Futurecoast (Halcrow, 2002, Burgess et al., 2002) was commissioned by Defra to improve the understanding of coastal evolution for the open coast of England and Wales (so not including Northern Ireland). It contains:

- Shoreline behaviour statements that give an improved understanding of coastal behaviour and qualitative predictions of future coastal evolution at both large and small scales;
- Assessment of future behaviour for an unconstrained scenario (with no defences or management) and a managed scenario (where present management practices continue indefinitely); and
- A 'toolbox' of supporting information and data including cliff behaviour statements, historical shoreline changes, wave modelling, an uncertainty assessment, morphological measurements including beach width, a coastal geomorphology reference manual and a thematic study on onshore geology, offshore geology, coastal processes, climate change and estuaries.

### Environment Agency Coastal Erosion Map

**4.3.3** In England and Wales the Environment Agency has produced open data maps of potential future coastal erosion positions for the short term (about 2030) medium term (about 2060) and long term (about 2100). The current Shoreline Management Plan policy is also shown. This map illustrates what is expected to happen where SMP policies are implemented and what is likely to happen if no active intervention occurs. The predictions of future erosion zones are made based on historical evidence, ongoing monitoring and other data. These zones are shown as a range, rather than at specific positions, due to the uncertainty in calculating future coastal erosion.

These maps are based on the National Coastal Erosion Risk Management (NCERM) project (Rogers et al, 2013) which began in 2006. The NCERM aimed to provide an accessible, national repository of relevant Environmental Agency coastal protection information. It aimed to link Coastal groups, coastal monitoring and other key information in one place and to enable SMPs and other underlying information to be updated dynamically.

### Shoreline Management Plans

**4.3.4** Since the 1990s, approximately 60 non-statutory coastal management initiatives have been established at both local and regional levels (Stojanovic and Ballinger, 2009). Shoreline Management Plans (SMPs) are used to assess each stretch of coast and select an appropriate management response (Cooper, 2015).

**4.3.5** SMP provides a framework for coastal management and for local/regional councils in conjunction with the Environment Agency (Cooper & Jackson, 2018). It also assists in budgeting and targeting of coastal risk management funding (NIEL, 2012). It provides detailed, technical strategies that consider environmental social and economic factors (NIEL, 2012). There are 22 SMPs encompassing the entire coastline of England and Wales.

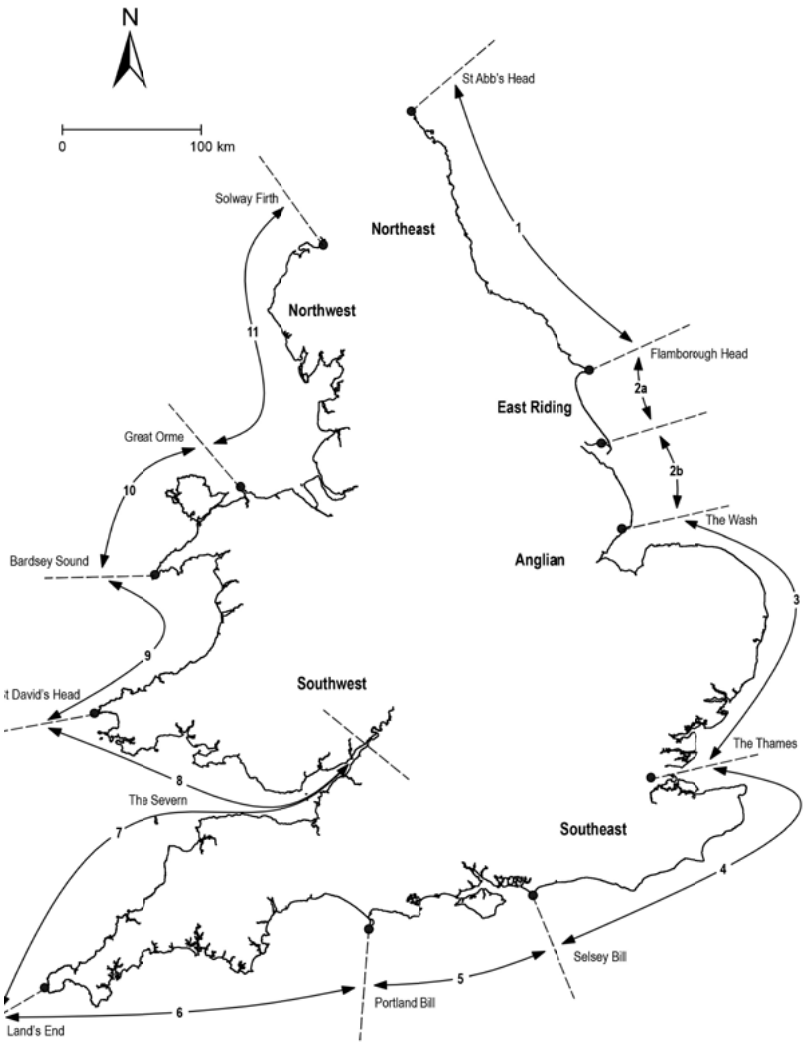
**4.3.6** Within each SMP area, the coast is divided into Policy Development Zones (PDZ). The PDZ are divided into Management Areas. There are four generic shoreline management policies considered within the SMPs; No Active Intervention (a decision not to invest in providing or maintaining defences); Hold the Line (maintaining or upgrading the level of protection provided by defences); Advance the Line (building new defences seaward of existing defence line); and Managed Realignment (allowing the shoreline to realign, landwards to seawards, sometimes with management to initiate and control change).

**4.3.7** They are normally prepared by local authorities as a means of informing policy on vulnerable areas, or areas of high conservation potential.

**4.3.8** The coastline of England and Wales is divided into 11 coastal cells and each cell is associated with a regional coastal group comprising of relevant local authorities, Natural England, National Trust and the Environment Agency. **Plate 4.1** shows the location of coastal cells. A Regional Coastal Monitoring Programme was developed within each cell, which is established in consultation with stakeholders and administered by a coastal observatory. The main elements of the Coastal Monitoring Programme include:

- beach profile surveys,
- topographic surveys,
- cliff top recession surveys,
- bathymetric and sea bed characterisation surveys,
- real-time wave data collection and
- aerial photography.

**Plate 4.1** Location of Coastal Cells and the Coastal Observatories



### Coastal Observatories

**4.3.9** Coastal observatories have been established for England and Wales comprising of local authorities' employees, funded by the Environment Agency and managed by a local authority. The Network comprises six Regional Programmes, collecting coastal monitoring data in a co-ordinated and systematic manner to serve the needs of coastal engineering and management. Plate 4.1 shows location of the Coastal Observatories in relation to the coastal cells.

- Northeast
- East Riding
- Anglian
- Southeast
- Southwest
- Northwest

### Wales

**4.3.10** Legislation, policy and management of coastal flooding and coastal erosion in Wales mirrors that in England, although the roles and responsibilities held by Defra are undertaken by the Welsh Government (WG), and those of the Environment Agency are undertaken by Natural Resources Wales (NRW).

**4.3.11** Some Local Authorities are designated as coastal risk management authorities under the Coast Protection Act (CPA) (1949) which provides them with powers (though not a duty) to protect the land against erosion or encroachment from the sea.

**4.3.12** The Environment (Wales) Act 2016 created a Flood and Coastal Erosion Committee in 2017 that reports to the Minister for Natural Resources. The purpose of the committee is to advise Welsh Ministers on matters relating to flood and coastal erosion risk management. The committee also facilities communication between the flood and coastal erosion risk management sector in Wales and the Welsh Ministers. The committee processes data, knowledge and intelligence into effective advice for Welsh Ministers through its links with all relevant organisations. https://beta.gov.wales/flood-coastal-erosion-committee/what-we-do

## 4.4 Scotland

**4.4.1** The Scottish Government has overall responsibility for policy on flood management. The Scottish Environment Protection Agency (SEPA) is designated as the strategic flood risk management authority under the Flood Risk Management (Scotland) Act 2009 (FRMA). Under the Coast Protection Act, local authorities have a role in coast protection.

**4.4.2** SEPA has produced Flood Risk Management Strategies (FRMS) for all of the Local Plan Districts. Whilst SEPA are not responsible for the management of coastal erosion, consideration has been given to this in the FRMS's by identifying areas that are likely to be susceptible to erosion, as well as areas where erosion could exacerbate flood risk.

**4.4.3** Integrated Coastal Zone Management (ICZM) is implemented by Local Coastal Partnerships (LCPs). LCPs are voluntary partnership groups comprising local and national representatives including Coast Hebrides, East Grampian Coastal Partnership, Solway Firth Partnership, Tay Estuary Forum, Forth Estuary Forum and Moray Firth Partnership, (Scottish Government, 2018).

**4.4.4** The Scottish Coastal Forum is a stakeholder group that was formed in 1996 and works closely with the Scottish Government. It was formed to encourage national level debate of coastal issues. The members advise Marine Scotland on the development of policy relating to marine planning and licensing within a sustainable marine environment (Scottish Government, 2018).

**4.4.5** Marine Scotland (MS) Science is the multi-disciplinary Division of Marine Scotland which undertakes monitoring, research and regulation of certain coastal activities. The purpose of Marine Scotland Science (Marine Scotland Science, 2018) is to;

- provide expert scientific, economic and technical advice and services on marine and freshwater fisheries, aquaculture, the aquatic environment and its flora and fauna,
- provide the evidence to support the policies and regulatory activities of the Scottish Government through a programme of monitoring and research,
- perform regulatory and enforcement activities, and
- represent the Scottish Government at national and international meetings.

**4.4.6** Shoreline Management Plans have only been developed by the local authorities for small sections of the Scottish coast. Therefore, the Scottish Government commissioned a National Coastal Change Assessment (NCCA). The NCCA aims to inform existing strategic planning (Dynamic Coast, 2018).

**4.4.7** The Dynamic Coast project in Scotland has digitised shorelines from maps created in the 1890s, 1970s and 2010s to assess how the coastline has changed over about 125 years. The coastal type has been mapped and the inherent erodibility of the coastal zone evaluated. A Coastal Erosion Susceptibility Model (CESM) was developed to identify areas with high erosion susceptibility (where the surficial geology lies below Mean High Water Spring (MHWS) and there is a sedimentary layer that can be eroded) (Dynamic Coast, 2018).

**4.4.8** Areas of erosion have been projected forward to 2050, to provide indicative figures of those natural and built assets at increased risk if the trends of coastal change continue. This assessment does not take account of any future management choices or accelerating erosion due to climate change (increasing vulnerability). A 'Whole coast assessment methodology' was then developed to look at the distribution and proximity of assets to the shoreline. Where these assets overlap with areas of projected coastal erosion, they are considered vulnerable. In some locations 3D maps of recent coastal change were made.

**4.4.9** The next phase of DynamicCoast.com will use the latest monitoring techniques to map and categorise the resilience of the Scottish coast and identify the links between erosion and flooding.

## 4.5 Ireland

**4.5.1** Natural processes, such as coastal erosion, do not recognise administrative boundaries or borders. This is especially pertinent at the coastal borders between Ireland and Northern Ireland which occur within sea loughs, and where activities in one administration could result in significant impacts upon the other.

**4.5.2** The Loughs Agency is a cross-border body established under the 1998 Agreement between the Government of the United Kingdom and the Government of Ireland. The aim of the agency is to provide sustainable management of fisheries and marine resources in the Foyle and Carlingford Areas (Loughs Agency, 2018).

**4.5.3** As with the UK, much of the recent legislation has been drafted in response to EU directives, and as such the Office of Public Works (OPW) has overall responsibility for flood and coastal erosion risk management under the Arterial Drainage Act (1945 & 1995) and Coastal Protection Act (1963).

**4.5.4** The Minor Flood Mitigation Works & Coastal Protection Scheme was introduced by the Office of Public Works in 2009. The purpose of the scheme is to provide funding to Local Authorities to undertake minor flood mitigation works or studies to address localised flooding and coastal protection problems within their administrative areas (Office of Public Works, 2018a).

**4.5.5** The Irish Coastal Protection Strategy Study (ICPSS) is a national study that was commissioned in 2003 with the objective of providing information to support decision making about how best to manage risks associated with coastal flooding and coastal erosion. The Study was completed in 2013 and provides strategic current scenario and future scenario (up to 2100) coastal flood hazard maps and strategic coastal erosion maps for the national coastline. This major study provides invaluable and essential information required to inform policy in this area, particularly for local authorities in relation to the proper planning and development of coastal areas (Office of Public Works, 2018c).

## 4.6 Coastal Erosion Solutions

**4.6.1** For many years, the default response to erosion along the coast has been to "hold the line" and build our way out of trouble (National Trust, 2015), with the primary method of providing coastal protection being to introduce a line of defence. Consequently, engineers have traditionally led the management of coastal change (Cooper & al., 2016).

### Hard Engineering

**4.6.2** Hard engineering techniques are the introduction of permanent concrete and rock structures to "fix" the coastline and protect the assets located behind (Eurosion, 2004).

**4.6.3** Traditionally, the emphasis for protection was seawalls and groynes. A sea wall is, as the name would suggest, a vertical or near vertical stone or concrete wall built along the shoreline, capable of resisting severe exposure from waves crashing against it (Williams et al., 2018). In contrast, groynes are introduced in a system of "walls" which extend from the beach to the ocean to influence sediment transport because of longshore current. Other types of hard engineered coastal protection structures include revetments and rock armour, breakwaters and jetties.

**Photograph 8.** Sea wall in Carrickfergus

**Photograph 9.** Stone revetment in Donaghadee

## Soft Engineering

**4.6.4** Increasingly alternative natural or soft engineering techniques are being used; this was one of the principle recommendations from Integrated Coastal Zone Management (ICZM) (Cooper & McKenna, 2008).

**4.6.5** Soft measures involve building with natural processes and relying on natural elements, introduced to a specific area such as sands, dunes, marshes and vegetation to prevent erosive forces from reaching the backshore (Eurosion, 2004; Pranzini & Williams, 2013). Examples include beach nourishment, dune regeneration and cliff stabilisation.

## Managed Retreat and Construction set back

**4.6.6** Managed retreat or managed realignment refers to land use change and relocating infrastructure (Williams et al., 2018). This concept was developed in Europe and involves abandoning lands at risk of erosion or flooding and relocating these assets further inland; this technique has been implemented in Essex and Sussex (Managed realignment, 2018). This process is chosen when a cost benefit analysis demonstrates that the cost of additional protection would largely exceed the value of assets to be protected in the long term, thus relocation is the more economically viable option. This technique is considered an environmentally sound solution as coastal erosion is not halted, and so sediment movement continues as it would, undisturbed.

