

# Local Authority Coastal Erosion Policy and Practice Audit

## Final Report

Comhairle Contae  
Fhine Gall  
Fingal County  
Council



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## Final Report: Local Authority Coastal Erosion Policy and Practice Audit

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## **Final Report: Local Authority Coastal Erosion Policy and Practice Audit**

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## EXECUTIVE SUMMARY

The Local Government Management Authority (LGMA) and County and City Management Association (CCMA) Climate Change subcommittee carried out two national audits among Irish coastal Local Authorities (LA) in 2016 to establish the extent of the coastal erosion at a national scale and investigate practices and policies in place to deal with the issue in Ireland at the LA level. UCC were appointed to prepare this report based on the findings of the two audits and to provide further clarification on several issues where required. Telephone interviews were used to supplement the original audits and address any gaps identified.

This report highlights the scale of coastal erosion in Ireland, as perceived by 19 LAs. Geological information, properties and infrastructure believed to be at risk of erosion in Ireland and is accompanied by an array of supplementary data contained in a WebGIS accessible using the following link:

<http://ucc.maps.arcgis.com/apps/View/index.html?appid=2d9bfd557e2f4d19810c0a6efc653e0c>

Outcomes from the review of the audits and the parallel literature review led the authors to conclude that:

- National policy dealing with coastal erosion is less developed than other coastal hazards, such as flooding and that the approach tended to be reactive rather than proactive.
- Methods in assessing coastal erosion vary greatly; further staff resources, erosion control options considered, approach to private property, level of coastal protection per county, and funding differs between LAs.
- Approaches in the Netherlands, UK, USA and Denmark and their experience could potentially contribute to future coastal erosion policy in Ireland. A national coastal landfill map was created as part of the tender requirements, by integrating information obtained from the Environmental Protection Agency (EPA), Regional Waste Offices (RWO) and telephone interviews with six sites identified at risk of erosion.

Key challenges in dealing with coastal erosion in Ireland, as identified by LAs, ranged from prioritisation to capacity resulting in recommendations for future best practice in Ireland including:

- Coastal Erosion should be a higher priority nationally – central government funding is recommended
- Stakeholder consultation is required at both the local and national level

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- Clarification needed on the responsibilities of LAs and private land owners in relation to private property
- Education and training should be made available to give all parties clarity on responsibility and specialised training

Overall, LAs were in favour of the development of national best practice guidelines. Recommendations for the development of a future coastal erosion policy or best practice guidelines in Ireland extracted from the study were categorised into short, medium and long term including the following:

- Identification of a common definition of risk
- Creation of a uniform national approach to assessing coastal erosion
- Publication of a set of national best practice guidelines concerning national erosion, including coastal defence systems, private property, and specially protected areas.

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### Table of Acronyms

Acronyms and Abbreviations	
CCMA	County and City Managers Association
CDP	County Development Plan
CELCP	Coastal and Estuarine Land Conservation Program (USA)
CZMA	Coastal Zone Management Act (USA)
CZMP	Coastal Zone Management Plan (USA)
DCLG	Department of Communities and Local Government (UK)
DEFRA	Department for Environment, Food and Rural Affairs (UK)
DSAS	Digital Shoreline Change Analysis System
ECOPRO	Environmentally Friendly Coastal Protection
EPA	Environmental Protection Agency (Ireland)
ETW	Effluent Treatment Works
FEMA	Federal Emergency Management Agency (USA)
GIS	Geographical Information Systems
GSI	Geological Society of Ireland
ICPSS	Irish Coastal Protection Strategy Study
ICZM	Integrated Coastal Zone Management
KL	Local Government (Denmark)
LA	Local Authority
LGMA	Local Government Management Agency
LLA	Lead Local Authority
MCA	Multiple criteria assessment
MMA	Minerals Management Services of the Department of the Interior (USA)
MPA	Marine Protected Area
NFWMA	National Flood and Water Management Act (UK)
NOAA	National Oceanic and Atmospheric Administration (USA)
NPWS	National Parks and Wildlife Service
OPW	Office of Public Works
RIB	Rigid Inflatable Boat
RWO	Regional Waste Offices
SAC	Special Area of Conservation
SMP	Shoreline Management Plan (UK)
UCC	University College Cork
USACE	US Army Corps of Engineers
USGS	United States Geological Survey
WebGIS	Online Geographical Information System

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## 1 Introduction

### 1.1 Rationale

This report is produced in response to a tender by Fingal County Council on behalf of the CCMA, won by the MaREI Centre, ERI, University College Cork, to assess national erosion policy and practice based on the experience of specific coastal Local Authorities (LAs) in Ireland (as shown in Figure 1, below). Note that not all LAs took part in each step of the study (see Figure 1.2).

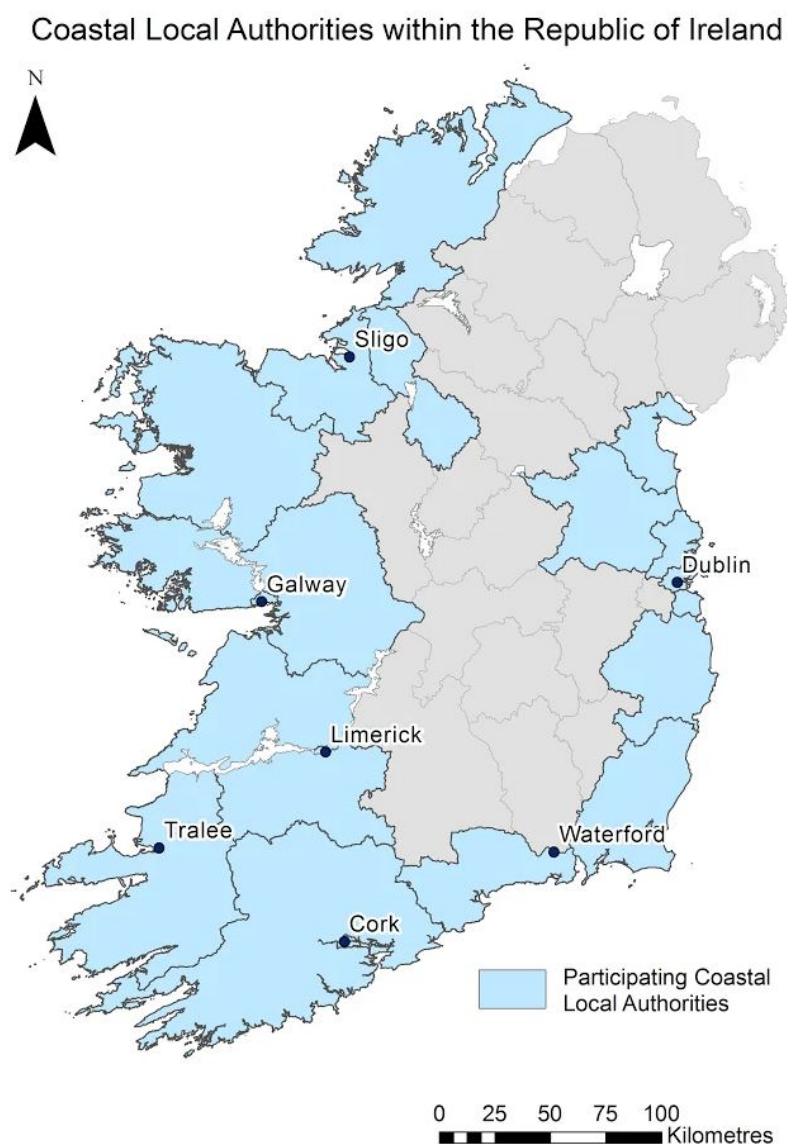


Figure 1-1 Map of the LAs which took part in at least one aspect (an audit or telephone interview) of the study: Donegal, Leitrim, Sligo, Mayo, Galway City, Galway County, Clare, Limerick City and County, Kerry, Cork City, Cork County, Waterford, Wexford, Wicklow, Dun Laoghaire, Dublin City, Fingal, Meath and Louth.

### 1.2 Scope

The main objectives of this tender were to determine the:

- Scale of the coastal erosion problem in Ireland
- Local Authority policy on coastal erosion

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- Local Authority practices in dealing coastal erosion

The outcomes from this process, alongside current international best practice, were used to suggest the most appropriate approach to coastal erosion management into the future, within an Irish context.

### 1.3 Approach

These objectives were achieved by reviewing and subsequently reporting on the outcomes of two existing audits conducted by the LGMA and CCMA Climate Change subcommittee. These attempted to determine both the extent of the coastal erosion problem in Ireland, and local authority policies and practices in terms of dealing with coastal erosion. It was acknowledged, however, that there were limitations to these audits and that further clarifications would be required directly from local authority personnel. In addition, it was felt important to contextualise these approaches with those adopted in other jurisdictions to inform the development of coastal erosion policy or guidelines for Ireland.

As such, the following approach was adopted (also see Figure 1.2):

- A thorough review of the outcomes of the existing audits was conducted and used to provide initial insights as well as highlight any information gaps.
- A questionnaire was subsequently designed to provide information that would augment the audits, clarify key aspects, and provide any missing information with respect to both the scale of erosion and the policy and practice associated with erosion management.
- A list of staff members with responsibility for erosion management in the 19 target local authorities was produced and the individuals identified were invited to complete the questionnaire during dedicated telephone interviews.
- A review of County and Local Development Plans was conducted to determine the approaches, and policies being developed, with respect to coastal management.
- An assessment of international best practice in erosion management.

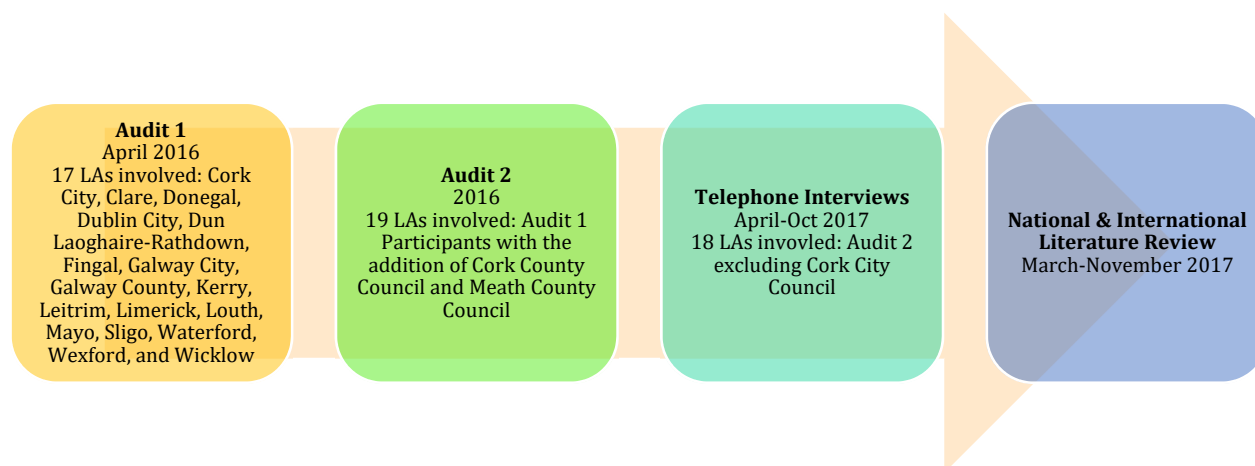


Figure 1-2 Research Process Timeline, including initial audits, telephone interviews, and national and international literature review.

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These outputs, in conjunction with other relevant background was subsequently utilised to:

- Produce a map of the coastal geological features and potential for erosion using a Geographic Information System (GIS).
- Tabulate findings and produce requisite maps (GIS layers) to highlight the historical and perceived risk to property (residences), infrastructure (roads), and waste infrastructure (land-fills).
- Compare and contrast the methodologies used to assess risk at local authority level.
- Provide an overview and analysis of current and future policies in County Development Plans with respect to erosion management.
- Determine which counties have an erosion management monitoring programme in place and their approach to monitoring.
- Assess if, and to what extent scientific information / expert opinion is being utilised in erosion management.
- Determine the practices and policies that apply to the protection of private and public property with specific reference to local authority enforcement of unapproved schemes.
- Quantify the number and type of protection schemes undertaken in recent years and the mechanism under which these were funded and, where implemented in Conservation Areas, any additional considerations / conditions put in place.
- Suggest practice and policy objectives for inclusion in any future local or national erosion management plans and indicate which agencies / stakeholders should be involved in their development.

Full details of the approaches adopted and the resulting outputs are contained in Sections 2 – 7 with final recommendations presented in Section 8.

## 2 Coastal Erosion in Ireland

Before a coherent national policy on coastal erosion can be developed, it is necessary to understand the scale of the potential coastal erosion problem in Ireland. As such, a key objective of this research was to determine what coastal areas are perceived as at risk of coastal erosion.

Coastal geographical features/areas of specific interest included: (1) coastal areas comprised of material most affected by coastal erosion (*e.g.* soft coasts, limestone, etc.), (2) public and private properties, (3) roads, (4) coastal conservation areas, and (5) current and historic coastal landfill sites.