**4.6.7** Construction setback is a method that has been implemented in the United States of America. A setback distance is calculated by predicting how far back the beach will erode in the future. This distance then determines where new buildings and infrastructure can be built (Jonah et al., 2016), thus removing the need for coastal protection for these properties.

# 5.0

# Assessment and Gap Analysis of Existing Data

# 5.0

# Assessment and Gap Analysis of Existing Data

## 5.1 Introduction

**5.1.1** A key objective of the study was to collate and review all available data which could inform Coastal Erosion risk and to undertake a gap analysis of this information to inform future data needs.

**5.1.2** An extensive data collation exercise was undertaken in conjunction with DfI and DAERA to identify the pre-existing data relating to, or being collated along the Northern Ireland coastline.

## 5.2 Data Identified and Collated

**5.2.1** National data sources were primarily transferred under licence from the Departments for review. These are listed in Table 5.1 and a review of the data is presented at section 5.3. Table 5.2 highlights further data that are known to exist but which were not received or reviewed for this study.

**Table 5.1** Data Sources collated

| Data type | Source | Years of coverage | Description |
|---|---|---|---|
| Natural Heritage & Designated sites | DAERA | N/A | Marine Protected Areas (MPAs) comprising of: Areas of Special Scientific Interest (ASSIs), Special Areas of Conservation (SACs), Special Protection Areas (SPAs), Ramsar Sites and Marine Conservations Zones (MCZs), National Nature Reserves (NNRs), Areas of Outstanding Natural Beauty (AONBs), Landscape Character Areas, NI Regional Seascape Character Assessment, World Heritage Site and NI Regional Landscape Character Assessment. |
| Sites of Interest | DAERA | N/A | Marine wrecks, disposal sites, seal haul out locations, shellfish sites, bathing waters, WFD shellfish protected areas. |

| Data type | Source | Years of coverage | Description |
|---|---|---|---|
| Historic Assets | DfC | N/A | Scheduled Historic Monuments, Areas of Significant Archaeological Interest, Defence Heritage, Historic Parks and Gardens, Industrial Heritage Record, Listed Buildings, Northern Ireland Sites and Monuments Record and Areas of Archaeological Potential. |
| Geology | British Geological Survey | N/A | Bedrock and superficial geology 1:625,000. |
| Geology | Geological Survey of Northern Ireland | N/A | Bedrock and superficial geology 1:250,000. |
| LIDAR | DfI Rivers | Various (small number of repeat surveys) | LIDAR covering rivers and estuaries. |
| LiDAR | OpenData NI | 2016 | Covering Red Bay at 3m resolution and a small area towards the NW of Strangford Lough at 2m resolution |
| Land use | EEA | 2012 | Geographical distribution of natural and built environments across Europe. |
| Flooding maps | DfI Rivers | N/A | Historical flooding maps and predictive flood mapping. |
| Tidal heights | DfI Rivers | See description | Tidal heights at gauges along the coastline: Lough Foyle, Lisahally (16 years: 2003 - present), Lagan, Belfast Lough (12 years: 2007-2017), Connswater, Connswater Alert (adjacent to Bombardier) (5 years: 2011 - present), Newtownards Canal, Portaferry Rd Alert (Strangford Lough): (2 years: 2014 - present), Newcastle Harbour (4 years: 2012 - present), Warrenpoint Harbour (12 years: 2004 - present), Newry River, Victoria Lock: (19 years: 1997 - present) Also a gauge at Lisahally (14 years: 2003-2017). |

| Data type | Source | Years of coverage | Description |
|---|---|---|---|
| Bathymetry | JIBS | 2008 | Joint Irish Bathymetric Survey (JIBS). HO order 1 standard bathymetry for the nearshore and beyond extending from Fair Head, around Rathlin Island and extending to Inishtrahull Island off Donegal. |
| Bathymetry | EMODnet | 2016 | Resolution of 0.125 arc-minutes. Generated for European sea regions from selected bathymetric survey data sets and composite DTMs, while gaps with no data coverage are completed by integrating the GEBCO Digital Bathymetry. |
| Bathymetry | Oceanwise | Unknown | Resolution of 1-6 arc-seconds (30-180m) depending on availability for a particular area. |
| Bathymetry | DAERA | Various | Admiralty Charts covering all of NI waters. |
| Coastal defences | DAERA | 2007 | Hard engineering and linear features as a shapefile around the coast of Northern Ireland. |
| Aerial Photography | DAERA | 2006 | JPG images. Entire NI coast. Oblique aerial photography images. |
| Aerial Photography | OSNI | 1974 to present. Every three years after 2003, sporadic before | Orthophotography data covering the whole of Northern Ireland |
| Pipelines | Oil and Gas Authority | Current | Information on where oil and gas pipelines make landfall. |
| Historic maps | SpatialNI | 1832 – 1963 | Various scales some include high and low water contours. |

| Data type | Source | Years of coverage | Description |
|---|---|---|---|
| Coastal migration map of Europe | EEA | 2016 | Extents of coastline at risk of erosion found in a wide scale assessment of Europe. The map is collated and harmonized from coastal recession information within the EMODNET-Geology project. When no recent generalized coastline migration data were available, the coastal erosion layer from the EUROSION project has been used. |
| Address Data | OSNI | Current | Building Polygons, property coordinates, specifications of domestic and non-domestic properties. |
| Enhanced DTM | OSNI | 2018 | Digital file showing break-lines and spot heights. Break-lines show changes in slope for cliffs and road embankments. An enhanced DTM provides a detailed representation of the topographical variations in the earth's surface. |
| Coastal defences | DfI Translink | 2018 | Coastal defences related to railway protection. |

**Table 5.2** Data Sources available – not collated

| Data type | Source | Years of coverage | Description |
|---|---|---|---|
| Beach Profiles | Ulster University | Since 2003, last six years on a monthly basis | Six beach locations along north coast (Downhill, Castlerock, Portrush West, Portrush East, Whiterocks, Portballintrae), multiple repeat DGPS profiles at each site. |
| Beach Profiles | Various | Unknown | Sporadic locations using GPS or levelling instruments and located at sites such as Magilligan, Portstewart, Giants Causeway, Murlough (Co. Down) andCloughy beach. All either irregular or one-off surveys |
| Meteorological Wind Data | Ulster University | Unknown | Three Ulster University met stations (Magilligan Point, Portrush and Strangford Lough west). Available for purchase only if required. |
| Bathymetry extents | Various | Unknown | Multibeam for Dundrum bay, Carlingford. |
| Bathymetry | Royal Navy/ UKHO | 2009 | Multibeam - from the mouth of Belfast Lough to Glenarm Point, north of the Maidens. |
| Bathymetry | Harbour Authorities | Unknown | Multibeam. Foyle, Larne, Belfast. |
| Bathymetry | NIEA (now DAERA) | Unknown | Multibeam. Dredge spoil site monitoring. |
| Bathymetry | Hydrographic Office | Various | Admiralty charts. All of Northern Ireland waters. |
| Bathymetry | AFBI | 2009 | At three locations during separate cruises covering North Klondyke (repeating the area covered by the Marine Institute in the MESH project), the area surrounding Outer Klondyke (2009) and the East and West Maidens (2009). |
| Bathymetry | Marine Institute Galway | 2003 | Multibeam. North Klondyke – MESH survey. |

| Data type | Source | Years of coverage | Description |
|---|---|---|---|
| LIDAR | IFOMAR/OSI | Unknown | Magilligan and most of Foyle and Benone to Rathlin (open access). |
| LIDAR | NIEA (HED) | Unknown | Some coastal sites using airborne lidar, patchy. |
| LIDAR | FUGRO-BKS | Various | Patchy coverage of coast and various years. |
| LIDAR | DAERA | Pending | Pending new initiative being proposed for all of Northern Ireland to be surveyed by lidar. |
| Aerial photography | BKS (NI) Ltd | Sporadic | Available for purchase if required, extents represented in appendix. |
| Aerial photography | MoD | Various | Historical (regular) photos of Ballykinler, Magilligan and Redbay. |
| Aerial photography | Local councils | Various | Some from Ards Borough Council. Sporadic. |
| Hydrodynamics | AFBI | Unknown | Salinity, temperature, fluorescence, turbidity. Operate 11 offshore sampling points but only water quality info collected. Located at North coast, L.Foyle N&S, Belfast L., Lagan Impoundment, Strangford L. North, Strangford Narrows, Quoile, Carlingford N & S. |
| Hydrodynamics | British Oceanographic Data Centre | Bangor - 1994 to present,<br>Portrush - 1995 to present | Tidal heights. |
| Hydrodynamics | Belfast Harbour (Harbour Commissioners) | 1901 - present | Tidal heights. Five different tide-gauge positions/machine types within Belfast Harbour. |

| Data type | Source | Years of coverage | Description |
|---|---|---|---|
| Hydrodynamics | Londonderry Port and Harbour Commissioners/ Rivers Agency (now DfI Rivers) | January 2007 - Present (Rivers Gauge – Lisahally)<br><br>1996 - Present (Harbour Commissioners Gauge – Lisahally). Note that there are some long gaps in these data. | Tidal heights. Rivers data are recorded at 15-minute time intervals, whereas the time interval for the Port Authority varies across the records (five minutes for the 1996-2000 period and 50 seconds since 2000). |
| Hydrodynamics | Marine Institute (Galway) | Malin Head - 1958 to 2002 then from 12 June 2008 at new location (55.37168, -7.33432) | Tidal heights. |
| Hydrodynamics | | 2008 Apr – 2013 Jan | Tidal heights. |
| Hydrodynamics | Commissioners of Irish Lights | 2015 onwards | Wave height, wave period off mouth of Foyle. |
| Hydrodynamics | UK Met Office | Hindcast | Wave height, wave period. Hindcast modelling of wave parameters on coarse model. |
| Hydrodynamics | Marine Institute, Galway | N/A | Wave modelling forecasts. The numerical wave model SWAN simulates surface gravity waves. Uses NCEP GFS for wind forcing and FNMOC Wave Watch 3data for the wave boundaries. A daily six-day forecast is generated for parameters such as significant wave height, mean wave period and mean wave direction. All Irish waters (Incl. NI) at a resolution of 0.025 degrees (approximately 1.5km). |

| Data type | Source | Years of coverage | Description |
|---|---|---|---|
| Hydrodynamics | QUB/Met Eireann/DHI | Unknown | Wave modelling forecasts. Hourly wave height and period for past and future predictions using ERA-Interim Reanalysis data. |
| Hydrodynamics | QUB/Met Eireann/DHI | Unknown | Nearshore currents tidal stream (model) atlas by Proudman and also by Marine Institute - surface currents provided in 1-hourly frequency. |
| Hydrodynamics | AFBI | Unknown | Morphodynamics modelling. Larne Lough hydrodynamic modelling, Modelling (Delft3D FLOW Hydrodynamic) conducted by AFBI, one-off. |
| Hydrodynamics | AFBI | Unknown | Morphodynamics modelling. Carlingford Lough, Modelling (Delft3D FLOW Hydrodynamic) conducted by AFBI, one-off. |
| Hydrodynamics | AFBI and QUB | Unknown | Morphodynamics modelling. Strangford Sea Lough modelling (Delft3D FLOW Hydrodynamic) conducted Feb 2014, one-off Mike 21 model. |
| Meteorological Data | UK Met Office; Ulster University | Unknown | Wind data. SixUK Met office stations operate around NI coast (Magilligan, Giants Causeway, Helens Bay, Orlock Head, Murlough, Killowen), three Ulster University met stations (Magilligan Point, Portrush and Strangford Lough west). |
| Land Cover Map | Centre for Ecology and Hydroloogy (CEH) | 2015 | Land cover derived from satellite images and digital cartography and provides land cover information for the entire UK. Land cover is based on UK Biodiversity Action Plan Broad Habitats classes. |
| Road sea wall condition report | Dfl Highway structures unit | 2018 | Condition and repair costs of sea walls along roads. Data has not been supplied as shapefiles but images of shapefiles ranked in terms of disrepair are shown along the coastline. |

## 5.3 Assessment of Collated Data

**5.3.1** The data received has been assessed in terms of quality, reliability, coverage and completeness below.

### Geology

**5.3.2** Geology data has been acquired from the British Geological Survey (BGS) and from the Geological Survey of Northern Ireland (GSNI). Both sources are of good quality and present the bedrock and superficial geology. These sources are highly reliable. The full extent of Northern Ireland is presented, BGS data at a scale of 1: 625,000 and GSNI at 1:250,000. These are both suitable scales for this project. The BGS data will give a good overview of the coastline and GSNI data will give more detail to assess individual beaches and inlets.

### LiDAR

**5.3.3** LiDAR data has been acquired primarily from OpenDataNI. The datasets on OpenDataNI include LiDAR supplied by OSNI, DfI Rivers, DfI Roads, DfC Historic Environment Division and others. It should be noted the data supplied by OSNI (the largest of the data holdings on OpenDataNI) were collected as both DTM (Digital Terrain Models) and DSM (Digital Surface Models). More detailed metadata on the LiDAR holdings is available on the OpenDataNI portal.

**5.3.4** The review of the data confirms that there are significant areas of the coast which do not have LiDAR coverage. Without any subsequent repeat surveys, there is currently no option to compare change to a "LiDAR" baseline.

### OpenData NI

**5.3.5** The Strangford Lough data was surveyed at 2m resolution and Red Bay at 3m. The lines were flown at a height of 200m with a line spacing of 100m. The data was initially processed in ACSAB propriety software "Coastal Survey Suite" to convert the data into LOCAL AUTHORITIES files. These files were subsequently imported into Caris HIPS software where the data was tidally corrected, cleaned and finally exported as an XYZ dataset. As this was a demonstration survey no tide gauge was established and tidal information was obtained using the UK Hydrographic Office's Total Tide software. The data appears to be reliable and of good quality.

### Land Use

**5.3.6** Land use data (Corine Land Cover (CLC)) was provided through the EEA from the Copernicus land monitoring service. This provides land use as an ESRI geodatabase. The Minimum Mapping Unit (MMU) for the CLC is 25 hectares for areal phenomena and 100 meter for linear phenomena. The time series (1990, 2000, 2006 and 2012) are complemented by change layers, which highlight changes in land cover with an MMU of five ha. This provides a complete record of land use in coastal areas of Northern Ireland at a sensible scale for this project. The quality and reliability of data appears to be very good by comparing the satellite images through Google Earth, as would be expected from this source of data.

### Coastal Defences

**5.3.7** A map of linear features and hard engineering around the coastline of Northern Ireland was compiled in 2006/2007 by DAERA from high resolution oblique aerial photographs (refer Figure 1 in Appendix B). This is of high quality and should provide a reliable and fairly

complete picture of the extent of coastal defences at that time. Vertical aerial photography has been used in order to assess the extent of features currently in place in order to add any built after the time of the study or missed. There are also asset management / maintenance records held by both DfI Roads and Translink which cover coast road sea defence maintenance and repair. These could be used to cross-check the locations of defence needs with the presence of defences and live / updated information on maintenance needs could be used to inform coastal erosion.