Information about these features/areas in Ireland was gathered from three general sources:

- Initial audit and telephone interviews with LAs
- Relevant national agencies (NPWS, EPA, RWO, and GSI)
- EU-funded EUROSION project (Doody, et al., 2004)

Geographical information, where available, was collated in a GIS database and included the following information:

- Geological typology (with classes ranked according to relative resistance to weathering),
- Properties and roads at risk of erosion, as reported by LAs,
- Coastal conservation areas, and
- Current and historic coastal landfill sites<sup>1</sup>.

A WebGIS was also set up to facilitate non-specialist access to the information contained in the GIS database (see Appendix I).

Note that all areas mentioned as “at risk of coastal erosion” are based on the perception and interpretation of LA representatives. In order for a comparable study to take place, future studies would require a shared definition of “risk” as well as a uniform methodology to assess “risk”.

### 2.1 Geological formations most affected by coastal erosion

As part of the initial audit, coastal LAs were asked to specify what geological formations are most affected by coastal erosion, specifically where buildings or infrastructure are at risk. Figure 2-1 provides an overview of the responses. The geological type reported to be most at risk was soft boulder clay cliffs, followed by a combination that may include two or more geological formations, including beach and dune systems, rocky cliffs, and soft boulder clay cliffs, and/or alluvial sands

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<sup>1</sup> Conservation areas and landfills within a 300 m buffer zone of the coast were considered to be “coastal”. Areas outside this buffer zone were therefore excluded from this database. 300 m is 1.5 times the maximum limit required for planning permission on an eroding shoreline.

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and gravels (an issue particular to Kerry County Council). Telephone interviews further revealed information about particular sites affected by erosion. For example, erosion of soft boulder clay cliffs is a problem at Fethard, Co. Wexford (Figure 2-2) and on the southern shore of Inishbofin, Co. Galway (Figure 2-3) and erosion of beach and dunes systems is an issue at Enniscrone, Co. Sligo (Figure 2-4) and Portrane, Fingal (Figure 2-5).

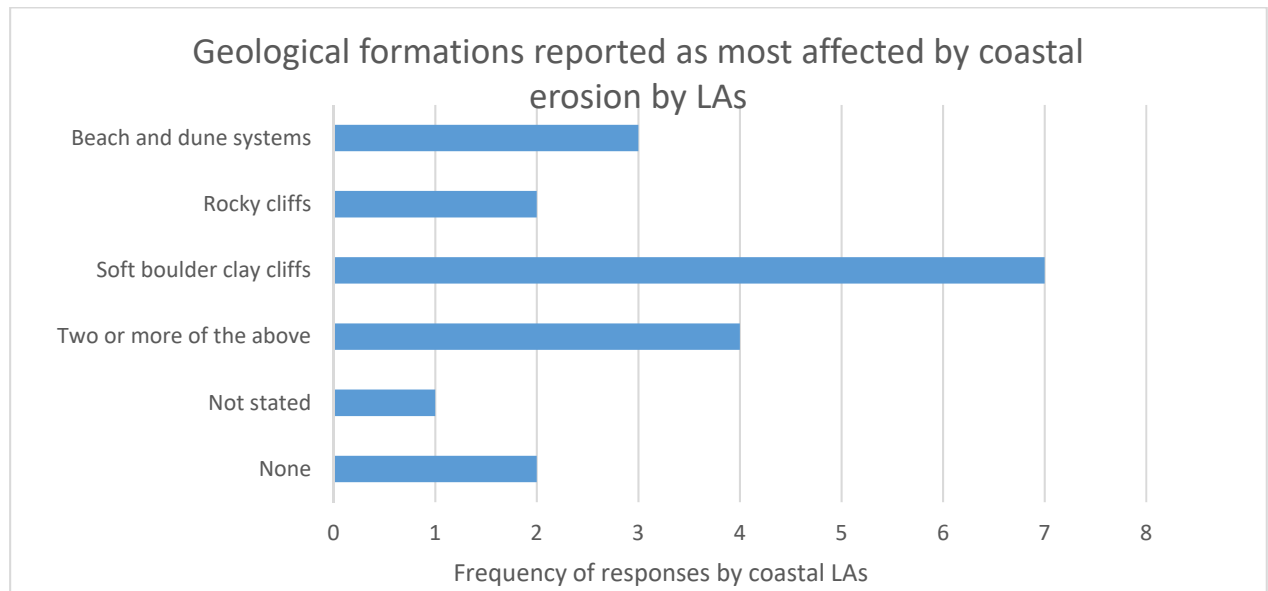


Figure 2-1 Overview of geological formations reported by LAs as the most affected by coastal erosion

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Figure 2-2 Soft cliff erosion at Fethard, Co. Wexford. Extracted from RPS (2011)



Figure 2-3 Shear eroded cliff face on the south coast of Inishbofin, Co. Galway. Extracted from RPS (2014)



Figure 2-4 Sand dunes at Enniscrone, Co. Sligo protect local amenities and a Caravan Park. Photo: Sarah Kandrot



Figure 2-5 Sandbags put in place at Portrane by local residents to slow down erosion. Photo: Hans Visser

To help coastal LAs better understand the spatial distribution of coastal geologic formations, a coastal geologic classification map has been produced for this study using digital information about coastal types (hard rock, sand, gravel, mud, protected, etc.) derived from the EUROSION project (Doody, et al., 2004). More detailed information about the hard rock geology of rocky coasts was obtained from the GSI's 1:100,000 bedrock geology GIS dataset. The two datasets were reclassified based on an adaptation of the coastal geologic classification of Gornitz et al. (1997) for the Irish coast. Within this classification, there are 5 major groups and 16 subgroups (see Table 2-1). The key discriminant between classes is the relative resistance of each rock type to chemical and physical weathering.



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Material description	Subgroup
I. Old Erosion Resistant Rocks (crystallines)	
	1. Igneous, volcanic (basalt, rhyolite, andesite, etc.)
	2. Igneous plutonic (granite, granodiorite, etc.)
	3. Metamorphic (schists, gneisses, quartzite, serpentinite, etc.)
II. Sedimentary Rocks	
	1. Shale
	2. Siltstone
	3. Sandstone
	4. Conglomerate
	5. Limestone
	6. Mixed or varied lithology (sedimentary rocks)
III. Unconsolidated Sediments	
	1. Unconsolidated Sediments - Type unknown
	2. Mud, Clay
	3. Sand
	4. Gravel, conglomerates
	5. Mixed or varied lithology (unconsolidated sediments)
IV. Recent Volcanic Materials	
	1. Lava
	2. Composite
V. Protected, harbour area, or artificial shoreline	

*Table 2-1 Coastal geologic classification used to produce coastal geologic types maps. The key discriminant between individual classes is the relative resistance of each rock type to physical and chemical weathering and is based on work published by Gornitz et al. (1997).*

Figure 2-6 shows the national coastal geologic typology map. Given the detailed nature of the dataset, the layer (called “Geologic types”) is perhaps best viewed in the Web Mapping Application, where features can be viewed and queried at all scales to determine geologic typology (see appendix I). At least forty percent of the Republic of Ireland’s coastline is made up of unconsolidated sediments. The rest is made up of old erosion resistant rocks (9.5%), sedimentary rocks (14.5%), and recent volcanic materials (<1%) or is protected or artificial (1.5%) or was not classified (33.5%).

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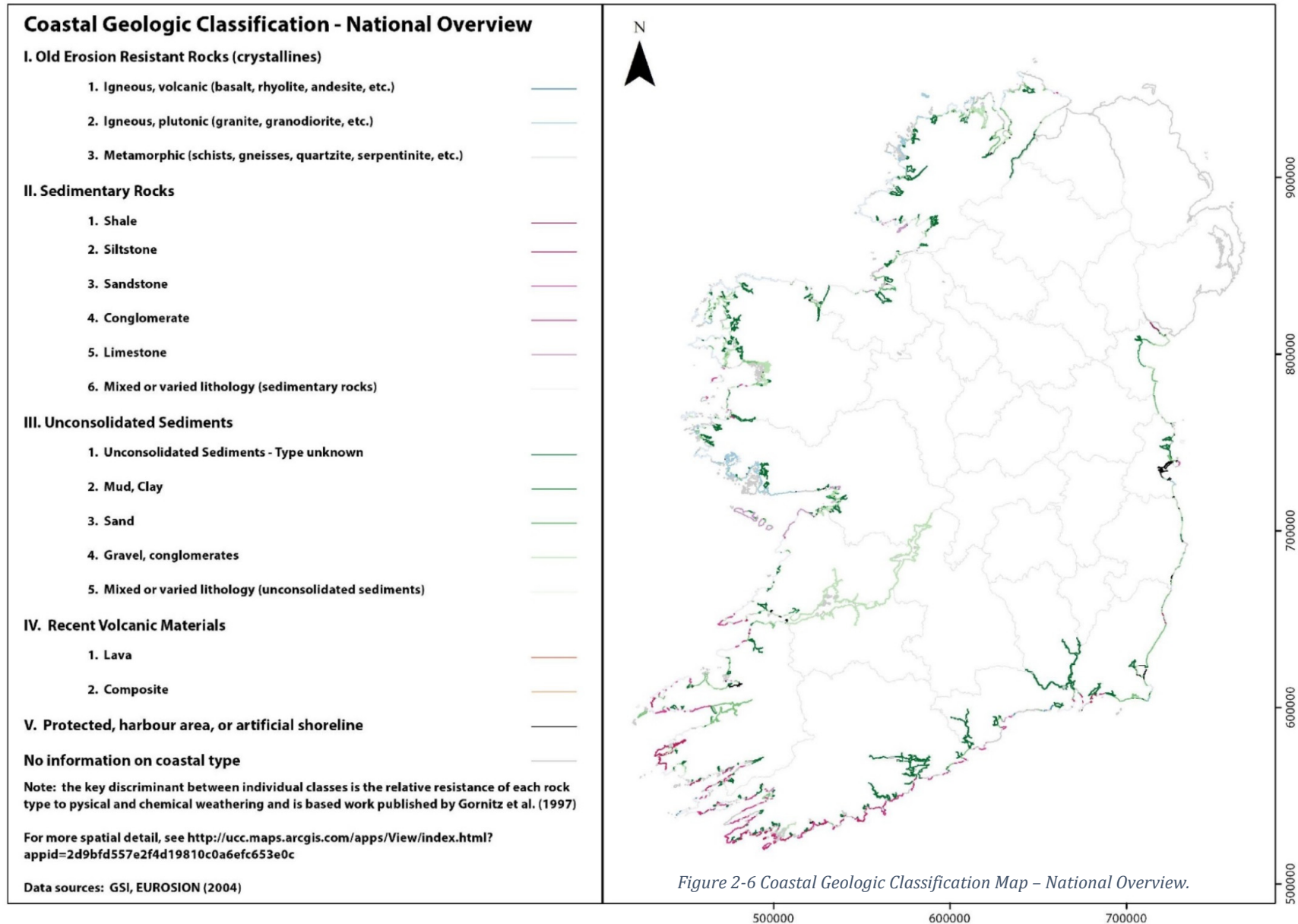


Figure 2-6 Coastal Geologic Classification Map – National Overview.

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### **2.2 Properties and Infrastructure at Risk**

In the initial audit, coastal LAs were asked about properties and roads at risk of coastal erosion in the medium term (the next 15 years). More information about these properties and roads was obtained during the telephone interviews – specifically, where at-risk properties and/or roads were located, if the properties were publicly or privately owned, and if their assessment of risk was estimated or based on a study. These responses were combined and subsequently mapped.

Results from the initial audit indicate that LA representatives perceived a total of 401 private residences to be at risk nationally (See table 2.2). Twelve LAs reported that they perceived one or more private residence as at risk of coastal erosion in their county, with three of those reporting that there were more than 100. Seven LAs reported that they perceived one or more public building(s) as at risk. Despite this, 37% (7/19) of coastal LAs reported that there is land zoned for housing, commercial or industrial use in areas of contemporary coastal erosion.

Thirteen LAs provided geographical information about sites they believed to be at risk of coastal erosion following on from the telephone interviews. A total of 130 locations were identified and integrated into the GIS database. Four LAs provided information based on published erosion risk management studies, reports or surveys. Table 2-2 provides a summary of information obtained from LAs with respect to their perception of properties at risk of erosion.

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Local Authority	Number of properties/ buildings reportedly at risk	Estimated or based on a study?	Notes
Clare County Council	18	Estimated	Several properties at Quilty and Cloghaninchy
Cork City Council	0	n/a	
Cork County Council	Not known	Estimated	Ballybranningan, Union Hall, Allihies mentioned in telephone interview
Donegal County Council	No information provided		
Dublin City Council	0	Estimated	In initial audit and telephone interview, it was reported that no properties were at risk of erosion in Dublin City
Dun Laoghaire Rathdown County Council	0	Estimated	In initial audit, it was reported that no properties were at risk of erosion in Dun Laoghaire Rathdown
Fingal County Council	2-13	Estimated and Study	The Coastal Erosion Risk Management Study Portrane – Rush (RPS, 2013) suggests 1 private property and possibly another 13 (depending on levels of erosion), as well as 1 public building (public toilets at Portrane) are at risk
Galway City Council	0-4	Estimated	Two sites (Drumlins at Knonagoneen and Gentian Hill) identified from Sailin to Silverstrand Coastal Protection Scheme and two others (Mutton Island causeway and rock armour in Salthill) mentioned in telephone interview; location of rock armour was not clear, so not included in GIS database
Galway County Council	263	Estimated	Response to initial audit was that "10% of the 2616 properties situ within 100 m of coast =261" (also 2 public properties reported to be at risk)
Kerry County Council	3	Estimated	Ballyheigue, Scraggane Bay, and Banna
Leitrim County Council	1	Estimated	Tynte Lodge only

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Limerick City and County Council	4	Estimated	Response to initial audit was "3 houses, one public building"
Louth County Council	239	Estimated and Study	At risk areas have been identified in the following Studies: 1. Irish Coastal Protection Strategy Study 2. Louth Coastal Erosion Study (2016) 3. Bellurgan Embankment Survey and Assessment
Mayo County Council	Not known	n/a	
Meath County Council	31	Estimated	Properties at Laytown
Sligo County Council	21	Estimated	GIS officer sent digital data on all properties at risk of coastal erosion in the county (estimated). Key sites include Strandhill, Rosses Point, and Ballast Quay.
Waterford City and County Council	60	Estimated and Study	Property locations obtained from Waterford city and county Council Coastal Infrastructure Survey and assessment Report (Malachy Walsh, 2015)
Wexford County Council	151	Estimated and Study	Strategic Review of Coastal Erosion in County Wexford
Wicklow County Council	26	Estimated	Place names reported in telephone interview: North Beach, Arklow, North of Wicklow town**, Ennereilly beach, Brittas Bay, Newcastle, Kilcoole

Table 2-2 Summary of information obtained from LAs about properties at risk of coastal erosion in the medium term.

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It is significant to note that the methods by which individual coastal LAs quantified properties at risk differed dramatically. For example, County Galway took a methodical approach. They used GIS to count the number of buildings within 100 m of the coast and estimated that 10% of those buildings are likely to be at risk of erosion. On the other hand, the majority of LAs estimated the figure based on their personal knowledge of the area. If the same methodology used by Co. Galway were applied to Co. Kerry (who reported 3 properties to be at risk), the resulting number of buildings would be approximately 360<sup>2</sup>.

The Irish Coastal Protection Strategy Study (ICPSS) presents another approach to assessing potential coastal erosion risk with varying results again (see Figure 2-7). This highlights the need for a common definition of “risk” as well as the need to apply a uniform methodology by all coastal LAs when quantifying risk.

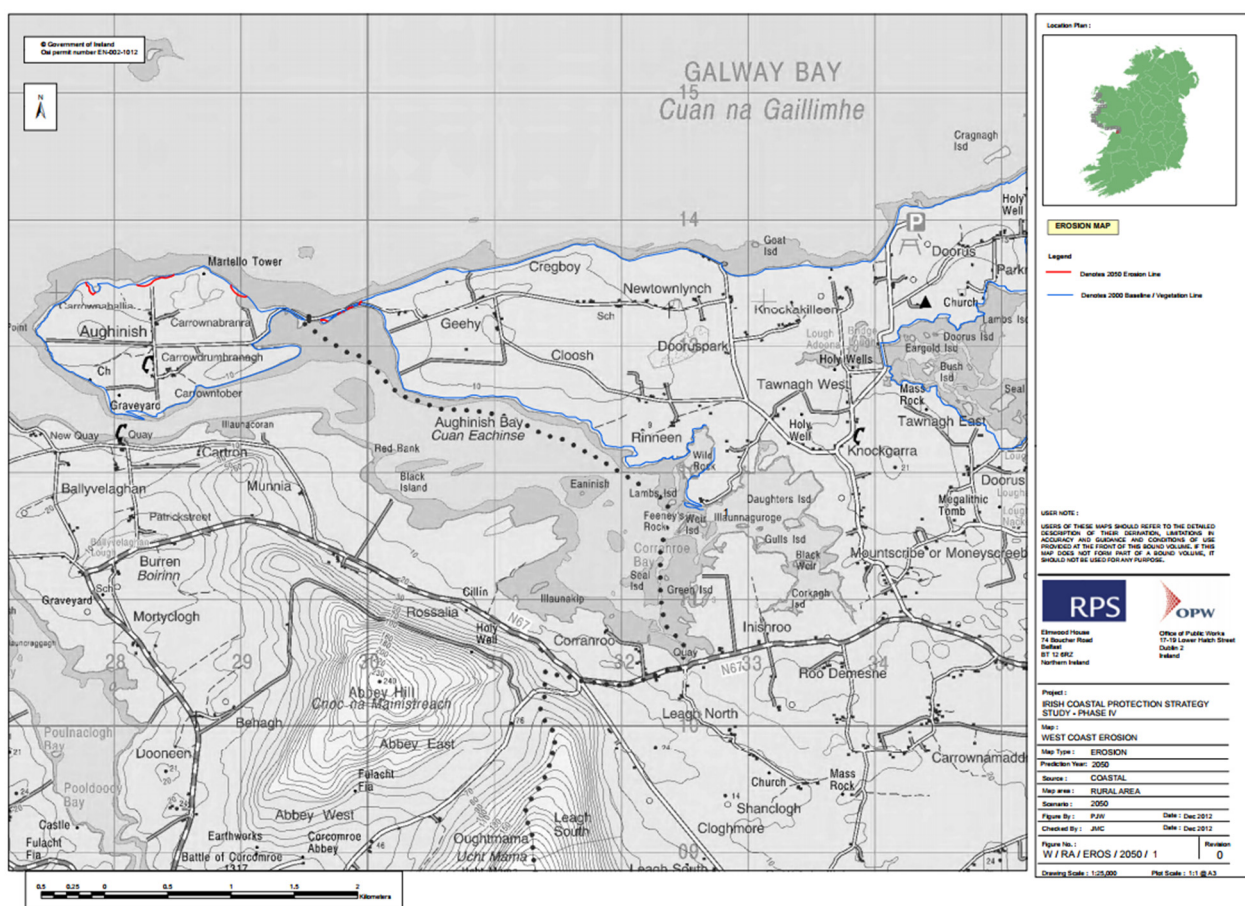


Figure 2-7 ICPSS report findings for Galway bay demonstrating the predicted movement of the coastline by 2050

<sup>2</sup> Calculated by counting the number of non-vacant buildings obtained from An Post Geodirectory data with 100 m of the coast for Co. Kerry (3,601) and taking 10% of that figure.

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A national map illustrating property LAs perceived as at risk of coastal erosion in the medium-term is shown in Figure 2-8. Detailed information about the individual features is accessible through the WebApp (see Appendix I).

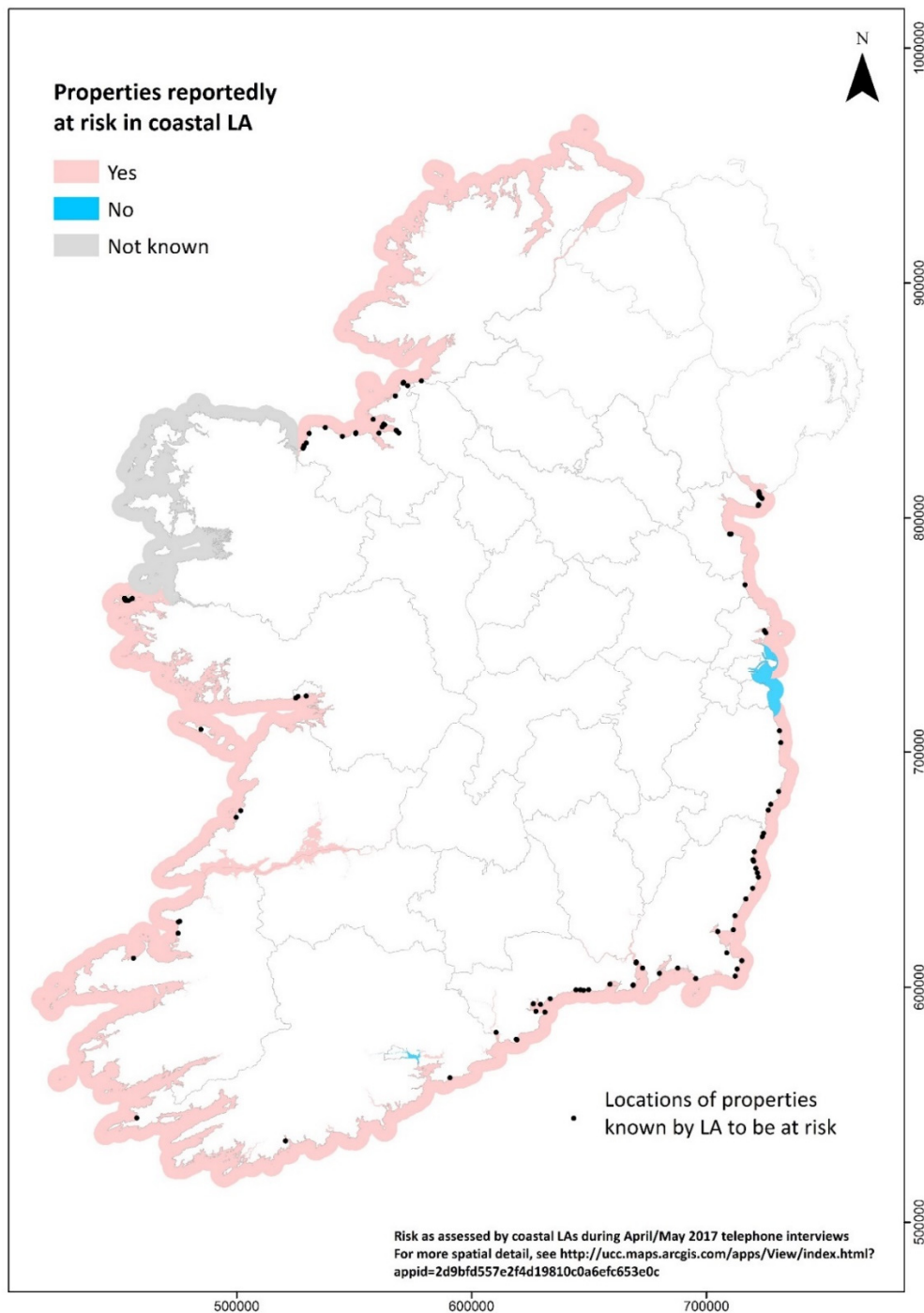


Figure 2-8 Properties perceived by LAs to be at risk of coastal erosion in the medium term

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Eleven coastal LAs reported roads at risk of erosion in their county (Table 2-3), with total lengths by county ranging from 1 km to 154km. Galway estimated that a percentage (not specified in this instance) of the total length of roads within 100 m of the coast would be affected by coastal erosion whereas Cork, for example, based their estimate on the length of road *and* its proximity to shorelines, identifying as eroding in the ICPSS. This reiterates the need for a common definition of erosion risk and a uniform approach to assessing the extend of any risk

Local Authority	Number of kms reportedly at risk	Estimated or based on a study?	Notes
Clare County Council	10	Estimated	Roads in Loop head/Loop peninsula and roads in Clahane (North of Liscannor) reported to be at risk, but not enough information to integrate into GIS database
Cork City Council	0	n/a	
Cork County Council	78.25	Estimated	Road lengths were estimated based on proximity to shorelines projected to erode in next 30/50 years, as reported in Irish Coastal Protection Strategy Study Phase 3 – South Coast Erosion Maps
Donegal County Council	No information		
Dublin City Council	0	n/a	In initial audit and telephone interview, it was reported that no roads were at risk of erosion in Dublin City
Dun Laoghaire Rathdown County Council	0	n/a	In initial audit, it was reported that no roads were at risk of erosion in Dun Laoghaire Rathdown
Fingal County Council	0	n/a	In initial audit, it was reported that no roads were at risk of erosion in Fingal
Galway City Council	0	n/a	In initial audit, it was reported that no roads were at risk of erosion in Galway City
Galway County Council	154	Estimated	Response to initial audit was that "154km within 100 m of coastline"
Kerry County Council	16	Estimated	Road lengths were estimated based on proximity to shorelines projected to erode in next 30/50 years, as reported in Irish Coastal Protection Strategy Study Phase 4 – South West Coast Erosion Maps; five key areas identified: <ol style="list-style-type: none"> <li>1 Waterville to Ballinskelligs,</li> <li>2 Rossbeigh to Cromane,</li> <li>3 Fermoyle to Tonakilly (Maharees, Magherabeg, Scraggane)),</li> <li>4 Ballyheigue to Banna, and</li> <li>5 Ballybunion.</li> </ol>
Leitrim County Council	0	n/a	In initial audit, it was reported that no roads were at risk of erosion in Leitrim



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Limerick City and County Council	10	Estimated	Road lengths obtained from report from Adare-Rathkeale Roads Assistant Engineer (Flanagan, 2016)
Louth County Council	9.5	Study	
Mayo County Council	Not known	n/a	
Meath County Council	1	Estimated	
Sligo County Council	10.2	Estimated	GIS officer sent digital data on all roads at risk of coastal erosion in the county (estimated based on personal experience)
Waterford City and County Council	10	Study	Infrastructure report doesn't contain information on this
Wexford County Council	4.57	Study	
Wicklow County Council	2	Estimated	Road at Ennereilly beach between Arklow and Bray reported in telephone interview

*Table 2-3 Summary of information obtained from LAs about roads at risk of coastal erosion in the medium term.*

Three coastal LAs provided specific geographical information about the locations of roads at risk but these were not determined using any acknowledged erosion risk studies. A composite national map of LAs who have indicated that their roads are at risk of coastal erosion in the medium-term is shown in Figure 2-9 which also includes specific sections of road identified as being at risk by the LAs.