### Flood Maps

**5.3.8** Flood maps were supplied by DfI Rivers and include historic flood maps of the extents of previous flood events in Northern Ireland in addition to Floodplain Tidal Premium, a predictive flood mapping product for tidal areas. The historic flood maps seem to be complete for all of Northern Ireland. They show the extents of 60 flood events going back to 1971, the vast majority of which are fluvial flooding although pluvial and coastal events are also recorded. This is a long enough time period to give a general idea about the history of flooding. The extents rely on records of flooding and therefore may not cover all areas that flood particularly in unpopulated areas, although these areas may be of less importance to this study. Some areas that have flooded in the past have now been protected by flood alleviation schemes. The Floodplain Tidal Premium dataset provides the results of hydrodynamic modelling and shows the extents of flooding for a range of return periods. An enhanced digital terrain model was also provided which shows the topography of Northern Ireland using points and breaklines.

### Tidal Heights

**5.3.9** This data was supplied by DfI Rivers and appears to be of good quality and reliability. The data covers the data ranges well although there are some gaps of a couple of months. Data has been provided from eight coastal gauges. Details of the coverage and locations are shown in Table 5.3.

**Table 5.3:** Tidal gauges data extent and coverage

| Location | Time range of records | Sampling frequency |
|---|---|---|
| Lough Foyle, Lisahally | July 2003 - present | 15mins before 2012,1 minute after |
| Lagan, Belfast Lough | 2007-2017 | 15mins before 2012,1 minute after |
| Connswater Alert | Feb 2011 - Present | 15 minutes |
| Newtownards Canal, Strangford Lough | May 2014 - present | 15 minutes |
| Newcastle Harbour | March 2012 - present | 1 minute |
| Warrenpoint Harbour | Sept 2004 - present | 15mins before 2012,1 minute after |
| Newry River, Victoria Lock | Nov 1997 - present | 15mins before 2012,1 minute after |
| Lisahally | Jul 2003 - 2017 | 15mins before 2012,1 minute after |

**5.3.10** There are also two "A class" Environment Agency tidal gauges in Northern Ireland situated in Bangor and Portrush. Data has not been acquired from these but is available.

### Bathymetry

**5.3.11** Bathymetry provided will enable us to assess roughly the wave conditions along the coastline. For these purposes in order to give a general idea, fine resolution is not required. Bathymetry has so far been obtained from EMODnet at a resolution of 0.125 arc-minutes which gives low resolution coverage of the entire coastline of Northern Ireland until deep water. EMODnet is a reliable source initiated by the European Commission and the data quality looks to be of good quality. Further bathymetric data has been provided from the Joint Irish Bathymetric Survey (JIBS). This data only covers an area around the north of NI. Within this area, the data extends to fairly deep water and is sufficient for our purposes. It extends from Fair Head, around Rathlin Island and to Inishtrahull Island off Donegal. This survey provided, for the first time, comprehensive multibeam bathymetry data over prioritised areas within the 3nm coastal strip between Donegal Bay and Dundalk Bay. The survey was conducted to IHO "Order 1" standard and is therefore of good quality.

**5.3.12** Oceanwise bathymetry data of good quality and coverage has been received from DAERA and is a DEM model composed of raster data. The surface has been created from hydrographic survey and chart derived data depending on the data available for a particular area and has a resolution of 1 and 6 arc seconds, which is approximately 30 and 180m, respectively. The 1 arc second DEM is provided as individually named half degree tiles and the 6 arc second as individually named two degree tiles.

**5.3.13** Extents of surveys from multibeam surveys for Dundrum Bay and Carlingford have been received from the UKHO Bathymetry DAC; however the data has not been received.

**5.3.14** Admiralty charts have also been provided by DAERA for a large extent. This is a good source of data and provides a good overview of the bathymetry in the area.

### Aerial Photography

**5.3.15** Two main sources are available for aerial photography, these are Snapmap images supplied by DAERA and OSNI aerial photography. DAERA Snapmap images appear to be of good quality and enable an assessment of the features present to be made. These were the images used for contingency planning in the event of an oil spill in 2006/7 and therefore will not show additional features built since then. Therefore, these images will only be used where there may not be anything of suitable quality. These images are oblique and therefore show more easily coastal defence structures in some cases. However occasionally images are taken from too far away to facilitate coastal defence identification. OSNI aerial photography provide a more complete record with repeat images every three years providing a good picture of the current state of coastal defences and their extent. These images cover the whole of Northern Ireland and are taken from directly above. The quality and resolution of these images is very high which makes coastal defence identification relatively simple.

**5.3.16** Aerial Photography is also available from Fugro-BKS however this has not been purchased. The survey in 2011 which was flown at 20cm GSD and available at 20cm GSD and the survey from 2010 was flown at 10cm GSD.

### Historic Assets

**5.3.17** Data provided by the Department for Communities provides a complete record of historic assets at the present day and is a reliable source of this type of data. The dataset covers all of Northern Ireland in a complete manner. It is of good quality explaining each site in categories and names the sites.

### Natural Heritage and Designated Sites

**5.3.18** Data provided by DAERA provides a complete record of these sites of interest at the present day and is a reliable source of this type of data. The dataset covers all of Northern Ireland in a complete manner and is of good quality explaining each site in categories and naming the sites. These sites cover a very large proportion of the coastline on Northern Ireland. Typically, designations overlap meaning the number of designations cannot be counted in a particular area to give a reliable assessment. Areas such as Strangford Lough are RAMSAR, SAC, AONB and SPA. In addition, for parts of its shoreline it is also an ASSI and NNR. These classifications have not been given a relative priority for now. This would enable an assessment to consider if managed retreat for example would be a suitable scheme for a section of coastline that is a designated site.

### Historical Maps

**5.3.19** Historical maps were provided by SpatialNI, these covered a range of periods and scales. The maps are based on local maps and in some cases rely on these being stitched together after being transformed to Irish National Grid. Not all layers therefore have coverage of the whole coastline. Due to counties being surveyed separately slight discontinuities and overlaps are present, although metadata states this effect is much reduced if the product is purchased. The quality is unlikely to be of the same standard as modern maps; however, it appears to be of suitable quality for this preliminary study. The level of detail included in the maps also varies, with some including high and low water contours and elevation contours.

### Coastal Migration Map of Europe

**5.3.20** A web map layer was acquired that represents coastal erosion or retrogradation over Europe – see Figure 2 in Appendix B. This shows the results of the Eurosion study; the map is collated and harmonized from coastal migration information within the EMODNET-Geology project and was completed in 2016. The coast was assessed based on geological and geomorphological data. This was part of a wide scale project and therefore whilst providing a good and reliable source of data for checking areas that we consider to be at risk in this study it would not represent the entire coastline at risk of erosion due to the scale represented.

## 5.4 Key Datasets

**5.4.1** In order to undertake a high-level assessment of coastal erosion risk within Northern Ireland the following datasets are considered key and have been utilised for the preliminary Vulnerability Assessment:

- geological maps;
- base maps;
- aerial photography;
- flood maps;
- land use data; and,
- historic and natural assets.

**5.4.2** These datasets have all been assessed and provide adequate coverage of Northern Ireland at an appropriate scale for the study.

**5.4.3** Aerial photography provides high resolution coverage of Northern Ireland appropriate for understanding the terrain and identifying coastal defences. Data for historic and natural assets shows the sheer number of sites along the coast and in order to use this data some prioritisation of sites will be conducted. Land use data describing the general land use is at an appropriate scale and aids the understanding of the vulnerability of the coastline.

## 5.5 Gap Analysis - Data Requirements

**5.5.1** As noted in Section 2, there are essentially two main coastal types that can erode by different mechanisms and at different rates: beaches and bedrock. (Note that these landforms can hold stable positions for long periods, so it should not be assumed that they are eroding.) Data needed to manage these coastal types will be different, to reflect the different processes and timescales involved.

**5.5.2** Even if high level to begin with, it is important to establish a consistent and justifiable baseline for the entire coastline from which different areas can be prioritised. For example, different reports give different percentages of eroding and defended coastlines, which makes comparison between reports difficult. This baseline should contain data on: coastline type, coastal defences and shoreline change.

### Coastal Erosion Baseline

**5.5.3** The shoreline should be categorised into the two categories: beach and bedrock. (Sub-classification into different beach and bedrock types would be useful, but possibly unjustifiable at this point. A good comparison would be with the Futurecoast dataset of foreshore and backshore types generated for England and Wales.)

**5.5.4** Within this project, a GIS layer has been created with defences identified from different datasets (including the identification of defences from aerial photographs). This dataset could be verified using local knowledge (from local council engineers for example or by site visits) to ensure its accuracy. It would be useful if the data on the position of the defence was expanded to include the defence type and condition, obtained from visual inspection (using, for example, the Environment Agency's Condition Assessment Manual, 2006). A similar asset database exists for England.

**5.5.5** Information on coastal defence type and condition is already used in prioritising asset maintenance and in undertaking assessment of potential future losses. This is carried out locally by owners of coastal defences (such as the maintenance inspections of roads and structures undertaken by DfI and Translink); this information could be collected and stored in a central, standardised database covering Northern Ireland. The creation of a central database recording coastal defence type, position, extent and condition for the whole of Northern Ireland could be based initially on the evidence from aerial photographs (with all defences accorded the same default condition until a condition assessment could be made). Local authorities and other asset owners could be required to check and update the entries whenever assets are inspected. The current system of asset maintenance inspections undertaken with the sole purpose of prioritising maintenance would thus be changed to the collection of standard, shared data that is made available for interpretation. This would allow regional or national scale assessments to be developed, that would inform both those with a duty to maintain assets and those monitoring the effects of coastal erosion.

**5.5.6** These fields could be created in a GIS database and filled in when known, with data for defences initially filled in as noted above. The information which is already collected on the condition of coastal defences (including for the road and rail network) should be incorporated, where possible.

**5.5.7** In order to demonstrate whether or not coastal erosion is a persistent issue, the long-term evolution of the shoreline should be assessed. Ideally this should be done for the entire coast in order to produce a consistent baseline, but areas where previous studies have shown minimal change over a long-time period could be omitted, or alternatively given the scale of the task, if required, the assessment could be conducted on a prioritised basis over a five or six year cycle, with areas considered at high vulnerability to coastal erosion addressed first.

**5.5.8** Westley and McNeary (2014) have already categorised the entire coastline into eroding or non-eroding based on a visual analysis of the coastline from oblique aerial photographs. However, this may miss areas where there are no visual signs of erosion today, but where erosion has occurred in the past, or may occur in the future. Nor does it quantify the rate of erosion.

**5.5.9** Step one in assessing coastal erosion would be to obtain Westley and McNeary's GIS information. Step two would be to quantify long-term coastal erosion using a series of historic maps and photos. Historical maps have already been made available by Spatial NI for a number of different periods. In order for a full long term evolution of the coastline to be derived these maps would need to be complete in extent along the coastline and have any offset effects caused by transformations of coordinate systems and boundaries between counties minimised. From these maps, cliff top and shoreline positions would need to be extracted to allow comparisons over time. Historical aerial photography could also aid this process. Currently the oldest photography acquired is from 2003 but there should be OSNI ortho-photography available with sporadic coverage back to 1974.

**5.5.10** Carrying out the steps above would leave Northern Ireland with a baseline understanding of what shoreline type was present, which areas were defended and which have been eroding. This database could be used with the GIS layers on asset types collected for this project to prioritise where further data should be collected.

### Additional data for beach management

**5.5.11** The creation of a consistent baseline understanding of where coastline erosion is occurring along with the identification of areas of high asset value (those considered as being at potential risk of coastal erosion) would allow the application of a risk-based approach to prioritise areas for more detailed monitoring as set out below.

**5.5.12** When a beach is eroding, data on the changes in elevation are useful in assessing the processes involved. It may not lead to any action – as beach erosion is a natural phenomenon – but will always help to improve understanding of the issue. Prioritised beach monitoring activities could include:

- Regularly repeated LiDAR surveys to allow a comparison of changes in shoreline and elevation over time. LiDAR is currently available for various years with some repeat surveys. A full study of the LiDAR data on the OpenDataNI platform would be required in order to assess the extent of repeat surveys amongst the data already available. In addition, it would be beneficial if a regular program for LiDAR surveys was established for the future.

- Beach profiles taken regularly through time and over the beaches at risk would be useful to assess the long-term stability of beaches on the coastline of Northern Ireland for a more detailed study. Beach profiles so far are available from Ulster University on a monthly basis for the last six years for the following beaches: Downhill, Castlerock, Portrush (East and West) and Portballintrae.
- A more detailed study of the areas at risk of erosion as it would be useful to know the depth of superficial sediments and the elevation of the surficial bedrock. If less erodible bedrock is beneath softer superficial geology it is important to know the depth of the more erodible sediments to determine if the coastline will retreat.
- Information on beach types, including particle size distributions from eroding beaches, as it would be useful in understanding how beaches are likely to evolve.
- Coastal impact assessments which often use numerical models to simulate waves and water levels. There is a shortage of measured data (especially of waves) for the calibration of numerical models.

### Additional data for the management of rock coasts

**5.5.13** Rock coasts are subject to episodic, local geotechnical failure (such as rock falls and slips). The locations and timings of these failures are impossible to predict in advance. Effort could be concentrated on identifying those areas where a single failure could lead to significant damage (whether by direct damage to an asset or through the blockage of a road or railway).

**5.5.14** If an area of rocky coast is identified as particularly vulnerable, detailed survey of this area by terrestrial and/or aerial LiDAR could be undertaken at regular intervals, to identify the typical volume and frequency of rock falls.

# 6.0

# Preliminary Vulnerability Assessment of NI Coastline

# 6.0

# Preliminary Vulnerability Assessment of NI Coastline

## 6.1 Introduction

**6.1.1** This section sets out the methodology used to assess which areas are vulnerable to erosion and to assess the coastal vulnerability to economic losses and to losses in natural capital and heritage. It starts with a brief review of some methods of assessing coastal vulnerability, which sets out the background knowledge against which the proposed methodology must be chosen.

**6.1.2** A number of approaches have been taken to conducting coastal vulnerability assessments. In many cases a vulnerability index has been developed in order to simplify the representation of complex processes as a combined measure that is more readily understood and can be used as a management tool. Some of these are summarised below (section 6.2).

**6.1.3** Another type of approach is to undertake an assessment of coastal geomorphology to understand historical coastal behaviour and how this may change in the future (as discussed in Section 6.3). Coastal erosion in the longer term can be determined by comparing the positions of shorelines and cliff positions from successive generations of Ordnance Survey maps (section 6.4). Map-based analyses of historical evolution have been carried out for the entire coastlines of England & Wales and Scotland. In both cases an assessment of future coastline position and/or vulnerability has been made to assist with coastal management.

## 6.2 Examples of Vulnerability Indices

**6.2.1** Coastal Vulnerability Indices (CVI) utilise mathematical analysis of a range of variables to predict the vulnerability of coastlines to erosion and climate change.

**6.2.2** For example, the US Geological Survey (USGS) devised a physically based coastal vulnerability index (CVI) to assess the vulnerability of the coastline to climate change. (Hammer-Close and Thieler, 2001; Thieler and Hammer-Close, 1999, 200a, 2000b). They collected data on:

- Geomorphology derived from state geology maps;
- Shoreline erosion and accretion rates (m/yr) from the Coastal Erosion Information System (May et al., 1982);
- Regional coastal slope (percent), from the subaerial coastal plain to the submerged continental shelf. This was calculated using data from up to 50km offshore, as coastal slope affects the risk of flooding and coastal erosion (Pilkey and Davis, 1987);
- Rate of relative sea-level rise (mm/yr) from tide gauges;

- Mean tidal range (m) from the National Ocean Service; and
- Mean wave height (m) from the USACE Wave Information Service.

**6.2.3** The variables were mapped at the level of the coastal county. Each variable was allocated an integer ranking between one (very low risk) and five (very high risk) for each section of the coast. The CVI for each section of coastline was then calculated using a mathematical equation.

### Vulnerability Indices applied to NI

**6.2.4** McLaughlin and Cooper (2010) compared coastal vulnerability indices at different scales, as applied to Northern Ireland, using previous vulnerability index by McLaughlin et al, 2002. They used variables that were of interest to policy makers as well as scientists to define the nature of the coast, the exposure to waves and socio-economic elements that are affected by coastal erosion. The final erosion score was made up of:

- Socio-economic factors
- Coastal forcing; and
- Coastal characteristics.

**6.2.5** As with any index system it is difficult to deal with changes in time. They found that the nature of the data used to calculate the variables depended on the scale being considered. This meant that important local variations in vulnerability were masked at a national scale.

**6.2.6** Westley and McNeary (2014) mapped the vulnerability of coastal archaeological sites in Northern Ireland using a GIS by:

- Mapping coastal erosion using the 2006 set of oblique aerial photographs;
- Incorporating digital Historic Environment Records into the GIS; and
- Undertaking more detailed studies at two locations.

### Applicability to current study

**6.2.7** As is evident the prediction of future coastline position is a difficult task, for which no standard predictive techniques have been developed. The data needed to apply the approaches is almost certain to be of variable quality (if it exists at all at present in NI).

**6.2.8** In principle, a formal coastal vulnerability index could be created and applied, at an appropriate scale, to the coast of Northern Ireland. However, for the current high level baseline study of coastal erosion risk management for NI, it is considered that there is insufficient reliable data.

## 6.3 Examples of Geomorphological Assessment

### Eurosion

**6.3.1** Eurosion (European Commission, 2004) was a European study into coastal erosion at a European scale (including Northern Ireland). The study is reviewed in Section 4.1. Its principle output was a map-based assessment of European coasts exposure to coastal erosion.

### Foresight overview of coastal erosion potential (England and Wales)

**6.3.2** As set out in Chapter 2, The Office of Science and Technology's Flood and Coastal Defence Foresight project (Evans et al., 2004) examines what might happen to flood risk over a 30 to 100 year timescale with the purpose to inform long-term policy with regard to Coastal Engineering and Management.

**6.3.3** The study estimated potential unconstrained shoreline evolution for England and Wales under four UKCIP02 future climate change scenarios (National Enterprise, Local Stewardship, World Markets and Global Sustainability). Evans et al. (2004) used basic assumptions on relative sea level rise, surge activity, wave height, littoral drift and shoreline movement. Average erosion rates were predicted at a national level. The results are mapped in Plate 2.2 (reproduced from Evans et al., 2004) (refer Chapter 2).

### Futurecoast

**6.3.4** As described in section 4.3, Futurecoast (Halcrow, 2002, Burgess et al., 2002) was commissioned by Defra to improve the understanding of coastal evolution for the open coast of England and Wales (not Northern Ireland).

## 6.4 Examples of Erosion Mapping and Extrapolation

**6.4.1** Whilst coast wide erosion mapping and extrapolation studies have not been undertaken for Northern Ireland, the rest of the UK have undertaken such studies in the following manner. As outlined in section 4.3 and 4.4 these include the Environment Agency Coastal Erosion Map covering England & Wales and in Scotland the mapping provided by the Dynamic Coast project.

**6.4.2** In England and Wales the Environment Agency has produced maps of potential future coastal erosion positions for the short term (about 2030) medium term (about 2060) and long term (about 2100). These can be found at http://apps.environment-agency.gov.uk/wiyby/134831.aspx (page accessed 23/03/2018). The predictions of future erosion zones are made based on historical evidence, ongoing monitoring and other data. These zones are shown as a range due to the uncertainty in calculating future coastal erosion.

**6.4.3** These maps are based on the National Coastal Erosion Risk Management (NCERM) project (Rogers et al, 2013) which began in 2006.

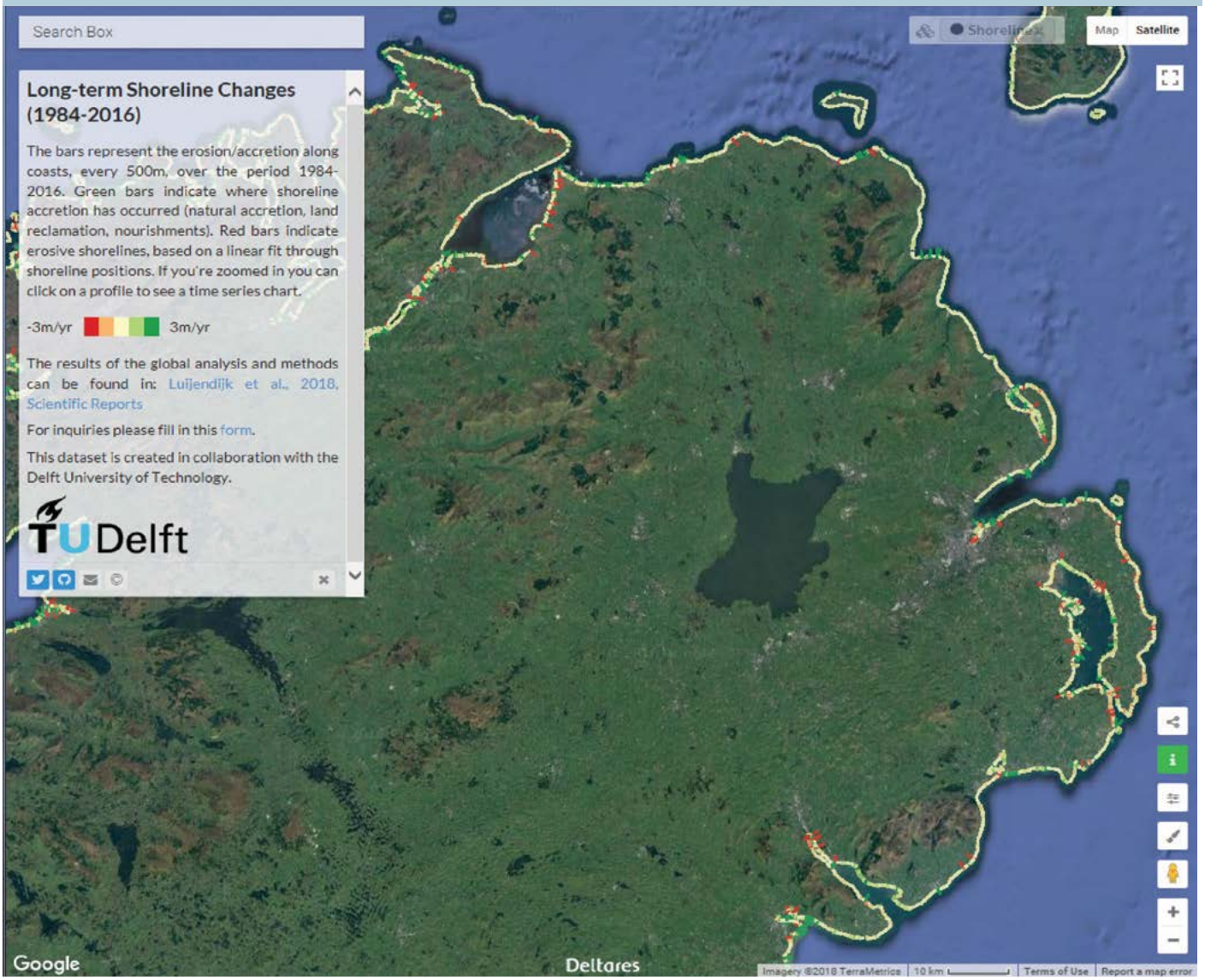
**6.4.4** The Dynamic Coast project in Scotland (http://www.dynamiccoast.com/) has digitised shorelines from maps created in the 1890s, 1970s and 2010s to assess how the coastline has changed over about 125 years. The coastal type has been mapped and the inherent erodibility of the coastal zone evaluated.

**6.4.5** In Ireland, the National Irish Coastal Protection Strategy Study (OPW, 2018) commissioned in 2013 investigated the potential for erosion along the Irish coast. The study divided the coast into six areas examining annualised erosion rates for each area.

### The State of the World's Beaches

**6.4.6** A plot from an analysis of "The State of the World's Beaches" (Luidenjeik et al 2018 – Nature publications) showing coastal erosion in NI is presented below. This is a crude analysis of coastal erosion between 1984 and 2016 using Google Earth Engine based on annual images undertaken by Delft University of Technology (Netherlands). This process could be used to undertake a much more detailed study where they use all cloud-free Landsat (1984 onwards) and Sentinel (2015 onwards) images, and can increase resolution from 500m to 100m. This procedure works best when there is a clear image of a sandy beach and a limited tidal range but may be a cost-effective way of obtaining coastal erosion data across Northern Ireland.

**Plate 6.1** The State of the World's Beaches




## 6.5 Methodology

**6.5.1** Utilising the existing available data, the following approach has been taken to complete a high-level preliminary vulnerability assessment of coastal erosion along the Northern Ireland coast consisting of two stages:

- Erosion risk appraisal.
- Vulnerability assessment.

**6.5.2** Further details of the methodology to be applied are given on the next page.

## Erosion Risk Appraisal

**6.5.3** The most relevant available data for assessing the risk of coastal erosion falls into the following categories:

- Superficial geology;
- Surficial / bedrock geology;
- Aerial photographs;
- Coastline;
- Database of coastal defences;
- Reports on geomorphology and erosion;
- Offshore wave climates;
- Bathymetry (and hence a parameter like coastal slope); and
- Historic coastlines (from which coastline changes can be derived).

**6.5.4** Although certain historic maps were collated, it was not possible to undertake a formal study of shoreline change (particularly as there are miss-alignments between successive maps). This has been identified as a principle data requirement in the Data Requirements. Therefore, at this stage the potential for erosion, has been assessed based upon a combination of published information regarding the bedrock geology and aerial photographs showing loose sediments forming a beach and geomorphological features, such as beach ridges or soft cliffs.

**6.5.5** The most important factor for classifying the potential for erosion has been the bedrock geology. However, this has led to questions over which types of rock should be in which category. It was determined that igneous rock (such as basalt) should be classed as low potential for erosion. Sedimentary and metamorphic rocks are generally considered as medium potential for erosion category. However, there can be considerable variability within each category. For example, locations where the bedrock is sandstone have been classified as having medium potential for erosion, even though the rate of erosion is likely to be low. These rocks are expected to erode, but the rate of erosion may be so slow as not to cause a problem within the next century.

**6.5.6** Beaches with lower-lying land behind have been classified as having a high potential for erosion. These locations will be subject to sediment transport and hence net erosion or accretion during storms and other events. Such impacts do not necessarily mean that coastal erosion (defined here as the long-term retreat of a coastline) is occurring, as some sedimentary features are relatively stable in the long term if they are in equilibrium with their forcing conditions. Hence the potential for erosion is identified, based on geology and appearance and then substantiated, where possible, through references to papers, reports and other anecdotal information.

**6.5.7** In selected locations, historical maps could be presented alongside modern maps or aerial photographs to identify whether coastal erosion has occurred / is occurring. However, at this stage due to the miss-alignment of historical maps this has not been conducted.

**6.5.8** As identified in the Data Recommendations, a more detailed study of historic changes in mapped cliff and shoreline positions will be required for the most vulnerable areas of coastline of Northern Ireland, to identify areas where this initial assessment suggests a high likelihood of shift in shoreline position.

## 6.6 Initial Results: Preliminary Baseline Vulnerability Assessment

**6.6.1** Once the areas most at risk of erosion had been identified, a review of the potential impact of erosion on physical assets, natural capital and heritage was undertaken. This took place in two stages:

- Identification of physical, natural and heritage assets; and
- Linking the assets to the erosion potential.

### Identification of Physical, Natural and Heritage Assets

**6.6.2** The following information has been used to identify physical assets:

- Base maps showing settlements, roads, schools, hospitals, power stations etc;
- Coastal defences (from 2007 plus additional defences identified from aerial photographs); and
- Pipeline routes showing where oil and gas pipelines reach landfall.

**6.6.3** Information is also available on each property, but this is considered unnecessarily detailed for this high-level study. Physical asset values are identified at a settlement level.

**6.6.4** As this is a high-level study looking at the Northern Ireland coast as a whole, higher importance has been attributed to larger settlements and major roads.

**6.6.5** Natural capital and heritage assets have been identified by undertaking a review of the data provided by DAERA which include:

- Areas of Special Scientific Interest (ASSIs);
- National Nature Reserves (NNRs);
- Special Areas of Conservation (SACs);
- Special Protection Areas (SPAs);
- Ramsar Sites;
- Areas of Outstanding Natural Beauty (AONBs);
- Marine Conservation Zones (MCZs)
- Landscape Character Areas;
- NI Regional Seascape Character Assessment;
- World Heritage Sites; and
- NI Regional Landscape Character Assessment.

**6.6.6** In many cases these areas overlap as different designations can be applied to the same feature, while RAMSAR sites are chosen based on their existing SPA / ASSI designations.

**6.6.7** Data provided by the Department for Communities provides a complete record of historic assets at the present day and is a reliable source of this type of data. The dataset covers all of Northern Ireland in a complete manner and is of good quality explaining each site in categories and naming the sites.