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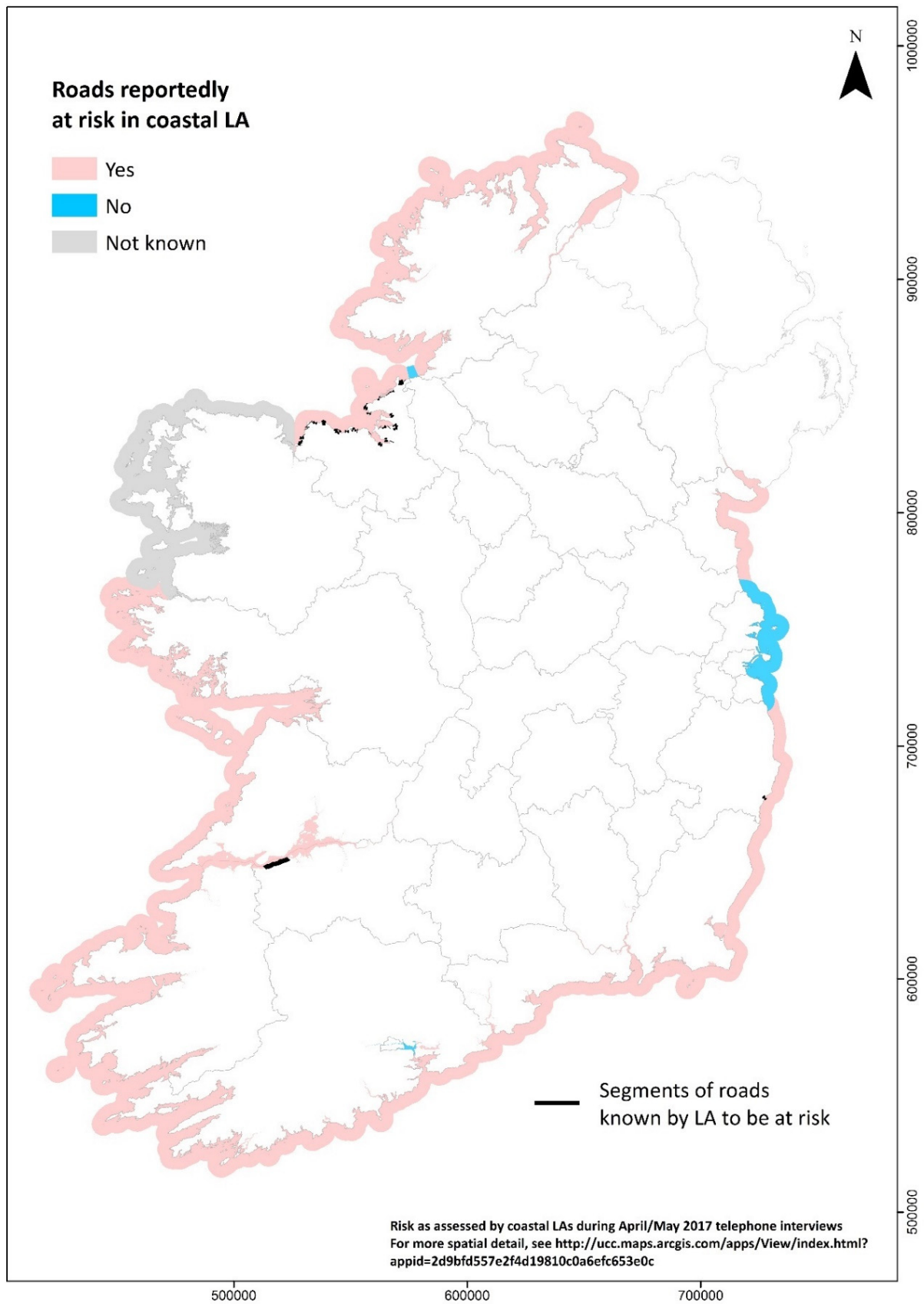


Figure 2-9 Roads perceived by LAs to be at risk of coastal erosion in the medium term

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### 2.3 Properties Lost in the Last Decade

In the initial audit, only three LAs reported the impact on property as a result of coastal erosion in the last ten years (either lost, destroyed, or rendered unusable-, namely Wicklow, Clare and Wexford (Table 2-4).

County	Properties LAs reported Lost in the Last Decade
Clare	A house in Clare almost became undermined in 2014 due to erosion of the coastline at the rear of the property. The house was unoccupied at the time, however Clare County Council carried out some temporary restorations of protection and no claims were made against the LA.
Wexford	Coastal erosion following storms caused five houses to be undermined and fall into the sea in Wexford. In the past some landowners have allowed their houses to fall into the sea, whereas others have constructed coastal protection works (both authorised and unauthorised). Wexford County Council commissioned a report for the whole Wexford coastline determining erosion rates; however, some areas predicted levels have been surpassed. The council demolished and removed properties falling into the sea; the LA stated the public understood the reasons for this and no claims were made against the LA for not protecting the private property.
Wicklow	A derelict house was lost to sea at Arklow, Wicklow; it is believed it may have been possible to refurbish however this was abandoned partly due to the proximity to the sea. The landowner abandoned the house in response to the erosion. Wicklow County Council did not provide assistance, and no claims were made against the LA for not protecting the private property.

Table 2-4 Private property affected by coastal erosion in the last ten years, reported by LAs.

### 2.4 Proposed Standardised Approach to Establishing Coastal Erosion Risk

Potential methodologies for assessing coastal erosion risk in Ireland were identified and assessed based on a combination of information received from LAs and international best practice.

It is evident from the results that the majority of coastal erosion risk reported by LAs is estimated. These estimates are often based on historical behaviour, e.g. if maps/photos show that there is evidence of past erosion, it is assumed that this behaviour will continue. Results suggest LAs perceive risk as low if there is not a history of erosion. Where there is no history of erosion, LAs tend to assess future risk (in response to, for example, sea-level rise) based on coastal type, e.g. a non-eroding soft coastline would have a higher risk than a non-eroding hard coastline.

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Interviews revealed there is no single approach to assessing erosion risk. LAs tend to employ consultants to perform these assessments, with methodologies ranging from using historical trends through to complex numerical modelling procedures. As each LA uses different methodologies, it is difficult to compare erosion risk nationally, meaning it is challenging for funding agencies to tackle problematic areas. To address this issue, three standardised approaches to assess national risk are proposed below and described in subsequent sections:

- A modified traditional approach
- A basic GIS approach
- A spatial multiple criteria analysis approach

### 2.4.1 Traditional approach

The traditional approach to assessing erosion risk taken by coastal LAs involves using data from maps, aerial/satellite imagery, field monitoring procedures, and/or numerical modelling studies to assess erosion risk. Risk is assessed in terms of:

- Human health and life (social),
- The environment,
- Cultural heritage,
- Economic activity, and
- Infrastructure (RPS, 2013)

The following methods represent current best practice methods supporting the traditional approach to assessing erosion risk.

#### Historical shoreline change

Coastal LAs can assess historical shoreline change using historic maps, photographs, and aerial and satellite imagery. Changes in shoreline position can either be measured manually or within a GIS by overlaying different layers on top of one another. A commonly used tool for assessing shoreline change using GIS is the digital shoreline analysis system (DSAS), developed by the US Geological Survey (Thieler, et al., 2009). With this approach, shorelines are surveyed in the field or digitised from maps and/or aerial imagery and rates of change can be calculated at specified intervals along the length of the shoreline. This allows local authorities to identify “erosion hotspots”.

#### Numerical modelling

Numerical modelling can be used to project erosion risk in the future (e.g. ICPSS). Two- and three-dimensional hydrodynamic, morphological, and sediment transport models can be used to model future shoreline positions with respect to properties and infrastructure. This method, however, is dependent on data availability and access to expertise.

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### Issues with this approach

A lack of baseline information on erosion risk factors from monitoring procedures limits the effectiveness of the traditional approach. Information from the telephone interviews with coastal LAs further revealed that currently (1) no uniform means of monitoring coastal erosion exists and (2) Ireland lack an official method of recording areas known to be at risk of erosion, which is a barrier to future knowledge transfer.

The traditional approach can be employed to assess erosion risk, but LAs would have to collaborate to make it *consistent* nationwide – e.g. identifying and measuring *specified* risk factors, such as historic rates of erosion, potential future rates of erosion, potential risk to conservation areas, properties, infrastructure, etc.

Often, the traditional approach is performed locally to deal with specific problem areas. At the national scale, risk assessment is more challenging in terms of data acquisition and presentation of results noting that the following approaches can help to address these issues.

### 2.4.2 A basic GIS Approach

The usage of geographical information systems to support coastal zone management is on the rise (Rumson, et al., 2017). In the US, for example, the National Oceanic and Atmospheric Administration have developed Digital Coast (<https://coast.noaa.gov/digitalcoast/>), a web-based resource for helping communities address coastal issues (NOAA, 2016). Data is made freely-available for coastal managers with (or without) GIS expertise to use at their convenience. Tools and training are also provided. A plethora of recommendations and methodologies within the coastal literature support the implementation of GIS within coastal zone management (Rumson, et al., 2017; Fraser, et al., 2017; NOAA, 2012).

It is evident from the telephone interviews that the majority of LAs (ten) have access to GIS expertise. Such expertise can aid in the proper storage of LA information relating to coastal erosion risk, and help assess risk to properties, roads and landfills.

A basic GIS approach to assessing the number of properties, lengths of roads, and landfills or other features potentially at risk of coastal erosion is to create a buffer of specified width around the coast and to “clip” these, such that only the properties, buildings, landfills and/or roads are contained within the buffer zone are extracted. For example, Figure 2-10 shows all buildings that fall within 100 m of the coast for Co. Kerry. The buildings data can be obtained from the Ordnance Survey Ireland’s PRIME2 and An Post’s Geodirectory Datasets (OSI, 2013; An Post, 2016). Information about the total number of buildings in this zone can be calculated within most GIS software, and the data can be further separated by type (commercial, residential, vacant, etc.).

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Similarly, Figure 2-11 shows all roads that fall within 100 m of the coast for Co. Kerry. As before, the total lengths can be easily calculated using GIS software, and the data can be further categorised by type (national primary road, national secondary road, third/fourth class roads, etc.).

Not all coastal areas are eroding (Villes & Spencer, 1995) and this must be factored into any determination. It is, however, possible to use data from, for example the EUROSION project (or the Irish Coastal Protection Strategy Study), to identify stretches of coast that are known to be eroding and create a buffer around these areas to extract information pertaining to them exclusively. Figure 2-12 shows the coastal areas classed as “eroding” from the EUROSION project. It is possible to create buffers around areas only classed as “eroding” and extract information about properties and roads at risk in the vicinity those areas only. Figure 2-13 and Figure 2-14 show examples of this approach for buildings and roads.

Information from the EUROSION project could be incorporated into a national assessment but it should be noted that the reliability of the data is limited. Firstly, the data is very broad in scale (accurate to 1:100,000) and secondly, the project was completed in 2004 and despite significant advances in technology, has not been updated since. More recently, strategic coastal erosion maps for the national coastline have been generated as part of the Irish Coastal Protection Strategy Study, which was commissioned by the OPW in 2003 and completed by RPS in 2013. The maps were generated using aerial photographic records of the coastline from 1973-75, 2000 and 2006. The coastlines, defined as the seaward limit of vegetation, were digitised from each photographic series, and a GIS system was used to compare these and establish the extent of coastal change over the intervening time period. From this information, an annualised rate of erosion was derived and used to project where the coastline could potentially retreat to by 2030 and 2050. It should be noted that the study assumes the rate of retreat will remain constant. It may be prudent for coastal local authorities to build on these datasets such that they can be most useful for future erosion management activities.

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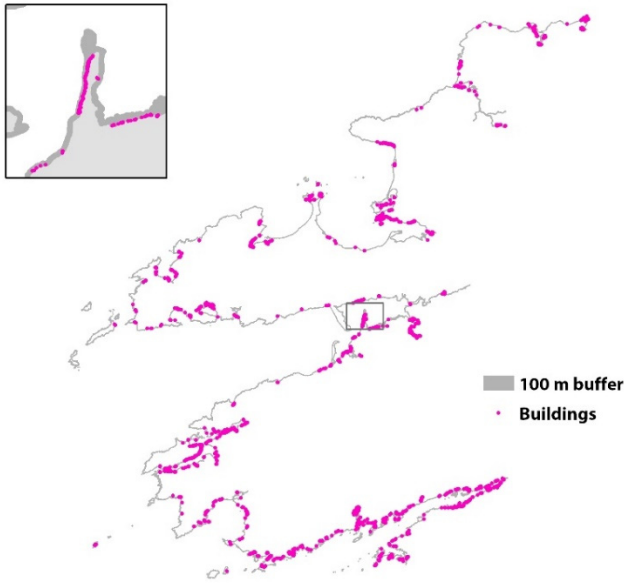


Figure 2-10 Buildings within a 100 m buffer zone along the coast of county Kerry. The inset shows more detail for the area around Cromane.