**6.6.8** The coverage of these sites is very high with a large number of assets along the coast and therefore a means of ranking their value was required. A summary of the types of assets is provided in Table 6.1 with a summary of the value of each based on the Design Manual for Roads & Bridges and is the accepted method by the Historic Environment Division, Department for Communities. Only very high and high asset values have been used in the vulnerability assessment. High and very high value assets will be assigned a high value in the traffic light scheme, while the remaining coast has been given a low value for historic asset value.

**Table 6.1:** Assessment of value of historic assets

| Category | Value |
|---|---|
| World Heritage Site | Very High |
| Scheduled historic monuments | High |
| Historic Parks and Gardens | High |
| Listed Buildings | A and B+: High, rest: Low - Medium |
| Areas of Significant Archaeological Interest | Low - Medium |
| NI Sites and Monuments Record | Low - Medium |
| Areas of Archaeological Potential | Low - Medium |
| Defence Heritage | Low |
| Industrial Heritage | Low |

### Linking the assets to the erosion potential

**6.6.9** The following traffic light system has been used to characterise erosion potential, physical, natural and heritage assets. For each category, a ranking based on one of three ranks: low, medium or high has been allocated. The categories allocated are:

- Low / medium / high potential for erosion;
- Low / medium / high physical asset value;
- Low / high heritage value; and
- Low / medium / high natural capital value.

**6.6.10** A medium category was not used for heritage value due to the large number of listed buildings and assets on the NI sites and monuments record within 150m of the coastline. The given information for these sites makes it difficult to assess which would be considered low and which would be considered moderate in terms of their value.

**6.6.11** To assess the categories of natural capital, high value was assigned to RAMSAR sites and the World Heritage site, while all remaining natural capital designations were assigned a moderate value.

**6.6.12** Parallel lines have been displayed following the coastline with colours for each of the four categories above. Areas where a high risk of erosion is combined with high asset values are identified by comparing the risk of erosion against the asset value. This was then supplemented with the application of the coastal defences layer prepared for this project. To illustrate this a series of drawings have been developed which set out the preliminary baseline review of vulnerability assessment.

**6.6.13** Figures 3 – 5 in Appendix B present this GIS based analysis for High Erosion Risk: High Physical Asset Value as follows:

- Erosion Risk versus High Physical Asset Value (Figure 3, Appendix B)
- Erosion Risk versus High Natural Asset Value (Figure 4, Appendix B)
- Erosion Risk versus High Heritage Asset Value (Figure 5, Appendix B)

**6.6.14** As the vulnerability assessment is preliminary and based on available information only, it was considered pertinent to present only the High Risk: High Asset Value within the report. It is felt that these Figures can be utilised to prioritise data collation requirements. However, the complete GIS analysis undertaken, which also encompasses low and medium asset value, is available to review on the Northern Ireland Marine Map Viewer (https://appsd.daera-ni.gov.uk/marinemapviewer/).

**6.6.15** When reviewing these Figures, it requires acknowledgment that not all areas indicated as at high risk of erosion are currently eroding; and in addition, it should be noted that the areas identified as at high risk of erosion or of high natural asset value may not be in need of defences. In some cases, the reason for the designation may not require sea defences and could even be related to the erosive nature of a particular section.

### In Summary

**6.6.16** Further study is required in order to assess the state and integrity of sea defences in areas where high erosion risk and high asset value coincide. In addition, a further more detailed assessment of the erosion risk in these areas in a further study would provide the evidence required to decide whether further coastal defences are required to protect these assets where no sea defences are currently present.

**6.6.17** Due to the high-level, preliminary nature of the study and recognising that the baseline data available is insufficient, allocation of risk ranking and the determination of vulnerability has to be considered and accepted as preliminary and of insufficient reliability to inform coastal management decision making.

**6.6.18** A more detailed assessment is beyond the scope of the current study and would require scoring of individual assets combined with more detailed data and information on erosion potential. As a consequence, the figures presented may assist in prioritising resource to areas that require further study on coastal change, however the vulnerability mapping will require revisiting following collation of the data identified in the Data Requirements.

**6.6.19** However, the findings of the preliminary vulnerability assessment do align both with other assessments and anecdotal evidence with regard to where coastal erosion is a concern. One example is along the Antrim Coast where the areas at high risk of erosion are mainly the pocket beaches found between sections of cliff. The preliminary vulnerability assessment mapping could therefore be utilised to assist in the prioritisation of geographical areas requiring further detailed data collation and coastal erosion vulnerability assessment.

## 6.7 Influence of Climate Change

**6.7.1** Understanding the influence of climate change on coastal erosion has been identified as one of the areas of highest risk by the UK Climate Change Risk Assessment (CCC, 2017). Climate change will be responsible for warmer temperatures over time and increases in sea level. Together these are responsible for increases in storminess along with increased extents and rates of coastal erosion (CCC, 2017).

**6.7.2** Storminess is forecast to increase during this century with more stormy winters off the north-west and northern coasts of Ireland and calmer summers. In addition, a higher prevalence of easterly winds may increase storminess on eastern coasts (Devoy, 2008).

**6.7.3** Sea level has been fairly stable in Northern Ireland over the last few hundred years due to post glacial rebound of the land mass (Orford et al., 2006). However recent tidal gauge measurements and scientific projections indicate a rapid increase in sea level over the next century (CCC, 2016). Sea level rises of between 20 and 40 cm are expected in Northern Ireland over this century (CCC, 2016).

**6.7.4** Sea level rise and increased storminess has implications for coastal erosion: it will increase the coastal areas susceptible to flooding and therefore increase the number of properties and infrastructure networks in compromised locations (Cooper et al., 2016).

**6.7.5** Any increase in sea level will lead to the inundation of land (except at a vertical cliff). Moreover, the deeper water level will let waves propagate further inshore before breaking, causing a change in sediment transport. One of the most widely used high level tools for assessing the impact of rising sea level on beaches is the Bruun rule (Bruun, 1962); Bruun proposed that coastline retreat rate is proportional to the rate of sea level rise. The approach balances sediment yield from the horizontal retreat of a profile with sediment demand from the rise in the profile. This implies that as the rate of sea level rise increases, the rate at which shorelines retreat will also increase.

**6.7.6** Much of Ireland's soft coastlines are less than 10 to 12 m above mean sea level, making them highly susceptible to rising sea levels and increased storminess (Carter, 1983; Carter et al., 1987; Delaney and Devoy, 1995; Devoy et al., 1995; Orford and Carter, 1984, Devoy 2008).

**6.7.7** Sea level rise will influence coastal erosion by causing previously stable beaches to move landward and accelerating the rates that retreating beaches move landward (Cooper, 2015). Increased air and sea temperatures due to climate change will also increase productivity of biotic systems which may lead to increased coastal sedimentary accumulation in some areas (Guilcher and King, 1961).

# 7.0

# Current Governance & Stakeholder Consultation

# 7.0

# Current Governance & Stakeholder Consultation

## 7.1 Current Governance

### Central Government

**7.1.1** As set out in the Introduction to the report, the Coastal Protection Act 1949 does not extend to Northern Ireland; rather coastal erosion in Northern Ireland has for the past fifty-one years largely been addressed by means of the 'Bateman Formula'.

**7.1.2** As a consequence, no one Executive department has the overall responsibility for the management of risk associated with coastal erosion, however the following departments are responsible for various aspects of coastal management relating to coastal erosion.

### Department for Infrastructure (DfI):

**7.1.3** The responsibilities of the Department for Infrastructure are broad and varied:

### DfI - Rivers

**7.1.4** DfI is the competent authority charged with implementing the requirements of the EU directive on managing flood risk. DfI - Rivers has responsibility for flood defence, including coastal flooding, and maintains 26km of statutory flood defences and two tidal barriers designed to reduce flood risk to low lying coastal property.

**7.1.5** Flood risk assessments have been undertaken and flood risk management plans and strategies produced. Much of this information has been collated and is available digitally.

**7.1.6** DfI - Rivers manage a number of structural assets which currently protect against coastal flooding. As the flood management authority, DfI Rivers has an interest in any future approach to the management of coastal erosion risk, especially if coastal flooding were predicted to occur as a result of coastal erosion.

**7.1.7** Data on coastal erosion risk would provide an evidence base to inform future decisions on the approach to asset management and also assist in identifying areas where coastal erosion may cause coastal flooding.

### DfI – Transport and Resources/Roads

**7.1.8** DfI - Transport and Resources/Roads remit covers road, rail and ports and has responsibility for coastal defences that protect the road and rail network.

**7.1.9** DfI - Roads are responsible for the maintenance of all public roads. Overtopping of some coastal roads can occur during storms and spring tides and has resulted in damage to some of the coastal roads especially the Antrim Coast Road section of the A2 and the A20 on the inner side of the Ards peninsula. DfI - Roads has completed a study of the impacts of coastal erosion and storm damage on the roads in this area which has identified the scope of potential remedial and preventative works, and prioritised locations where works are required.

**7.1.10** The Department's response to coastal erosion is reactive responding only to asset maintenance requirements with no policy or strategy in place to consider the impacts of climate change and coastal erosion. Very little data is available digitally and the information that is available comprises inspection reports that are not in a format that is easily accessible for use by other parties to identify and assess the impact and rates of erosion.

**7.1.11** Coastal erosion data would assist the Department to develop long term strategies to protect transport infrastructure and identify areas where this could be achieved in a more sustainable manner.

### Translink

**7.1.12** Translink is responsible for maintenance of sea defences relating to railway infrastructure. A detailed survey of all sea defences was undertaken in October 2017 on behalf of Translink and Northern Ireland Rail (NIR) and recommendations made regarding the requirement for and scope of remedial works /potential upgrades required in the urgent, short, medium and long term. Again, this information is currently not available for use by external parties to identify and assess the impact and rates of erosion.

**7.1.13** As set out in Section 5.5 Data Requirements, the development of a Coastal Erosion Baseline would be assisted through the implementation of a coordinated systematic asset monitoring programme across DfI from which the data is uploaded onto an available GIS database.

### DfI - Planning

**7.1.14** DfI - Planning has two key roles:

- Strategic Planning
- Planning policy.

**7.1.15** Strategic Planning Division are responsible for determining regionally significant planning applications as well as those applications which are "called in" from Local Authorities;

**7.1.16** Planning Policy Division develops planning legislation and policy in line with Ministerial direction, leads on the Regional Development Strategy and the preparation of policy guidance and advice for Local Authorities.

**7.1.17** The Planning Policy Division was instrumental in assisting Local Authorities transition into the role as decision maker for terrestrial planning, and continues to provide support in bringing forward continuous improvement initiatives, as well as advice and support in the development of Local Development Plans.

### Department for Agriculture, Environment and Rural Affairs (DAERA):

**7.1.18** DAERA's role with respect to coastal erosion is varied and complex and includes, but is not necessarily limited to:

- Marine Plan – responsible for preparation of a marine plan for Northern Ireland and once it is adopted, monitoring and future reviews;
- Marine licensing – decision maker for developments undertaken below mean high water springs;
- Consultee and technical adviser supporting Local Authorities as well as DfI Planning on all planning applications and the development of Local Development Plans; and
- Nature conservation adviser, responsibility for designation of all nature conservation features, monitoring and management of protected sites.

**7.1.19** DAERA holds a vast array of data and information relating to coastal issues, which is required to support their role as both adviser, decision maker and regulator. DAERA also has the technical expertise to advise on data collation; the collation of such data may also assist in assessment of Marine Licence applications as well as management of protected coastal sites.

### Department for Communities (DfC)

**7.1.20** Department for Communities (DfC) have a limited remit in coastal erosion with respect to the potential impacts upon known and undiscovered heritage assets.

### Local Government

**7.1.21** Local Government Reform in 2015 saw the number of Local Authorities (LAs) across Northern Ireland fall to eleven, seven of which have some coast line:

- Antrim and Newtownabbey
- Ards and North Down
- Belfast City Council
- Causeway Coast and Glens
- Derry and Strabane
- Mid and East Antrim Borough Council
- Newry, Mourne and Down District Council

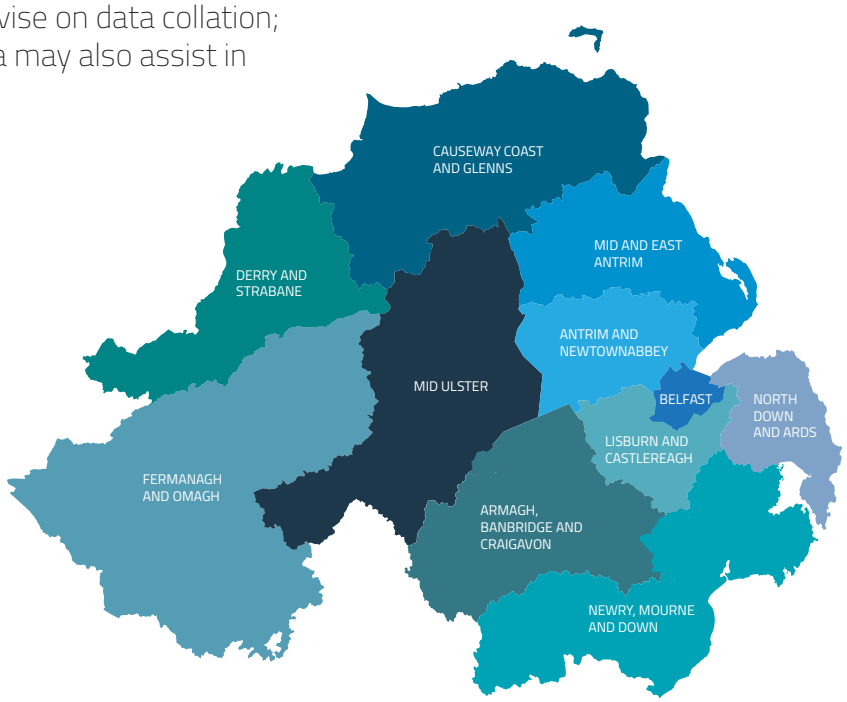



**Plate 7.1.**
Northern Ireland's Council Boundaries

**7.1.22** In addition to the change in areas, a change in the roles and responsibilities of LAs was also implemented which included devolvement of planning responsibilities from central to local government. This means that LAs now have responsibility for:

- Local development planning;
- Development management – determination of the majority of planning applications; and
- Planning enforcement.

**7.1.23** As such LAs have a requirement to ensure that future plans and strategies reduce the risk associated with coastal change by avoiding inappropriate development in vulnerable areas and not exacerbating the impacts of physical changes to the coast. They are also required to identify any area likely to be affected by physical changes to the coast and make provision for development and infrastructure that needs to be relocated. They are required to only grant permission for development where it is demonstrated that it will be safe over its planned lifetime and not have an unacceptable impact on coastal change.

**7.1.24** LAs across Northern Ireland are currently at various stages in the preparation of their Local Development Plans (LDPs).