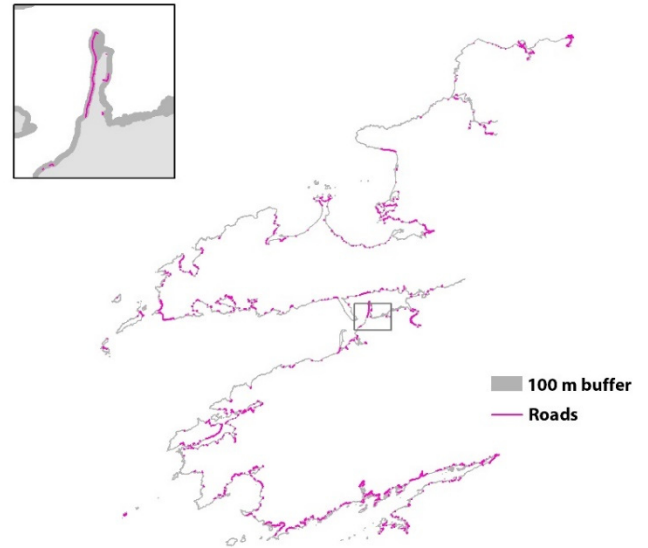


Figure 2-11 Roads within a 100 m buffer zone along the coast of county Kerry. The inset shows more detail for the area around Cromane.

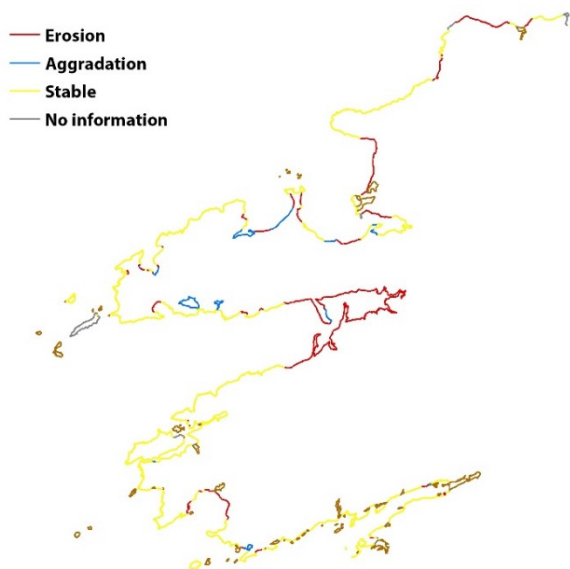


Figure 2-12 Classification of coastal areas from the EUROSION project for County Kerry.

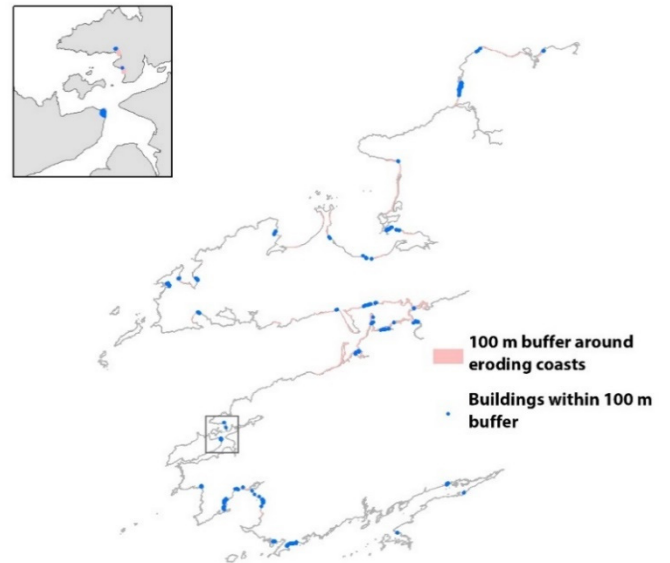


Figure 2-13 Buildings within a 100 m buffer zone of eroding coastline in county Kerry. The inset shows more detail for the area around Knightstown.

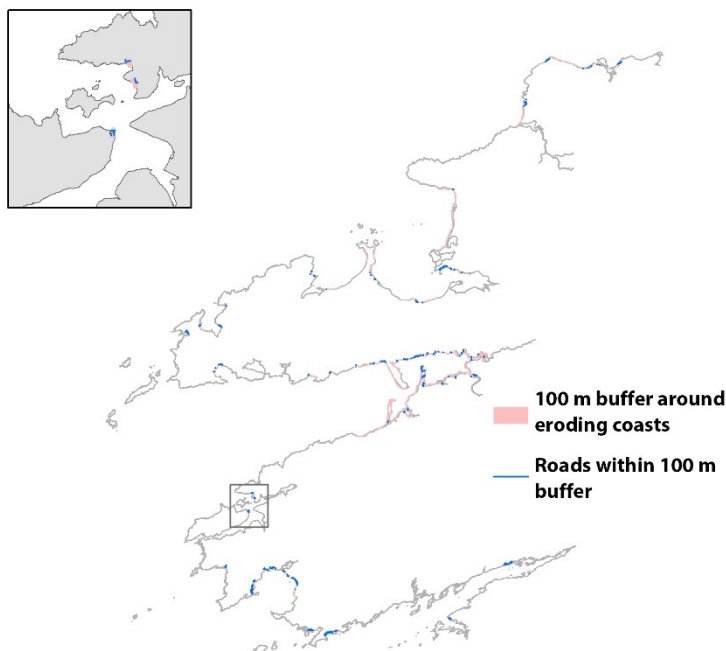


Figure 2-14 Roads within a 100 m buffer zone of eroding coastline in county Kerry. The inset shows more detail for the area around Knightstown.

### Barriers to use of GIS

A limiting factor with this approach is a lack of capacity or access to expertise. While the majority of LAs have access to GIS expertise, some may not or their remit may not extend to coastal erosion. Several LAs indicated that during the recent economic downturn, many GIS officers were made redundant but that the recent economic recovery has led to the creation of new mapping positions – as such, capacity should not be an issue in the future.

With respect to the methodology as outlined above, it should be emphasised again that the scale (1: 100,000) and age of the EUROSION dataset are limiting factors with regard to its usage. While this information may be useful for erosion management at a national scale, more detailed data are required for management at the local level.

### 2.4.3 Spatial multiple criteria approach

A basic GIS approach can help to identify properties and roads at risk of erosion, yet some coastal areas are higher risk than others are. In this case, a spatial multiple criteria approach (MCA) can help to identify and prioritise high-risk areas. MCA is a technique for evaluating various alternative scenarios based on multiple and conflicting criteria and objectives (Carver, 1991). In a geographical context, it is often used for GIS applications such as site suitability analysis, flood risk evaluation, or landslide vulnerability (Michael & Samanta, 2016; Wang, et al., 2011).

Granja *et al.* (2014) developed a methodology using spatial MCA to assess coastal erosion risk in Portugal; this could be adapted to the Irish coast. The methodology uses morphological, hydrodynamic, and meteorological indicators as input layers. The specific parameters are grouped into two categories - susceptibility indicators or vulnerability indicators - and are



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assigned individual weightings according to their relative contribution to erosion risk. The parameters are then used to create susceptibility and vulnerability indices, which feed into a final mathematical description of erosion risk; the output of which is defined as the erosion risk index.

The weighted features can be overlain on top of one another using spatial analysis techniques and displayed according to their erosion risk index score. The data can then be mapped accordingly, allowing LAs to prioritise high-risk areas (e.g. see Fig 2.15). While the potential exists to use this information to make more informed management decisions, its usage by coastal LAs in practice is yet to be documented.

To implement spatial MCA, first, a national GIS database would be required with key data layers as follows:

- Coastal geologic type
- Elevation
- Slope
- Sediment budget
- Wave climate
- Historical erosion trends
- Modelled future erosion trends (e.g. from CFRAMS)

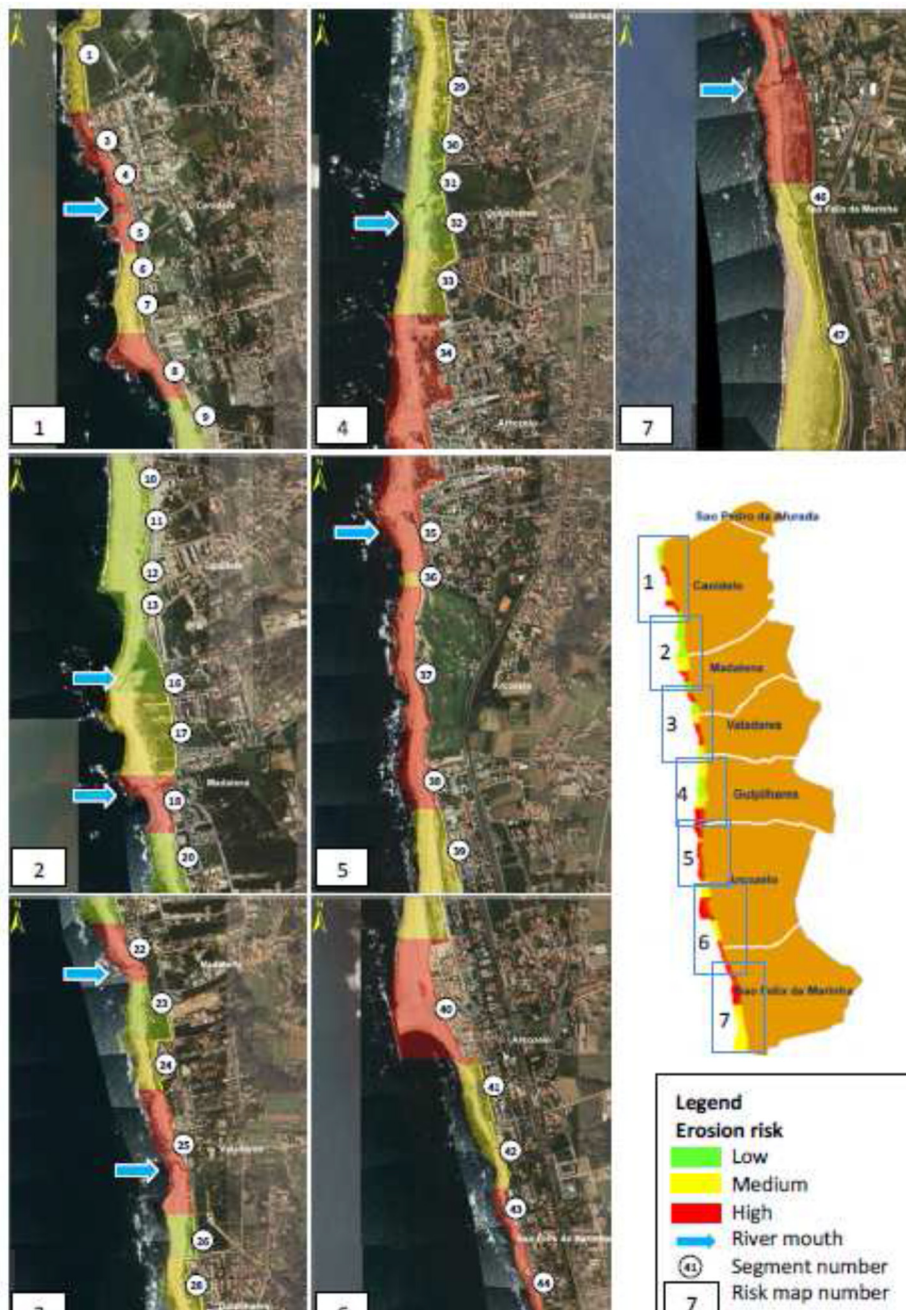


Figure 2-15 Erosion Risk Map for NW Portugal developed using spatial MCA. Extracted from Granja et al. (2014)

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- Roads
- Commercial/residential properties
- Population density
- Property values
- Landfill sites
- Conservation areas

The output of such an analysis would be an erosion risk map, similar to that of Granja *et al.* (2014). LAs and funding agencies could use the information to prioritise high-risk areas from a national perspective.

### Issues with this approach

A skilled GIS practitioner would be required to perform this analysis. A single practitioner, however, could carry out this analysis at a national scale, provided all the required data is available and local practitioners could use this as framework. Risk maps may need to be created on a regular basis (e.g. every 10 years) such that updates to the database could be integrated into the analysis.

As before, the quality of this analysis is only as good as the data that goes into it, much of which is presently unavailable according to the LAs.

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### 2.4.4 Limitations and Conclusions

Three approaches to assessing potential coastal erosion risk which can be implemented in Ireland have been proposed – a traditional approach, a basic GIS approach, and a spatial multiple criteria approach (assessing potential coastal erosion risk to buildings, infrastructure and landfills which can be implemented in Ireland). The proposed methodologies are not necessarily mutually exclusive – where data is lacking and it is not possible to, for example, perform a spatial MCA, it may be more practical to implement the traditional or basic GIS approach. The basic GIS and spatial MCA approaches require some in-house or external GIS expertise and capacity.

The erosion risk data obtained in this study can serve as a useful baseline for assessing present and future risk at a national scale and prioritising sites that may require intervention. This data may serve as useful input for a simple GIS analysis of erosion risk or a more complex spatial Multiple Criteria Analysis (MCA), whereby spatial variations in erosion risk could be quantitatively assessed.

While the development of this database is a start, there are some limitations and/or data gaps that should be acknowledged.