### Groups considering Coastal Management

**7.1.25** In 1995, the Department of the Environment consulted on delivering coastal zone management in Northern Ireland (DoE 1995). This resulted in the establishment of the Northern Ireland Coastal and Marine Forum (NICMF).

**7.1.26** The NICMF was a non-statutory and voluntary body that's main task was to develop the document 'Toward an Integrated Coastal Zone Strategy for Northern Ireland, 2006-2026 (DOE, 2006) to advise government on objectives and priorities for management and conservation of the coastal zone (Cooper, 2011). However, this Strategy did not review the Bateman Formula. The NI Coastal and Marine Forum stopped meeting in that context in September 2010.

**7.1.27** In 2016, the DRD and DoE Ministers jointly chaired a new Coastal Forum, specifically to discuss the issue of coastal erosion. Council CEOs and the National Trust were invited to these meetings.

**7.1.28** During 2018, local council planning officers convened a coastal group to assist in policy development around local development plans. DfI and DAERA were invited to attend this group.

## 7.2 Marine Planning and Legislation in NI

### Marine Planning in NI – evolution of the draft Marine Plan 2018

**7.2.1** The Marine and Coastal Access Act 2009 (MCAA) and the Marine Act (Northern Ireland) 2013, require the Department of Agriculture, Environment and Rural Affairs (DAERA) as the Marine Plan Authority (MPA), to prepare marine plans. The Plan will facilitate the sustainable development of the marine area.

**7.2.2** The consultation period for the proposed Marine Plan for Northern Ireland (DAERA, 2018) closed on 15th June 2018. The Marine Plan's vision is to create a healthy marine environment which is managed sustainably. To do so, when formally published, the Plan will set out a range of objectives and associated policies against which activities and development in the marine environment will be assessed. Key policy objectives in the draft plan detail which data and assessment on coastal erosion is imperative to allow for informed decision making encompass:

- Climate change and sea level rise;
- The requirement to avoid adverse impact on coastal processes; and
- Land and Sea Interaction.

**7.2.3** The Marine Plan (when adopted) will be used by public authorities in taking decisions which affect or might affect the marine area, including authorisation or enforcement decisions, and decisions that relate to the exercise of any function capable of affecting the marine area. It will contribute to Integrated Coastal Zone Management. Consideration of coastal processes is an essential component to the management of the land sea interface. Data on coastal erosion and coastal processes is integral to the capability to deliver this function.

### Strategic Planning Policy Statement for Northern Ireland (SPPS)

**7.2.4** The SPPS was published by the DoE in 2015 with the aim of furthering sustainable development. It sets out strategic planning policy for a wide range of planning matters and sets direction for local authorities to bring forward operational policies within their LDPs.

**7.2.5** Successful implementation of the SPPS requires planning authorities to focus on delivering spatial planning. This requires a positive and proactive approach to planning, and a coherent long-term policy framework to guide and influence future development across the region.

**7.2.6** The 2011 Act transfers responsibility for the preparation of LDPs from the Department to councils and establishes a plan-led planning system which gives primacy to the plan in the determination of planning applications unless other material considerations indicate otherwise.

**7.2.7** Coastal erosion is referred to in three different sections:

- Mitigating and adapting to climate change (3.13) – avoiding development in areas with increased vulnerability to the effects of climate change, particularly areas at significant risk from flooding, landslip and coastal erosion, and highly exposed sites at significant risk from impacts of storms.
- Regional strategic policy (6.42) – Development will not be permitted in areas of the coast known to be at risk from flooding (see flood risk), coastal erosion or land instability.
- Implementation (6.46) – Local Development Plans should identify areas of the coast known to be at risk from flooding, coastal erosion, or land instability where new development should not be permitted.

**7.2.8** In order to implement this legislation, LAs need to be able to identify locations within their areas where coastal erosion may be occurring. The Regional SPPS must be taken into account in the preparation of Local Development Plans (LDPs) and in the determination of planning applications.

### Adoption of EU led Marine Policy

**7.2.9** The Northern Ireland Executive and UK government committed to jointly introduce new marine legislation to provide a framework based upon a strategic system of marine planning to ensure the sustainable development of Northern Ireland's marine waters.

**7.2.10** The Marine Strategy Framework Directive (MSFD) came into force in July 2008 and is the environmental pillar of the EU's Integrated Maritime Policy. This European legislation aims to protect the marine environment by an ecosystem-based approach to management.

**7.2.11** Due to the nature of the devolution settlement this framework has been achieved through three interlocking pieces of legislation:

- Marine and Coastal Access Act (MCAA) 2009;
- UK-wide Marine Strategy Regulations, 2010 which transpose the MSFD; and
- Marine Act (Northern Ireland) (MA) 2013

**7.2.12** Sustainable development is at the heart of the MA, and the MA builds upon the provisions set out in the MCAA to establish a strategic system of marine planning. It provides the policy framework for the marine planning system and taking decisions affecting the marine environment.

## 7.3 Analysis of Stakeholder Consultation

**7.3.1** Consultation was undertaken with selected stakeholders in order to identify:

- Data and information held by the organisations relating to coastal erosion;
- Data needs and requirements; and
- Knowledgebase and sources of guidance.

### Methodology

**7.3.2** Representatives from a range of organisations for whom coastal erosion is either an operational issue or one which they need to consider as part of governance, either on a local or central level were interviewed.

**7.3.3** It was not the aim of this study to undertake a detailed or formalised stakeholder engagement exercise, but more to gain an understanding of the current approach to issues surrounding coastal erosion within and across different organisations and departments in Northern Ireland and to assess where the needs for data and guidance lie.

### Local Government

**7.3.4** Interviews were undertaken with one or more representatives from all of the coastal councils across Northern Ireland. The liaison was undertaken predominantly by means of short telephone interviews.

**7.3.5** The interviews focussed around the following subjects:

- Data and information held by the authority;
- Priority given to coastal erosion and key drivers;
- Needs of the organisation;
- Persons / departments who deal with the issue of coastal erosion; and
- Level of knowledge / expertise and requirements for support, training or assistance.

### Central Government

**7.3.6** Liaison was undertaken with one or more representatives from the departments detailed below. The liaison was undertaken predominantly by means of short telephone interviews.

**7.3.7** Telephone interviews / discussions were undertaken with:

- DfI – Planning;
- DfI – Rivers;
- DfI – Roads
- DfI – Water and Drainage Policy Division; and
- DAERA.

**7.3.8** DfI Roads (Operations) and Translink were also consulted with regard to the maintenance of their coastal assets.

### Other Stakeholders

**7.3.9** The following key stakeholders were interviewed:

- National Trust;
- Royal Society for the Protection of Birds (RSPB);
- Ards Peninsula Coastal Erosion Group (a community group).

**7.3.10** Other stakeholders whom would have been valuable to review and discuss coastal erosion with include:

- Ulster University;
- Loughs Agency;
- Shared Environmental Services.

## 7.4 Review of Interview Commentary

### Local Authorities

**7.4.1** Liaison was undertaken with one or more representatives from the Councils detailed below. The liaison was undertaken predominantly by means of short telephone interviews.

- Newry Mourne & Down;
- Mid & East Antrim;
- Causeway Coast & Glens; and
- North Down & Ards.

**7.4.2** The Local Authority (LA) boundaries were redrawn relatively recently at the same time as the responsibility for planning was passed from central to local government. Although experienced planning officers transferred to the Councils from the Planning Service, as a consequence of the Bateman approach to coastal erosion the Local Authorities do not have an understanding of coastal erosion nor at present the technical expertise to address it. This directly effects their ability to develop effective Local Development Plans (LDP) and provide informed planning advice to planning committees with regard to development on the coastline. This situation will be amplified when they are required to interpret and apply the policy objectives of the Marine Plan.

**7.4.3** Key issues from the discussions with the LA representatives are:

- In most LAs, the planning teams appear to be more aware of the need to consider and address coastal erosion within their administrative areas than other departments of the council. This is as a result of compiling the information necessary to inform land zoning and other policy within their Local Development Plans (LDPs). LDPs must consider coastal issues for a number of reasons including nature conservation, tourism, recreation, heritage and development.

- Most LAs undertake little or no beach management, and did not consider themselves responsible for the construction, maintenance or management of coastal defences. This was considered to be the responsibility of central government departments;
- Most LAs did not consider that they had sufficient technical expertise to assess coastal erosion related issues. Many utilised the expertise available within the Shared Environmental Services Department (based at Mid and East Antrim Borough Council); and
- In general, planning teams were not aware of how to find or access appropriate data to enable them to assess coastal erosion issues either on a strategic level or for individual applications. Some highlighted concerns regarding the lack of evidence available to inform planning decisions especially where they are required to provide expert, evidenced advice to planning committees making potentially controversial decisions.

## Selected Stakeholders

### National Trust

**7.4.4** National Trust owns and / or manages 108 miles (22%) of the Northern Ireland Coastline. As such they have a significant interest in the development of policy and strategy relating to coastal protection which is demonstrated by their commissioning of the report "Coastal data: current status and future options" an audit of existing coastal data in NI, its accessibility, quality and deficiencies. The Trust also organised the Shifting Shores Wave 2 Seminar where stakeholders were invited to discuss key issues relating to management of coastal erosion. The outcomes of the seminar are summarised in Shifting Shores Wave 2 – Summary Report.

**7.4.5** As a major coastal land owner, they have an interest in developing a coherent, sustainable coastal management strategy with less reliance on hard defences, particularly in the face of recent storms.

**7.4.6** They are keen to promote partnership working, and to contribute towards development of future policy and strategy.

### RSPB

**7.4.7** The RSPB owns and / or manage a considerable amount of the coastline around Northern Ireland with 10 reserves, many of which are coastal and include, but are not limited to, parts of:

- Causeway Coast;
- Strangford Lough;
- Lough Foyle;
- Rathlin Island; and
- Larne Lough.

**7.4.8** They are keen to promote sustainable solutions to address and manage coastal erosion including the use of managed retreat to identify opportunities for habitat creation. They are currently working with a range of landowners including the National Trust and various industries on schemes to manage and restore mudflats. They have put forward proposals for managed retreat / habitat creation in an area of Lough Foyle which has been subject to erosion in recent years.

**7.4.9** The RSPB published the Sustainable Shores report in February 2018 which covers the whole of the UK and includes a review of:

- Past and future losses of coastal habitats;
- Potential opportunities for creating new habitat; and
- Policy and funding context for delivering new habitat.

**7.4.10** Five potential areas for coastal habitat creation have been identified, but the report concludes that insufficient data is available publicly in NI to undertake a detailed assessment of the risks to protected sites.

**7.4.11** The organisations were keen to highlight their concern regarding a reliance on hard engineering solutions and were keen to work with central and local government in the development of strategy and policy regarding coastal erosion and coastal flooding.

### Ards Peninsula Coastal Erosion Group

**7.4.12** The group was formed after the storms in 2014 to try and raise awareness of the effects of coastal erosion on the peninsula with central and local government. The roads on the peninsula were damaged and some were closed for approximately four months as storm damage had resulted in them being undermined. This resulted in significant disruption to commuters as well as businesses. There was also concern regarding recent planning decisions to allow development of land immediately adjacent to a beach, which was displaying signs of erosion. The group has been successful in lobbying central government to raise the profile of the issue in Northern Ireland.

## 7.5 Summary

**7.5.1** Information on coastal erosion is required by a wide range of central government and local government bodies in order to undertake their day to day activities, as well as forward planning for their respective departments and organisations.

**7.5.2** Some information is already available albeit spread across several departments and institutions, and is not necessarily available in a format that is easy to use and assess. The data that is available is often incomplete and does not always give complete coverage of the coastline.

**7.5.3** The skills necessary to commission and interpret the data are limited to some individuals in central government and academia with very limited expertise across most of the LAs and broader Departmental personnel. In general, across all of the above listed decision makers and groups, an increased understanding of coastal erosion risk management needs to be developed to allow appropriate decisions to be made in accordance with existing planning policies (SPPS), the UK Marine Policy Statement and the draft Marine Plan for Northern Ireland, when it is adopted. The first step on this path is the collation of the data required to understand coastal erosion vulnerability.

**7.5.4** As coastal erosion has historically not been considered as a significant issue of concern in Northern Ireland, there are no or very limited budgets available within central government and local authorities to implement remedial measures following erosion damage caused by storms.

**7.5.5** There appears to be an acceptance across all organisations and institutions that a move towards a more strategic approach is required, and at the very least the data on coastal erosion to determine risk must be collated.

**Table 7.1:** Summary of Stakeholder Needs

| Stakeholder | Data / Information Held | Responsibility / Interest | Data Need |
|---|---|---|---|
| Local Authorities | In most cases, very little data is available and reorganisation has resulted in limited in house expertise or knowledge about their areas. | Development of local plans<br>Decision maker for planning applications.<br>Clear role in shoreline management. | Information on coastal erosion risk required to enable evidence based decision making, both at plan level as well as for individual applications. |
| Shared Environmental Services Department | None | Assist / guide most LAs re: sustainability issues. | As per and in support of LAs. |
| DfI Rivers | Significant amount of data held which has been collected to assist in flood risk management planning and water framework directive assessment. | Responsibility for coastal flooding.<br>Maintenance of statutory flood defences.<br>Likely consultee in shoreline management planning. | Coastal erosion data and an understanding of coastal erosion risk where it is predicted to cause coastal flooding. |
| DfI Roads | Some data regarding the condition of flood defences. | Maintenance of infrastructure.<br>Likely consultee in shoreline management planning. | Data would assist in long term planning. |
| Translink | Some data regarding the condition of flood defences. | Maintenance of infrastructure.<br>Likely consultee in shoreline management planning. | Data would assist in long term planning. |

| Stakeholder | Data / Information Held | Responsibility / Interest | Data Need |
|---|---|---|---|
| DAERA | A significant amount of data is held, but not necessarily sufficient / appropriate to confirm the locations and rate of erosion. | Marine Licensing, Marine Plan, Biodiversity etc.<br>Statutory consultee in terrestrial planning.<br>Likely consultee and technical adviser in shoreline management planning. | Data would assist in numerous aspects of the department's current work as well as being required for shoreline management planning. |
| RSPB | Limited qualitative data regarding reserves. | Management of several coastal nature reserves.<br>Interest in habitat creation / enhancement through managed realignment. | Data required to assess impacts upon existing reserves and enable design of managed realignment / habitat creation schemes. |
| National Trust | Limited quantitative data. Some anecdotal qualitative data. | Management of significant proportion of beaches, coastline and coastal properties.<br>Interest in sustainable coastal management. | Data required to assess impacts upon portfolio and enable development of risk management strategies. |
| Academia | Numerous research projects have been undertaken by the two main universities, Ulster University and Queens University. Numerous research and monitoring projects have been undertaken; however, the information and data gathered is currently only available in published research papers. | Both universities have well respected research teams, an interest and expertise in coastal erosion monitoring and sustainable coastal management along the NI coast. | Research interests means that there is always a need for data collection.<br>The universities have good links with the LAs and are currently undertaking several joint studies with the LAs. |

# 8.0

# Conclusion

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# Conclusion

## 8.1 Overview and Summary

**8.1.1** The value of the Northern Ireland coastline for tourism, recreation, nature conservation and heritage is an inarguable fact. Equally the occurrence of coastal erosion and its potential implications cannot be ignored especially in the context of climate change, sea level rise and increased storms.

**8.1.2** The primary aim of the study was to undertake a baseline and gap analysis of the data currently held or available which could be utilised to inform coastal erosion risk management; to complete an initial preliminary vulnerability assessment of the Northern Ireland coastline to erosion; gather an understanding of the needs of stakeholders and decision makers with a marine and coastal interest; and to identify future areas of work required to inform a policy on coastal erosion.

### Baseline and Gap Analysis

**8.1.3** A review of available data was assessed in terms of quality, reliability, coverage and completeness. The gap analysis highlighted that basic information on coastal erosion in Northern Ireland is not readily available. As neither central nor local government has legislation covering coastal erosion risk management this outcome could perhaps be considered as unsurprising. Some intermittent coastal surveys have been undertaken by both government and academic organisations; however these tend to be 'one-off' surveys looking at a particular asset and cannot therefore be readily used to measure how the coastline is changing. To progress this, a key consideration is the establishment of a robust baseline from which to measure coastal change in Northern Ireland.

**8.1.4** To this end an approach has been outlined for further consideration. This includes a review and confirmation of the extent of coastal defences present and a review of historical mapping and orthophotography to demonstrate whether or not coastal erosion is a persistent issue. This work would assist in prioritising geographical areas for more detailed data collation and erosion assessment. Additional data considerations specific to eroding beaches and hard coasts are made but these are secondary and can be directed by the outcome of the initial exercise.

## Preliminary Vulnerability Assessment of NI Coastline

**8.1.5** A high-level preliminary vulnerability assessment of coastal erosion along the Northern Ireland coast has been undertaken utilising the data which is currently available. This high-level assessment consists of two stages: an Erosion Risk Appraisal and a Vulnerability Assessment. The vulnerability assessment simply compares areas of high/medium/low erosion risk against physical asset value, historic asset value and natural asset value also at high/medium/low value.

**8.1.6** The initial results of this preliminary assessment did identify areas at potential risk of erosion coinciding with areas of high physical asset value as well as high historic and natural asset value. However, the primary conclusion reached by the preliminary vulnerability assessment ties directly back to the priority data collation considerations: due to the high-level nature of the study and the lack of coastal erosion specific data (i.e. data collected at the same location, in the same way, over time), allocation of risk ranking is arbitrary; consequently, the reliability of the vulnerability mapping must be approached with a high degree of caution until such time as the exercise can be repeated utilising appropriate, more detailed data.

**8.1.7** Despite this analysis, the assessment does contribute to the evidence base in support of the conclusion that coastal erosion is an issue of potential concern for particular areas of Northern Ireland. The preliminary vulnerability assessment mapping could be utilised alongside other inputs to assist in the prioritisation of geographical areas requiring further detailed data collation and coastal erosion vulnerability assessment; for example, those areas which are currently undefended where there is a high erosion risk and high asset value overlap.

## Stakeholder Needs

**8.1.8** Consultation was undertaken with selected stakeholders in order to identify their data needs and requirements. In general, across all policy and development decision makers, there was awareness that an increased understanding of coastal erosion risk management needs to be developed to allow appropriate decisions to be made.

**8.1.9** For Local Authorities, the key need is easily accessible data on which to base reliable decisions with regard to local development planning and development control. The first step in this regard is the provision of robust, accepted coastal erosion vulnerability mapping. As well as allowing development control decisions to be made objectively, in the longer term, vulnerability mapping can be used in the local development planning process to inform local longer term management of areas where coastal erosion is occurring.

**8.1.10** As coastal erosion has not been formally identified as a problem, there are very limited or no budgets available within Local Authorities to address the issue. There is also an expectation that coastal erosion is an issue to be addressed nationally by central government and that the necessary research, maintenance and coastal defence budgets should be found at that level.

**8.1.11** Data on coastal erosion vulnerability, if predicted to cause coastal flooding, would be useful to DfI Rivers as the authority with responsibility for flood risk management. This would assist in informing future policy and management of existing flood defences.

**8.1.12** DfI Roads and Translink both manage assets which constitute coastal defences and require frequent maintenance. The asset

monitoring data has applicability to coastal erosion assessment and should be made available on a shared platform. Vulnerability assessment is essential to informing longer term asset management decisions.

**8.1.13** DAERA as the Marine Authority with lead responsibility for Marine Licensing and production of the Marine Plan already set marine and coastal policy and maintain the existing Marine Map Viewer. Undertaking the role of lead body to coordinate collection, collating and making data available on a single platform would seem a natural evolution of DAERA's current role.

**8.1.14** The consultation and liaison process instigated as part of this study is incomplete and should continue with more in depth analysis of the needs of each of the stakeholders and the interrogation of existing knowledge held within the National Trust and the University of Ulster.

## 8.2 Needs and Opportunities – a discussion on the way forward for NI

**8.2.1** Recognising that the current political situation in Northern Ireland has a significant effect on the abilities of all stakeholders to engage more actively with the issue of coastal erosion, it is imperative that the issue is approached collaboratively. Responsibility should be shared and agreed across Local Authorities and Departments working on the delivery of agreed prioritised requirements and actively seeking funding for those requirements. A Department may act as technical lead but the overall ownership of coastal erosion risk management is one of shared responsibility dependent primarily on geographic/administrative area.

**8.2.2** The previous Ministers for Regional Development and Environment established a Coastal Forum with Local Authorities and the National Trust. The Coastal Forum is considered as having a key role to play in the delivery of the collaborative working required to deliver coastal erosion risk management in Northern Ireland over both the short and long term.

**8.2.3** The following priorities are considered the key tasks which would require to be delivered to bring the understanding of coastal erosion in Northern Ireland to a level which is comparable with our counterparts across the UK:

- Improve coastal erosion baseline for NI;
- Delivery of a coordinated monitoring programme on coastal change;
- Collating, managing and making accessible key information; and
- Development of evolving robust coastal erosion vulnerability mapping.

**8.2.4** The above will facilitate and inform;

- Future policy direction and strategies for coastal management;
- Improving and empowering coastal decision making, which may require new legislation;
- Funding requirements

### Improve Coastal Erosion Baseline for NI

**8.2.5** The preliminary vulnerability assessment utilising the data currently available has demonstrated that the data is not suitable for the purpose of driving forward a Coastal Erosion Risk Management strategy for Northern Ireland. The Data Requirements outlined in Chapter 5 identifies a clear priority for the generation of a coastal erosion baseline from which other decisions can be made and priorities flow. It is felt that the delivery of this baseline should be considered as a next step.

### Co-Ordinated Monitoring Programme

**8.2.6** With the availability of reliable baseline data on coastal erosion in Northern Ireland it will be possible to develop a prioritised and coordinated monitoring programme. This could direct data collation at appropriate geographic scales – local and focussed where coastal erosion risk is high, to national where the mode of data collation is efficient and cost-effective.

**8.2.7** This will allow the development of an understanding of how the coast of Northern Ireland is changing, particularly in areas identified as vulnerable. This is essential for informing planning and licensing decisions along the coastline. However, it is essential that the monitoring programme is collaborative and involves all decision-makers; including DfI, DAERA, local authorities and the National Trust.

**8.2.8** Progressing further consideration of an appropriate, risk-based monitoring programme should be a priority consideration for the Coastal Forum.

### Collating and Managing Key Information

**8.2.9** Currently, there is some data/evidence being collected by central government, local authorities, research institutions and the National Trust. However, studies are being undertaken on an ad-hoc basis, with no strategic overview. The information is not being collated centrally or analysed at regular intervals to inform how the Northern Ireland coastline is changing.

**8.2.10** Going forward, all data collected, by all parties, could be collated and made accessible on a single platform to enable regular analysis of coastal change. One body could coordinate key data collection exercises, collating and managing the information which could be accessed by relevant stakeholders from a single map viewer (INSPIRE compliant). The existing Marine Map Viewer maintained by DAERA may be a possible tool for this purpose. Historic data could be provided by stakeholders for inclusion. Regular analysis and reporting could be provided for all partners.

### Development of Robust Coastal Erosion Vulnerability Mapping

**8.2.11** From the stakeholder feedback received it is clear that accessible coastal erosion vulnerability mapping would be a highly useful tool for all coastal decision makers and as such, development of assessment and vulnerability mapping should be continued. In this regard the National Coastal Change Assessment project in Scotland (Dynamic Coast) could be used as a reference point. The first step in this regard is the review of historic mapping (as discussed above) to generate the baseline coastal erosion data for Northern Ireland. Subsequent decisions on data required to enhance the vulnerability mapping would then be taken as part of the Coordinated Monitoring Programme.

### Policy and Strategy

**8.2.12** The existing Northern Ireland coastal policy framework (the application of the Bateman Formula) at present is one of coastal protection rather than coastal management. This policy is considered unsustainable in the long-term, particularly in light of the impacts of climate change. This approach also contradicts EU ICZM and Environmental Assessment principles. These are outlined in Eurosion documentation (http://www.eurosion.org/project/eurosion_en.pdf) and emphasise the importance of understanding coastal processes, sediment movement and erosion in managing flood risk, particularly in the context of climate change.

**8.2.13** However, there is no unified approach or strategy to Coastal Erosion Risk Management across the UK and Ireland; each country has taken a different overall approach dependent on the perceived and actual risk of coastal erosion. It is also evident that coastal erosion in England is a much greater issue than it is for Northern Ireland and the evidence base to demonstrate the need for a national Shoreline Management Plan / Coastal Observatory approach is not yet available or apparent. As a consequence there is no typical pathway to be followed; rather policy and strategy to address Coastal Erosion Risk Management in Northern Ireland must be allowed to evolve as the data and our understanding increases.

**8.2.14** Departments (DAERA/DfI) should continue to consider the strategic way forward in light of emerging information on coastal erosion risks. The Coastal Forum would appear to be an appropriate mechanism through which this work may be progressed in collaboration with Local Authorities and the National Trust. This would provide a means through which central and local government can work together to improve the knowledge base on coastal erosion and consider appropriate change to the existing policy framework to ensure that identified coastal risks are more effectively managed.

### Improving and Empowering Coastal Decision Making

**8.2.15** The Stakeholder Analysis chapter highlighted that local authority planners and decision makers do not consider themselves to have sufficient expertise or insight to allow them to make evidence based assessments where development effects the coastline. There is hence a clear need to educate, inform and empower these personnel.

**8.2.16** All decision makers (planners, marine licensing officers, infrastructure asset managers etc.) need to be involved in making coastal management decisions, in addition to the local stakeholders. Typical decisions are around where it is appropriate to hold the line, advance the line, natural management, managed retreat or other options.

**8.2.17** In England, Scotland and Wales similar groups of experts from central and local government and academia are involved. The disciplines covered include coastal and flood risk management, nature conservation, marine management and licensing, planning, GIS/mapping and academia etc.

**8.2.18** Northern Ireland will need to decide on the best way forward to manage coastal decision making based on its specific needs and circumstances and in this regard the debate sits well within the Coastal Forum. This debate may inform future legislation needs.

### Funding Requirements

**8.2.19** The need for funding to ensure that coastal change needs are appropriately resourced has been identified. Some authorities and the National Trust are proactive in this regard. It is recommended that the LAs and Departments alongside the National Trust, RSPB and landowners continue to work closely together to maximise opportunities. This should be built upon through the support for closer working between Local Authorities and departments to identify and maximise opportunities and increase the likelihood that funding applications will be successful. It is considered that opportunities exist for a joined up and collaborative approach to funding similar needs and ensuring effective use of resources. For example, funding information needs, beach studies etc.

## 8.3 Collaborative Way Forward

**8.3.1** This baseline study of coastal erosion risk management in Northern Ireland has found that the NI coastline has areas which are potentially at risk of erosion. However, the data currently available is insufficient to develop the necessary Coastal Erosion Vulnerability mapping. More information and data is required to bring the understanding of coastal erosion to a comparable level with our UK counterparts.

**8.3.2** A shared responsibility approach is recommended to manage the risk of coastal erosion, which requires Local Authorities, Departments, the National Trust and other stakeholders working collaboratively to agree and deliver prioritised requirements. This will ensure that a consistent, holistic approach is adopted within Northern Ireland.

**8.3.3** To that end, proactive input from those bodies involved with the Coastal Forum should be recognised and encouraged and these existing relationships should be developed alongside input from the Departments to secure funding.

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# Appendix A:

## Recent Local Research

### Shifting Shores Living with a changing coastline (National Trust, 2007)

The aim of this report was to understand how the climate of NI is likely to change in the future and how these changes will impact key coastal sites and summarise the main finding of the Future Coastal Scenarios for Northern Ireland research. It also looked at what management and policy challenges these changes will present. The results from the research suggested significant changes to the climate in Northern Ireland including, warmer annual temperatures, wetter winters and drier summers, sea level rise, increased frequency of extreme storm surge events and greater frequency of extreme wave events. The impacts of these climate change factors on three key coastal sites (Giant's Causeway, north-east Strangford Lough and Murlough National Nature Reserve) are discussed. Two types of management techniques were evaluated; hold the line and adaption. The report highlights that all coastal communities and stakeholders face the same challenges as the National Trust and therefore must work together to plan future coast management. The National Trust concluded that working with natural coastal change where possible was the preferred option.

### Shifting Shores playing our part at the Coast (National Trust, 2015)

The report states that there have been some important strides forward in public policy since the previous Shifting Shores publication. This report highlighted the need for adaption and working with natural processes in NI and that coastal defence as the only response to managing coastal changes looks increasing less plausible. It states that in order to recreate a naturally functioning shoreline that will free us from the sea defence cycle of construction, fail and reconstruction we need to adapt and understand the forces of nature at work. The National Trust are currently attempting to 'future proof' sections of the coastline of the UK. Adaption plans at six sites in the UK were detailed; Mount Stewart, Formby, Freshwater West, Godrevy, Dunsbury Farm and Dunwich. The National Trust aim in the future to continue to encourage coastal adaption for long-term sustainable coastal management instead of short-term engineered defences.