#### *Limitations of geologic typology data*

It should be cautioned that erosion risk cannot be deduced from the geologic maps alone (Penning-Rowsell, et al., 2014; Dawson, et al., 2009). This is because varying levels of susceptibility to erosion exist for each rock type depending on such factors as mineral content, cementation, grain size and the internal structure of the rock (Gornitz, et al., 1997)

In addition, there are some gaps in the EUROSION data where geologic type was unknown or may have changed since the report was published in 2004. This could be problematic if the data were to be used at a local scale. At the national and county levels, though, the data provide a good approximation of the scale of erosion in Ireland.

#### *Limitations of property and infrastructure risk data*

The majority of LAs did not have access to geographical information of properties and roads at risk of erosion in a form that could readily be integrated into a GIS database. For example, information in relation to roads at risk of erosion in County Kerry was excluded from the GIS database because road lengths were visually estimated based on proximity to eroding shorelines. In order for this information to be fully integrated, more specific information (e.g. grid references) would be required to determine what lengths of roads are at risk and their specific location.

In addition, LAs had varying approaches to characterising properties/roads considered at risk. For example, Galway County Council reported 10% of properties and road within 100 m of the coastline as at risk in the next 15 years. It is evident from the telephone interviews that this

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method is not based on first-hand knowledge and as such, is potentially an overrepresentation of erosion risk relative to “risk” as defined and identified by other counties. This reiterates the need for a clear definition of “risk”, and a limitation to developing a GIS erosion-risk database based on responses from LAs (as risk is perceived differently).

The results also highlight the issue of LAs adopting different procedures to report properties and infrastructure at risk. In the case of Waterford City and County, infrastructure, such as seawalls protecting roads, are grouped in with properties at risk within the GIS database because geographical information about the roads themselves (e.g. lengths affected) was not included within the Malachy Walsh (2015) report, from which the data was derived from.

Also, where digital (GIS) data was provided (e.g. for County Sligo), features were sometimes represented in different ways (some properties were represented as points and some as polygons or areas). This could pose a problem for future GIS analyses that require data to be represented consistently (either as points or as polygons).

The telephone interviews revealed that information about the location of properties and/or roads at risk is mostly estimated based on past or personal experience/knowledge, and there is no single formal repository for this information. This is exemplified by the fact that a majority of LAs provided no information on the locations of properties or roads at risk. A single databank containing information about erosion risk factors in the form of a GIS database, like the one created in this study, would be a useful resource for LAs. It should be maintained and regularly updated by a GIS expert. This would be especially useful for new staff, who may be unaware of all sites known to previous staff members. Such a database could also be used to systematically assess erosion risk to roads and properties.

The level of detail at which geographical information inputted into the GIS database was limited by the availability of digital data from the coastal LAs. In some cases, geographical information at the property/site level was available (e.g. Tynte Lodge, Co. Leitrim). In other cases, geographical information only at the place name level was available (e.g. Quilty, Co. Clare). Qualitative rather than quantitative information about these townlands means that it is not possible to quantify how many properties/sites are at risk nationally. This is also an issue for roads – e.g. it is not possible to translate descriptions, such as “roads in Loop Head”, into mapped information.

To conclude, a digital web-based GIS database has been set up to deliver information about the scale of the potential coastal erosion problem in Ireland. This is populated with information obtained from coastal LAs, relevant national agencies (NPWS, EPA, RWO, and GSI), and the EUROSION project (Doody, et al., 2004). While gaps in the data do exist, these can easily be

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addressed when data become available to help provide a more holistic view of national coastal erosion risk.

### 2.5 Landfills

A national coastal landfill map was created as per the tender, by integrating information obtained from the EPA, the RWO, and the telephone interviews (Figure 2-16). The map shows all waste sites reported by LAs within 300 m of the coast<sup>3</sup>. The sites are symbolised according to whether they are thought to be at risk of coastal erosion. Information about waste sites obtained from the telephone interviews is summarised in Appendix II.

Thirty-eight of the waste sites in the GIS database were coastal (within 300 m of the coast). Only six sites were reported as at risk of erosion by LAs– Tramore (Co. Waterford), Ringsend (Dublin City), Southpark (Galway City), Bray (Co. Wicklow), Rush and Skerries (both Fingal). Of those, one (Bray) was considered high risk, one (Southpark) was considered medium risk, one (Tramore) was considered medium/low risk, and level of risk was unspecified for Ringsend, Rush and Skerries.

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<sup>3</sup> Waste sites outside of this buffer zone were not considered to be at risk of erosion, and were therefore excluded from this analysis. 300 m is 1.5 x the maximum limit required for planning permission on an eroding shoreline.

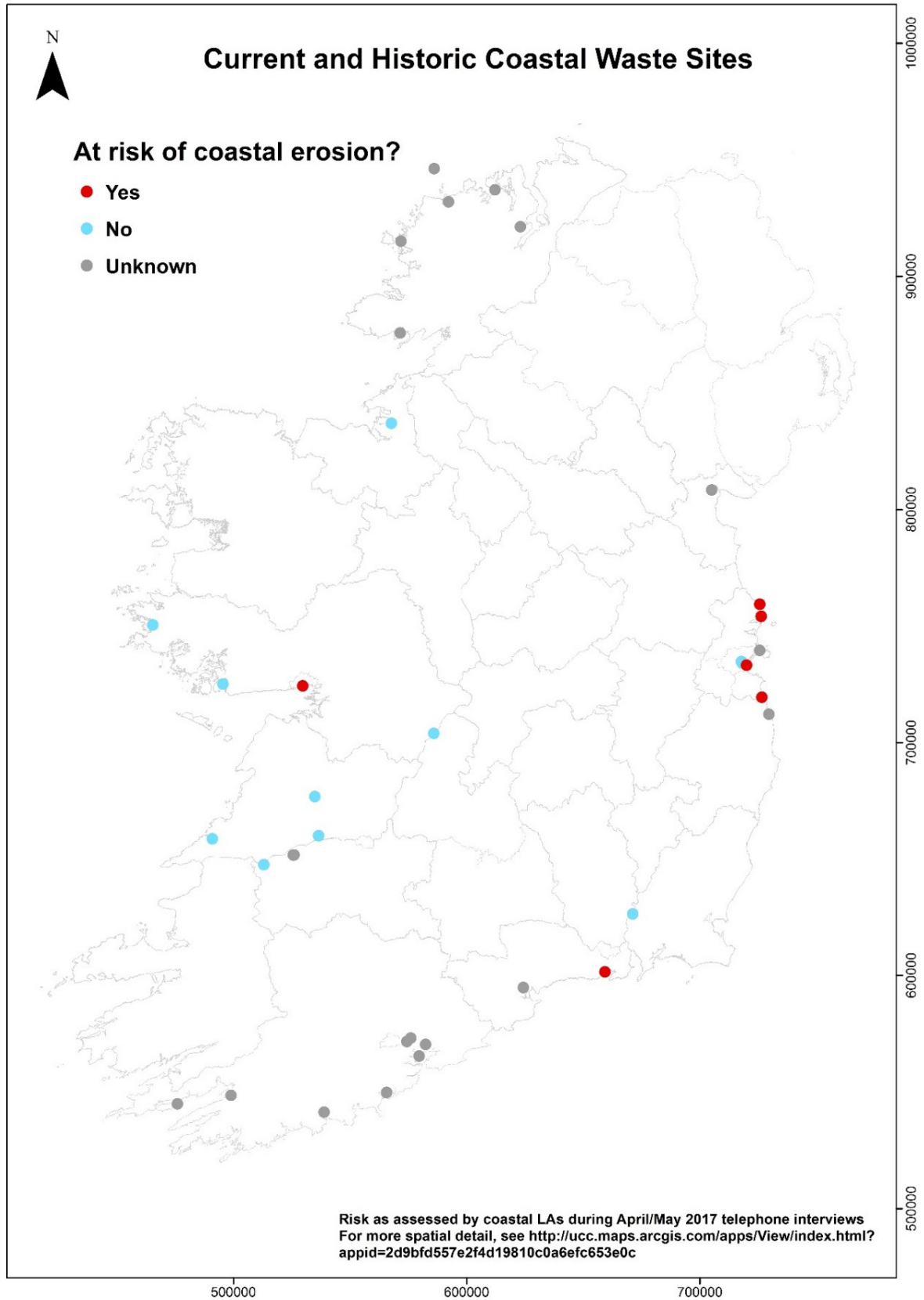


Figure 2-16 Current and historic coastal waste sites near the coast with corresponding erosion risk as indicated by LAs.

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### 2.5.1 Limitations of landfill data

Due to the lack of a single national database of coastal landfill data, agencies may have different information about landfill sites (and, sometimes, at different levels of geographic detail). In addition, some historic landfill sites recorded in a 1998 EPA report (EPA, 1998) were not listed by the WERLA. As they were not mapped, it was not clear if they were coastal (See Appendix II). Mapping of such sites was beyond the scope of this report; however, this is worth considering for future studies.

### 2.6 Key Recommendations

- The term “risk” must be defined in order for comparable baseline information to be gathered.
- A uniform methodology must be established for national management of coastal erosion – three potential approaches have been outlined.
- A single national databank on coastal erosion risk/damage, and coastal defences in place should be considered noting that in-house GIS expertise will be required for the effective implementation of any databases.
- A single database on coastal landfill sites, accessible to coastal LAs, is required.
- Need for guidelines on dealing with coastal erosion and private property, for instance responsibility to protect/dismantle properties, aimed at both LAs and private landowners.

### 3 Local Authority Policy on Coastal Erosion

This section considers the current status of national coastal erosion policy, in order to inform the development of recommendations to shape future national guidelines for coastal erosion management.

It is clear from this study and the literature, the approach to coastal protection around Ireland has been reactive rather than proactive (Murphy, 2017). The principal legislation relevant to coastal protection works consists of the Foreshore Acts, 1933-2014; the Planning and Development Acts, 2000-2017; the Harbours Acts, 1996-2015, and the Coast Protection Act, 1963 which addresses coastal erosion through instructing LAs to apply to the OPW for funding (See Table 3.1). Ireland’s approach to coastal protection involves selective investment in coastal protection schemes where justifiable on the grounds of: public safety, loss of public property, economic and environmental losses (Department of Communications, Marine and Natural Resources, 2004).

It was noted that ambiguities relating to local authority jurisdiction in the foreshore compound issues relating to erosion management and coastal management more broadly. Legally, local authority jurisdiction ends at mean high water mark. Part XV of the Planning and Development Act, 2000, attempted to address this situation by introducing a new definition of 'foreshore' comprising the 1933 definition but to include “land between the line of high water of ordinary or medium tides and land within the functional area of the planning authority concerned that adjoins the first-mentioned land”. This has been of limited utility in terms of erosion management. Aside from the legislation listed in Table 3-1, coastal protection works must also comply with legislation deriving from the EU, such as the Environmental Impact Assessment Directive and Habitats Directive (Appropriate Assessment).

Legislation	Relevant Information
Foreshore Acts, 1933-2014	<p>The Foreshore Act 1933 defines the foreshore as "the bed and shore, below the line of high water of ordinary or medium tides, of the sea and of every tidal river and tidal estuary and of every channel, creek and bay of the sea or of any such river or estuary". There was no outer limit prescribed in the original Act but this was later confirmed as being 12 nautical miles under section 60 of the Maritime Safety Act, 2005 and becoming section 1A of the Foreshore Act.</p> <p>The Foreshore Acts enable the Minister to grant foreshore leases and licences for specific purposes. A lease is generally required where development necessitates exclusive occupation of the foreshore and covers</p>



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	<p>activities such as bridges, piers and reclamation works. A licence is usually granted for development that does not require exclusive occupation of the foreshore and as such can cover certain coastal protection works.</p> <p>The Act also provides the Minister with authority to prohibit by order or notice the removal of beach material from the foreshore (sections 6 and 7). Section 13 of the Act relates to the deposit of any material on the foreshore or seashore, without the consent of the Minister or otherwise than in accordance with such consent.</p> <p>Section 9 of the 1933 Act deals with authorisation for sea defence works on the seashore and requires that anyone carrying out such works apply to the Minister for authority to do so.</p>
<p>State Property Act, 1954</p>	<p>The State Property Act, 1954 vests ownership of the foreshore in the Minister for Public Expenditure and Reform on behalf of the State. There is a legal presumption that the State owns all of Ireland’s foreshore unless it can be shown that it has been the subject of a grant of title or has been adversely possessed over time. The burden of proof of ownership rests on the claimant.</p> <p>According to settled case law, when the sea gradually and imperceptibly encroaches upon the adjoining land through the process of natural erosion a new area of foreshore may be created. In such a case ownership of the land inundated by the sea may transfer from the owner of the adjoining lands to the State as the owner of the foreshore. Where, however, the movement of water is sudden or temporary, there may be no change in the ownership of the property in question.</p>
<p>Planning and Development Acts, 2000-2017</p>	<p>The purpose of the Planning and Development Acts is to ensure proper planning and development and in this way Local Authorities are required to have County Development Plans (Local Area Plans), grant permission for development where appropriate, and comply with over-arching Ministerial guidelines such as those on Flood Risk Management, prepared under section 28 of the 2000 Act.</p>
<p>Harbours Acts, 1996-2015</p>	<p>Certain specified harbours are managed, controlled, operated and developed by dedicated harbour companies. These companies have specified powers within their harbour areas, including the powers to make bye-laws in relation to those activities specified in Part 1 of Schedule 6 of the Harbours Act, 1996.</p>

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Coast Protection Act, 1963	This Act was enacted originally to enable the Commissioners of Public Works to prepare Coastal Protection Schemes where a local authority has become concerned about encroachment by the sea. The Act provides the OPW with a legal basis to operate their approach to coastal defence works currently.
Local Government Act, 2001	Section 199(6) of the 2001 Act gives local authorities the power to make bye-laws in respect of its functional area including in respect of the foreshore and of coastal waters adjoining that functional area and with the agreement of any other local authority, of the coastal waters adjoining the functional area of that other local authority.
Waste Management Act, 1996	Each local authority and the Environmental Protection Agency shall carry out monitoring of the nature, extent and effects of emissions to the environment arising from the holding, recovery or disposal of waste as it considers to be necessary for the performance of its functions under this Act (this includes the coastal zone).

Table 3-1 National legislation of relevance to coastal protection works

### 3.1 County Development Plan Policies With Respect to Erosion

Historically, coastal erosion in Ireland is managed on a reactive, localised manner with little national co-ordination (Murphy, 2017). Under the Planning and Development Act, 2000, every planning authority must generate a Development Plan every 6 years (Irish Government, 2000). LAs are not required to have a coastal erosion strategy, however most LAs include coastal erosion in the County Development Plan (CDP).

In 2004, phase one of a national coastal erosion study, the ICPSS, was published. This phase examined the country as a whole, while phases two to five subsequently investigated Ireland's coastline divided into four areas. Aerial photographic records of the coastline from 1973-75, 2000 and 2006 were used as the primary basis for the erosion assessment. The coastlines, as determined by the seaward limit of vegetation, were digitised from each photographic series and a Geographical Information System (GIS) was used to compare and establish the extent of coastal change over the intervening time. From this information, an annualised rate of erosion was derived and used to project where the coastline could potentially retreat by 2030 and 2050 (assuming the rate of retreat remained constant). LAs reported this was consistent with local opinion in some areas, however, in other locations the predictions suggested there would be no erosion where erosion was noted by landowners and local authorities, and vice versa. Some researchers believe long term and cyclical patterns of the sediment budget were not taken into account in the study (Murphy, 2017). These predictions had an input into some, but not all, CDP and coastal protection decisions.

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Figure 3-1 CDPs

Ten coastal LAs do not have policies in their CDP regarding property or infrastructure currently at risk of coastal erosion. Seven LAs indicated they have policy to deal with property and infrastructure currently at risk of coastal erosion. Dun Laoghaire Rathdown (DLR) Council and Clare County Council have a more detailed policy statement on how to address the existing risks. The other plans contain statements that are more general and do not identify what actions will be taken if property or infrastructure is impacted by coastal erosion. Table 3.2 summarises references to coastal erosion in each coastal LA’s CDP.

Six LAs stated they plan to amend their CDP to alter or include a coastal erosion section. The extent of these amendments is not detailed by all LAs and may be minor. Donegal indicated they are in the process of developing a coastal erosion strategy in conjunction with the OPW. Fingal aim to use soft engineering solutions or managed realignment where possible, with the intention to use a more long-term thinking approach.

Coastal erosion is a transboundary issue; this suggests a coherent national approach to coastal erosion would be more effective than individual LAs strategies. There is, however, one recorded instance of LAs working together; Dun Laoghaire-Rathdown and Wicklow had a transboundary coastal erosion issue and cooperated to address it accordingly.

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County	Policy for currently affected areas	Policy to avoid future erosion issues	Areas at Risk
Clare	Engage with the OPW to develop appropriate strategies for the management of identified coastal flood and erosion hazards and associated risks;	Developments permitted only where the Council is satisfied they will not be at risk from coastal erosion or inundation, and will not increase erosion in the future. ICPSS findings are used to advise planners of hazards and potential risks to future proposed developments.	As determined by the ICPSS report: <ul style="list-style-type: none"> <li>• Cloughaninchy</li> <li>• Kilbaha</li> <li>• Liscannor Bay, incorporating: <ul style="list-style-type: none"> <li>○ Lahinch</li> <li>○ Liscannor</li> <li>○ Clahane</li> </ul> </li> <li>• Mal Bay, incorporating: <ul style="list-style-type: none"> <li>○ Quilty village to Seafield</li> <li>○ Spanish Point</li> <li>○ White Strand, Miltown Malbay</li> </ul> </li> <li>• Doolin</li> <li>• Flaggy Shore/Aughinish Island</li> <li>• Ross Bay</li> </ul>
Cork City	No specific policy mentioned in CDP	No specific policy mentioned in CDP	Areas of flooding mentioned, however no coastal erosion sites.
Cork County	Identify, prioritise and implement necessary coastal protection works subject to the availability of resources, whilst ensuring a high level of protection for natural habitats and features.	Ensure the County's natural coastal defences, such as beaches, sand dunes, salt marshes and estuary lands, are protected and are not compromised by inappropriate works or development. Employ soft engineering techniques where possible.	No areas mentioned in CDP
Donegal	No specific policy mentioned in CDP	The Council will continue to prevent coastal erosion through engineering works.	Rosstown
Dublin City	No specific policy mentioned in CDP	No specific policy mentioned in CDP	No areas mentioned in CDP
Dun Laoghaire - Rathdown	No specific policy mentioned in CDP. However, CDP refers to a Coastal Defence Strategy Study.	The Planning Authority will refer to the Coastal Defence Strategy in the assessment of planning applications in the areas identified within the strategy as being at risk from	No areas mentioned in CDP. However, CDP refers to a Coastal Defence Strategy Study.

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		erosion and/or coastal flooding.	
Fingal	Identify, prioritise and implement necessary coastal protection works subject to the availability of resources, whilst ensuring a high level of protection for natural habitats and features, and ensure due regard is paid to visual and other environmental considerations in the design of any such coastal protection works.	Ensure the County's natural coastal defences, such as beaches, sand dunes, salt marshes and estuary lands, are protected and are not compromised by inappropriate works or development. Employ soft engineering techniques as an alternative to hard coastal defence works, wherever possible. Development should be set-back a sufficient distance from soft defences and erodible coastline to allow for natural processes, such as erosion and flooding, to take place in these areas. Prohibit new development outside urban areas within the areas indicated on Green Infrastructure maps, which are within 100m of coastline at risk from coastal erosion. Establish a coastal monitoring programme to provide information on coastal erosion on an ongoing basis.	Portrane Rush
Galway City	No specific policy mentioned in CDP	Facilitate sustainable flood defence and coastal protection works in order to prevent flooding and coastal erosion subject to environmental and visual considerations. Have regard to the findings of the OPW's Irish Coastal	No areas mentioned in CDP.

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		<p>Protection Strategy Study (2013) of the west coast.</p> <p>Continue to protect the coastal area and foreshore and avoid inappropriate development in areas at risk of coastal erosion and/or would cause and escalate coastal erosion in adjoining areas.</p>	
Galway County	<p>Respecting the changing physical nature of the coastline having particular regard to erosion, land instability and changes to the intertidal zone.</p> <p>Consider carrying out environmentally sensitive coastal protection works where necessary subject to works being appropriately designed which will not exacerbate existing problems of coastal erosion.</p> <p>Establish a coastal monitoring programme to provide information on coastal erosion on an ongoing basis.</p>	<p>Restricting the development of undeveloped sections of the coastal zone.</p> <p>Regard the findings and recommendations of the ICPSS in the assessment of planning applications.</p> <p>Prohibit the removal of beach material, sand and gravel.</p> <p>Prohibit new developments and refurbishments outside of the boundaries of existing coastal settlements where such development could not be adequately defended over the lifetime of the development without the need to construct new or additional coastal defence works.</p> <p>Prohibit development of any building outside of existing coastal settlements where it is within 100m of 'soft shoreline'.</p>	<p>Using ICPSS report to identify areas at risk, listed as:</p> <ul style="list-style-type: none"> <li>• Kilpatrick</li> <li>• Ardamine</li> <li>• Glascarrig</li> <li>• Killincooly</li> <li>• Ballinesker</li> <li>• Rosslare</li> <li>• Tacumshin</li> <li>• Kilmore Quay</li> <li>• Ballyteige Burrow</li> <li>• Cullenstown</li> <li>• Fethard</li> </ul>

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Kerry	Implement sustainable site-specific management policies and initiatives to reduce the risk of coastal erosion, as appropriate.	Prohibit development in areas of the Coastal Development Zone where the natural erosion process is likely to threaten the viability of such development. The council will preserve sand dunes by undertaking appropriate management measurement in consultation with relevant agencies and landowners. Ensure that due regard is given to the ICPSS reports, including coastal flood hazard and predictive coastal erosion maps, as part of flood risk assessment, development management and forward planning.	<table border="1" data-bbox="1018 199 1331 504"> <thead> <tr> <th colspan="2">Types of Coastline</th> <th>Total (km)</th> <th>At Risk (km)</th> </tr> </thead> <tbody> <tr> <td rowspan="2">Beach</td> <td>Dunes</td> <td>98</td> <td>44</td> </tr> <tr> <td>Glacial Cliff</td> <td>207</td> <td>50</td> </tr> <tr> <td colspan="2">Marine Wetland</td> <td>26</td> <td>6</td> </tr> <tr> <td colspan="2">Estuarine</td> <td>47</td> <td>8</td> </tr> <tr> <td colspan="2">Total</td> <td>378km</td> <td>108km</td> </tr> </tbody> </table> <p data-bbox="1018 517 1331 555">Analysis of Soft Coastline susceptible to Risk of Erosion</p> <p data-bbox="1018 568 1331 629">As identified in the ICPSS report for County Kerry:</p> <ul data-bbox="1018 629 1331 786" style="list-style-type: none"> <li>• Waterville to Ballinskelligs</li> <li>• Rossbehy to Cromane</li> <li>• Fermoy to Tonakilly</li> <li>• Ballyheigue to Banna</li> <li>• Ballybunion</li> </ul>	Types of Coastline		Total (km)	At Risk (km)	Beach	Dunes	98	44	Glacial Cliff	207	50	Marine Wetland		26	6	Estuarine		47	8	Total		378km	108km
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Total		378km	108km																							
Leitrim	No specific policy mentioned in CDP	Development permitted in areas at risk of flooding which may require expensive engineering works.	No areas mentioned in CDP																							
Limerick	No specific policy mentioned in CDP	No specific policy mentioned in CDP	No areas mentioned in CDP																							
Louth	To work closely with the Office of Public Works (OPW) in its work to identify and manage the risks associated with coastal flooding and coastal erosion.	To require all proposed developments within 100m of the coastline of Louth, outside the settlements and in Zone 3, to submit supporting documentation on coastal erosion. New development will be prohibited unless it can be objectively established based on the best scientific information at the time of the application, that the likelihood of erosion	From the ICPSS study: <ul style="list-style-type: none"> <li>• Drogheda to Laytown</li> <li>• Annagassan to Cruisetown</li> <li>• Dundalk</li> <li>• Carlingford to Greenore</li> </ul>																							

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		at a specific location is minimal taking into account, <i>inter alia</i> , any impacts of the proposed development on erosion or deposition.	
Mayo	It is an objective of the Council to undertake, or facilitate the provision of, environmentally-sensitive coastal protection works where appropriate where it can be demonstrated that the development will not have significant adverse effects on the environment including the integrity of the Natura 2000 network.	<p>It is an objective of the Council to support measures to protect the coastal edge and coastal habitats from destruction and degradation to ensure that their roles as ecological corridors, coastal flooding and storm surge buffers are retained and enhanced.</p> <p>It is an objective of the Council to protect, enhance and conserve all beaches in the County</p>	No areas mentioned in CDP
Meath	No specific policy mentioned in CDP	A precautionary approach should also be applied to the performance of existing flood defences and the extent of future coastal erosion.	No areas mentioned in CDP
Sligo	<p>Identify, prioritise and implement coastal protection works within the coastal zone that are considered necessary, subject to the availability of resources.</p> <p>Continue to employ soft engineering techniques (i.e. dune stabilisation and planting) where appropriate.</p>	<p>The following general guidelines should be adhered to in the coastal zone:</p> <ul style="list-style-type: none"> <li>• no building or development within 100 metres of 'soft' shorelines;</li> <li>• no further reclamation of estuary land;</li> <li>• no removal of sand dunes, beach sand or gravel;</li> <li>• all coastal defence measures should</li> </ul>	<p>Areas at risk based on current coastal protection works carried out by the Council are the Strandhill Coast Protection Scheme and Mullaghmore Harbour Breakwater Improvement Works. Dune management schemes involving 'softer' methods have been carried out at Enniscrone, Strandhill and Mullaghmore, on a phased basis. Proposed Coastal Protection works:</p> <ul style="list-style-type: none"> <li>• Strandhill effluent treatment works – coastal protection works</li> <li>• Enniscrone strand - protection of riverbank, pumping station</li> </ul>



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		<p>be assessed for environmental impact;</p> <ul style="list-style-type: none"> <li>careful consideration should be given to the implications of using 'hard engineering' solutions.</li> </ul>	<ul style="list-style-type: none"> <li>and lifeguard building</li> <li>Pullaheeny - coastal protection</li> <li>Strandhill - dune management</li> <li>Easkey - scenic drive protection</li> </ul>
Waterford	No specific policy mentioned in CDP	Recognise the value of the county's natural coastal defences including estuaries, and sand dunes and ensure their protection.	No areas mentioned in CDP
Wexford	Carrying out of environmentally sensitive coastal protection works where necessary	Consider the findings and recommendations of the Irish Coastal Protection Strategy Studies in the assessment of planning applications. Aim to establish a coastal monitoring programme to provide information on coastal erosion on an ongoing basis. Prohibit removal of beach material sand and gravel.	The ICPSS assessments have estimated the erosion risk lines for the coastline in the years 2030 and 2050. The erosion maps identify Kilpatrick, Ardamine, Glascarrig, Killincooly to Ballinesker and Rosslare along the southeast coastline and Tacumshin to Kilmore Quay, Ballyteige Burrow to Cullenstown and Fethard along the south coastline as being prone to erosion risks.
Wicklow	Objectives: CZM7: To facilitate the provision/reinforcement of coastal defences and protection measures as identified in the Murrrough Coastal Protection Study and where considered necessary.	Objectives: CZM1: Ensure no removal of sand dunes, beach sands or gravels through application of the provisions of the Foreshore (Amendment) Act (1992). CZM3: to protect both public and private investment by prohibiting any new building or development (including caravans and temporary dwellings) within 100m of 'soft shorelines' i.e. shorelines that are	Area divided into 12 coastal cells, two of which require protection: Wicklow Town and Environs, Brittas Bay (dune protection).