### Northern Ireland Coastal Data: Current Status and Future Options (Cooper & Jackson, 2017)

The report highlights the importance of the coast in Northern Ireland by saying it is one of its most valuable natural assets and most variable coastline in the world. It states that an understanding of how the coast works is vital for effective shoreline management. Climate change in Northern Ireland is leading to warmer temperatures and a higher sea level. This report reviewed the existing data available in Northern Ireland and identified data gaps. The paper determined that NI lacks the basic information needed to make decisions regarding the risks associated with coastal erosion. Region-wide coastal monitoring is vital if coastal management

decisions are to be made based on accurate and up-to-date information on climate change. The current shoreline management is reactive and poorly structured and continuation of current practice will lead to coastal degradation and loss of amenity value. From this, it was recommended that a coastal observatory, similar to those in operation in England and Wales should be developed for NI. The coastal observatory would collect and collate data and provide reports based on the data to government departments, agencies and local authorities. The report concluded that establishing a coastal observatory in Northern Ireland is essential to provide the necessary support for decision-making in the current framework and in any future strategic approach.

### Shifting Shore Wave 2 Seminar: Summary Report (National Trust, 2018)

The seminar was attended by representatives from DAERA, DFI, National Trust, RPS, Local Councils and community groups. The seminar included presentations from;

- National Trust (Introduction),
- DAERA (Central Government Update + Background to Coastal Management in NI),
- Prof. Andrew Cooper, Ulster University (Northern Ireland Coastal Data),
- Ards and North Down Borough Council (Planning in Coastal Councils),
- DfI (Management of Coastal Flood Risk),
- Prof. Jim Hansom, University of Glasgow (Scotland's National Coastal Change Assessment), and
- East Solent Coastal Partners (Effective use of coastal data in shoreline management).

The National Trust's seminar summary paper concluded that it was essential that better coastal management was implemented in Northern Ireland and that the coastal policy framework urgently requires updating. National Trust recommended that investment could be given to coastal monitoring and data gathering allowing a Coastal Data Centre to be established. National Trust recommended that Shoreline Plans should also be developed by government departments and councils working together. It was acknowledged that hard coastal defences may not be the best solution in the future and better long term management plans need to be developed.

### Legislative and Policy Response to the Risk of Coastal Erosion and Flooding in the UK and Ireland (McKibbin, 2016)

This report discusses the problem of coastal erosion and evaluates the level of threat in Northern Ireland. It states that the rates of coastal erosion vary greatly around the UK with England being effected the most with 29.8% of its coastline suffering from erosion compared with 19.5% of Northern Ireland's coastline. Climate change predictions include an increase in relative sea levels around the NI coastline and an increase in the storminess of the weather. Extreme weather events and the subsequent flooding events have highlighted the problem of coastal erosion in NI. The report also reviews the departments/bodies responsible for coastal erosion in the UK and Northern Ireland. It concludes that, considering recent incidents, coastal flooding can be more severe than fluvial flooding.

### UK Climate Change Adaption Programme 2017 Evidence Report

The Reports states that there is currently no system in place that decides if a section of the coast should be protected or when other more appropriate measures should be used. NI has planning guidance on flood risk, however, there is no specific guidance on coastal planning.

# Appendix B:

**Figure 1:** Extent of Coastal Defences in NI

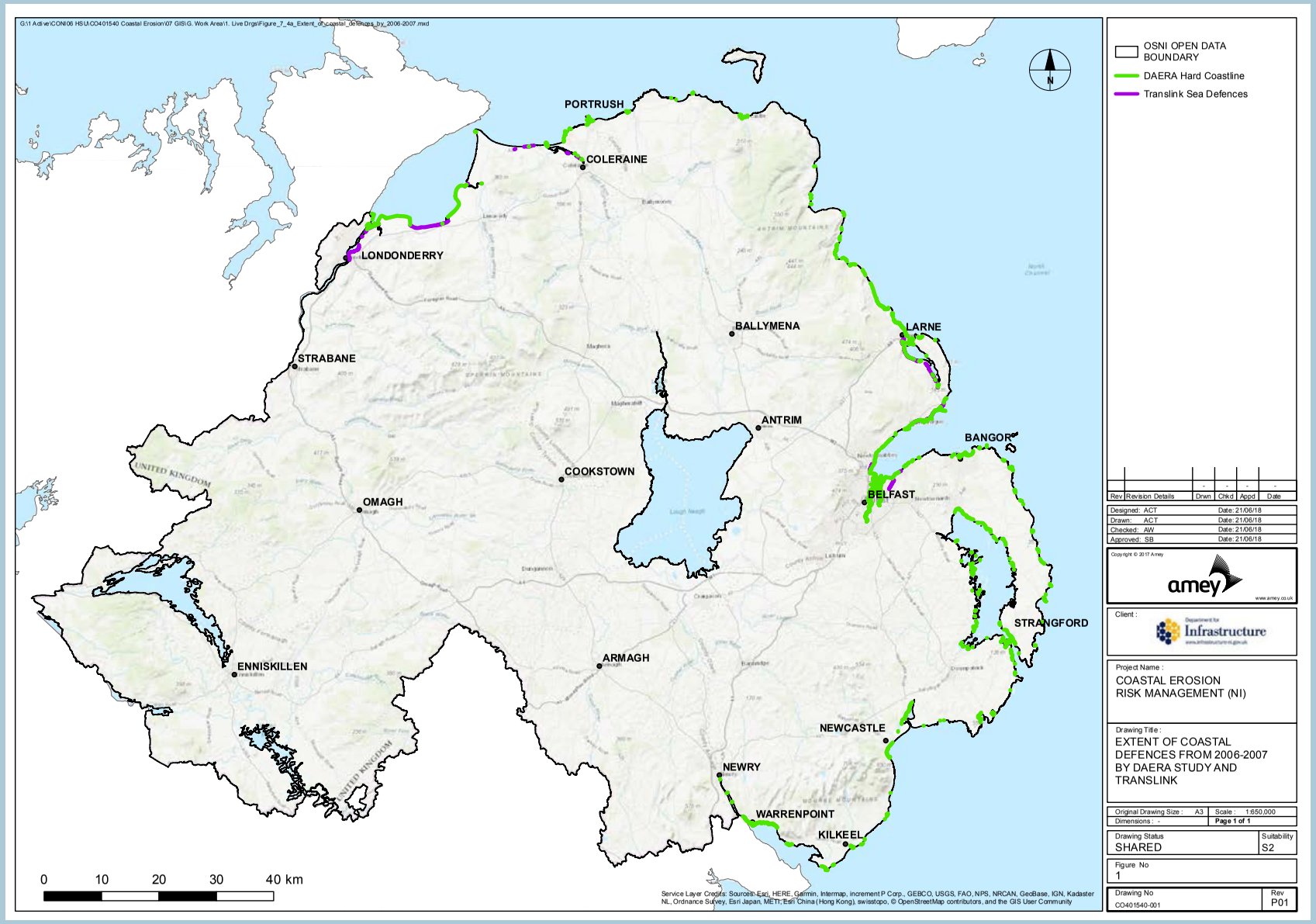
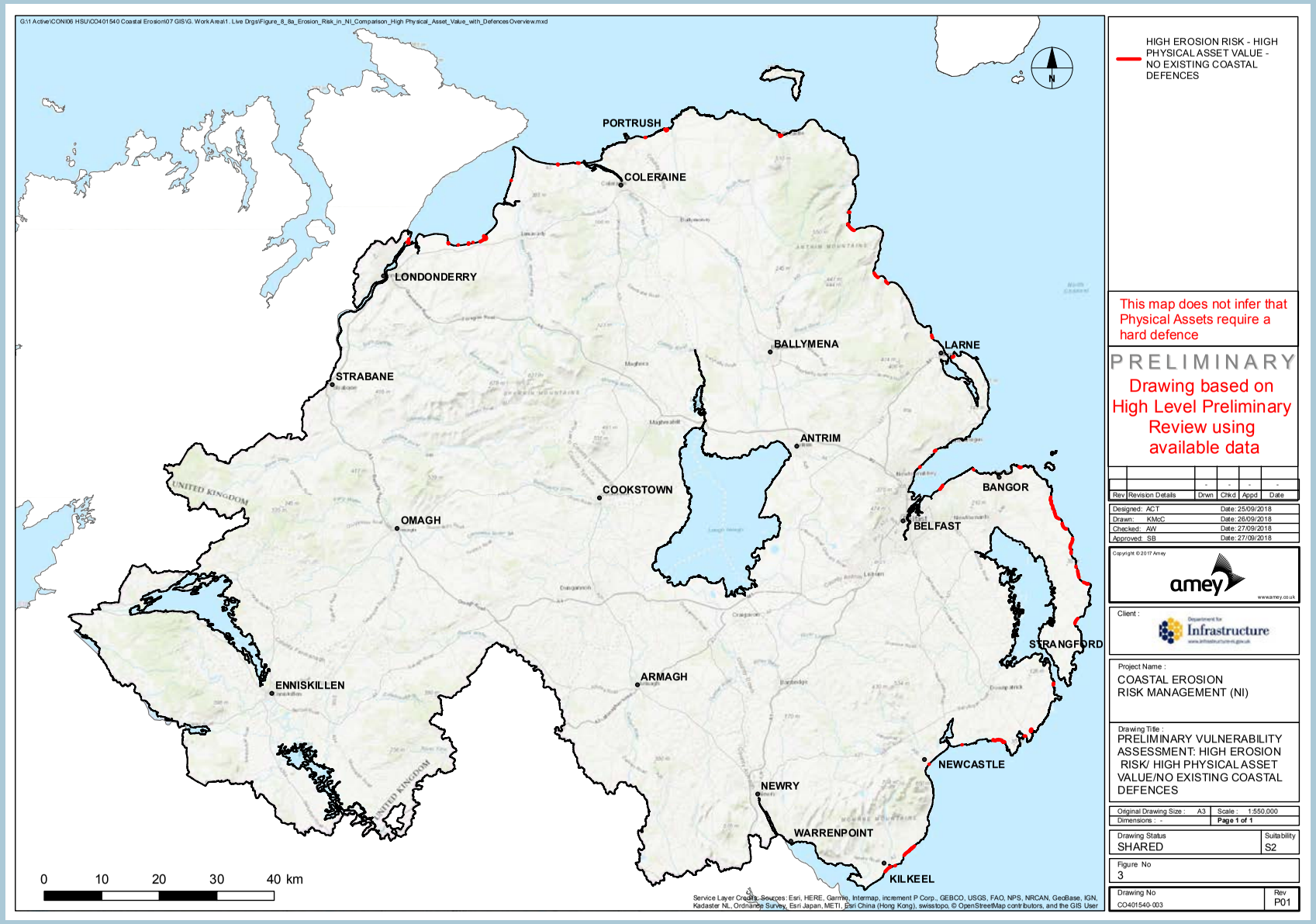


**Figure 2:** Eurosion Study - Coast of NI at risk

**Figure 3:** PVA - High Erosion Risk - High Physical Asset



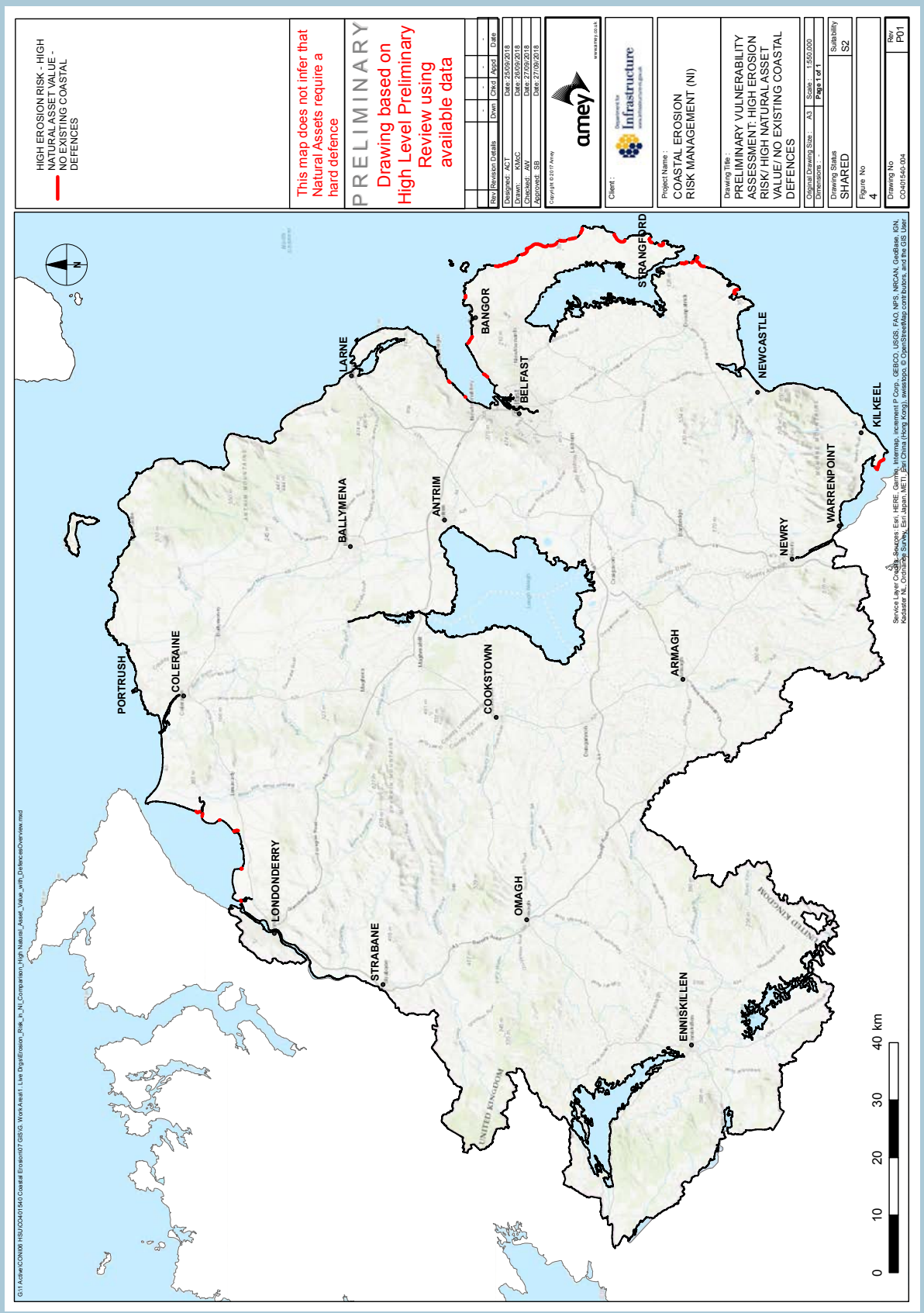



**Figure 4:** PVA - High Erosion Risk - High Natural Asset

**Figure 5:** PVA - High Erosion Risk - High Heritage Asset