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		prone to coastal erosion. CZM4: Prohibit development of habitable structures below 3m (OD Malin).	
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Table 3-2 Policy in CDP dealing with areas currently affected by coastal erosion, and future coastal erosion issues, in addition to areas at risk mentioned in CDP.

### 3.2 Planning

In the interviews, eight LAs (Sligo, Wicklow, Louth, Mayo, Leitrim, Fingal, Limerick and Wexford) stated their Authority abide by a buffer zone for planning of developments close to areas of erosion.

The buffer zone varies in length from 30-100m from an eroding coastline. However, telephone interviews revealed only one LA (Sligo) stated that planning applications had not been granted within the buffer zone in the last five years. Others responded to buffer zone queries with “N/A” or stated harbour developments, private extensions and larger public development planning applications were granted.

The Sligo County Development Plan 2017-2023 (p. 181).states that it is the policy of Sligo County Council to “prohibit development in coastal areas where the natural erosion process is likely to threaten the viability of such development” As a general guideline, the CDP states that no building or development should be allowed within 100 metres of ‘soft’ shorelines. However, according to the Sligo representative, these are used as guidelines and there are no formal criteria to prohibit new developments in the coastal zone.

The Dublin City representative stated they do not need a buffer zone as erosion is not prevalent in the city noting that that there may be restrictions due to issues related to flooding.

Clare County Council have planning restrictions in place to protect views (scenery/tourism) as well as combat erosion and flooding concerns. The LA representative felt that planning permission would not be granted now for some properties that currently exist in areas vulnerable to erosion/flooding, due to increased awareness of flooding and erosion. Clare suggested, however, that applicants for planning indicated that areas were historically not prone to flooding or erosion in support of their applications without any evidence to validate these statements.

Seven LAs require scientific information to be submitted as part of new development applications in the vicinity of eroding shorelines, in an effort to determine the likelihood of coastal erosion on site. However, the type and detail of this information appears to be determined by the applicant rather than outlined by the LA (See Table 3.3).

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<b>Is scientific information requested for new development applications close to eroding shorelines?</b>		
Clare Co Co	YES	Such applications are not regular and so there isn't much historical information of this nature to call on - varies depending on nature of application and would comprise details of previous storm impacts and information generated by modelling programmes.
Cork City Co	NO	N/A
Cork Co Co	NO	
Donegal Co Co	NO	TBC
Dublin City Co	NO	Deposition problems but no significant coastal erosion problems currently or envisaged in near future.
Dun Laoghaire Rathdown Co Co	YES	Reference to Strategy
Fingal Co Co	YES	Usually not submitted with initial application and this information is sought as part of an additional information request. The applicant is to provide an erosion risk assessment to determine if the proposed development is likely to require coastal protection measures within the life time of the development. Determination submitted by engineering firm.
Galway City	NO	Developments adjacent to shorelines are considered on a case by case basis and would be dependent on the project/development type.
Galway County	NO	Most of the coastline forms part of an SAC which requires Screening Reports and more than likely full NIS. Flood Risk Assessment guidelines also apply.
Kerry Co Co	YES	Generally, for large-scale developments an environmental assessment is provided as part of the planning application, (providing a formal EIS is not required) and any erosion issues would be flagged at this stage of screening/scoping. As coastal protection works would be included as part of an application in the vicinity of a shoreline, an EIS and/or an NIS may be requested.
Leitrim Co Co	NO	This information would not normally be submitted as part of a planning application; however, it is likely that it would be requested under the further information process.
Limerick City and County	NO	This needs to be considered for future developments. It has not been an issue to date.
Louth Co Co	YES	Any appropriate information
Mayo Co Co	NO	Visual Inspection of planning application and/or assessment/report from developer
Meath Co Co	NO	If a particular application for development on or close to shore was submitted, then protection against erosion would have to be considered. I have not seen such information to date
Sligo Co Co	NO	
Waterford City and County	NO	
Wexford Co Co	YES.	To consider the development of a building (including caravans or temporary dwellings) within the boundary of an existing settlement where the development is within 100m of a 'soft shoreline', that is, shorelines that are prone to erosion. It must be

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		objectively established based on the best scientific information available at the time of the planning application, that the likelihood of erosion at the location is minimal taking into account, inter alia, any impacts of the proposed development on erosion or deposition, and that the development will not pose a significant or potential threat to coastal habitats or features. Such an assessment must be carried out by a suitably qualified and indemnified professional.
Wicklow Co Co	YES	Report from Consulting Engineer would be requested by Planning if development is near soft coastline

Table 3-3 Responses to "Is scientific information requested as part of development applications close to eroding shorelines?"

### 3.3 Monitoring

Five LAs stated they monitor coastal erosion and/or coastal protection structures. The level of monitoring varies with Sligo, Kerry and Clare having more structured comprehensive programmes, whereas Wexford and DLR's are less developed. The monitoring practices highlighted varied according to LA- as supported by the outcomes from the telephone interviews below.

Sligo have monitored erosion using photographic evidence, aerial photography, comparative map studies, and physical site surveys. They observe locations at risk during and after major coastal events, which is then added to the Sligo "records and knowledge bank"; An example given was the Strandhill effluent treatment works (ETW) coastal protection scheme which was completed circa 2010, with planning for this scheme based on monitoring/measuring the recession and trends of the fore dune ridge over the previous 20 years.

In Kerry, a coastal erosion monitoring regime was established in 2009. The LA representative stated monitoring usually takes place annually at the following locations: Mountain Stage/Rossbeigh, Inch and Bunaneer, Sleah Head, Dunquin, Valentia (Foilhomurrin) and periodically from a shoreline walk, Ballyheigue and Fenit Road. These surveys are visual, supplemented with photographic records, and are carried out from the Council's boat in most cases. The LA compare photographs with previous years to identify areas that are exhibiting signs of erosion.

Clare stated they carry out feasibility studies at a total of 9 locations with a view to apply for OPW funding to carry out coastal strengthening works as a result of coastal damage inflicted at these locations during the coastal storm events of 2014. The locations are New Quay, Doolin, Clehane, Liscannor, Lahinch, Whitestrand, Spanish Point, Quilty and Kilbaha. The LA states the studies involve detailed modelling across a range of criteria with a view to identifying the most appropriate remediation/strengthening approach.

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DLR's monitoring involves intermittent visual surveys at Shanganagh cliffs, as well as the installation of concrete triangulated with the coast to show difference over time (these structures are checked every 6 months). Wexford monitor using a combination of methods, involving surveys of newly eroded coastline using GPS.

Donegal and Fingal LAs said there are plans to instate a monitoring program within their jurisdiction; however, there is no plan in place currently. The majority of other LAs say the reason for not having a monitoring program in place is lack of resources.

### **3.4 Key Recommendations**

- National legislation is quite broad in terms of coastal defence, thus clarity of responsibility for dealing with coastal erosion is needed.
- National guidance is needed to ensure that protocols dealing with coastal erosion are to be included in the CDP.
- Monitoring, using a uniform approach in each LA, is essential in long term planning for coastal erosion.
- Guidance on how to use planning as a key tool in lowering the impact of future coastal erosion should be considered. As previously, a uniform approach, which all LAs can adopt, is recommended.

## 4 Local Authority Practices Dealing with Coastal Erosion

### 4.1 Staff Resources and Coastal Erosion

The telephone interviews highlighted LAs are currently working with limited resources focused on coastal erosion, with 12/18 local authorities having the combined staff time equivalent of one-person part time (less than 20 hours a week) devoted to coastal erosion (See Table 4-1). The LAs key contact point (see Appendix IV) has been in that position for periods ranging from 8 months to 10 years with the average being just over 3 years.

<b>LA</b>	<b>Staff Involved</b>	<b>Background of Staff</b>	<b>Note</b>
Clare	<i>1.25 engineers; occasional extra for projects; also one engineer who is full-time on defence schemes (since mid-2014; employed as a result of W2013/2014 storms)</i>	<i>Civil engineer w/ various experiences in the LA; was an area engineer in coastal roads</i>	
Cork City	<i>No information provided</i>	<i>No information provided</i>	<i>No information provided</i>
Cork county	<i>3 part-time - equivalent of 1 part-time. 1.5 full-time people on coastal issues. 6 area engineers, a minor amount of their time would be dealing with coastal erosion.</i>	<i>Engineering - civil</i>	<i>Kevin has been in his position for 3 years.</i>
Donegal	<i>6 part-time (would be involved in assessing risk of erosion to roads and environment)</i>	<i>Engineers (roads), environmental scientists</i>	<i>Lots of changes in staff so nobody has been in their current role for more than 2 years</i>
Dublin City	<i>1 part-time + 1 person to organise contractors to re-stabilise walls</i>		<i>38 years' experience, chartered structural and civil engineer; in charge of flooding w.r.t. WFD</i>
Dun Laoghaire Rathdown	<i>1 part-time (10%)</i>		
Fingal	<i>1+3 (coastal liaison group) all part-time</i>	<i>parks and ecology and landscape, engineers, admin</i>	
Galway City	<i>1 part-time, Daithi has been there 8 months</i>	<i>Engineering - civil</i>	

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Galway County	<i>1 part-time</i>		
Kerry	<i>1 part-time (since last September)</i>	<i>Civil engineer</i>	
Leitrim	<i>1 part-time (very minor part of the role) - 1.5 years - don't have much to do with coastal erosion</i>		
Limerick	<i>Multiple part time - Various engineers tasked with projects</i>	<i>Engineering</i>	
Louth	<i>1 part-time for 5 years</i>	<i>Sewage treatment design, drainage site supervision, water design, motorways and road design, flooding, CFRAM progress groups, infrastructure,</i>	
Mayo	<i>5 part-time at officer level</i>	<i>engineer, ecologist, outdoor staff who install the defence structures</i>	
Meath	<i>1 part-time</i>	<i>Engineers (roads), environmental scientists</i>	<i>11km of coast falls in one municipal district. Local transportation staff in the area would be directed by the area engineer based on reactive emergency temporary works. No direct staff. Contractors to deal with bigger works. Same municipal district engineer (senior executive engineers) has been there for at least 10 years. Supporting staff would have changed. Executive engineers would have changed a lot. Very few new staff coming in due to the embargo. Same staff however, some retirements so less people.</i>
Sligo	<i>1 part-time, but also 1 understudy engineer +3-4 area engineers</i>	<i>Civil engineer</i>	<i>Strong knowledge of coastline of Co. Sligo (30+ years of experience); very aware of coast; working for council since 1984</i>
Waterford	<i>3 part-time</i>	<i>engineering</i>	
Wexford	<i>2 part-time (20% coastal) for 4 years</i>	<i>Engineering</i>	
Wicklow	<i>Equivalent of 1 part-time - Marc + 4 district engineers (senior executive engineer grade), less than 10% of everyone's time</i>	<i>Engineering</i>	<i>Attempting to coordinate any contact with OPW and coastal defence schemes to report to one contact. Coastal cells match up with districts so each district engineer has a coastal cell. Marc has been there 2 years</i>

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*Table 4-1 Staff resources as identified in interviews.*

It is evident from the interviews, that coastal erosion knowledge tends to be retained by personnel themselves rather than in any database. As a consequence when a change in staffing occurs any new staff member has to gain insight from the incumbent on the level of risk, In the case of a sudden, or unexpected change of personnel there is an obvious possibility that this knowledge will be lost if it remains undocumented.

All interviewees stated they have an important role in decision support for coastal defence projects, either being the main decision maker themselves or else being part of a panel who decide. Only two of the 18 LAs' however, had specific training in coastal erosion management. Sligo personnel were trained in a two-week course provided by Dr Jimmy Murphy (UCC). Louth personnel attended a coastline management seminar in Belfast. The latter stated this was very informative and were of the opinion that the approach taken to coastal erosion in England and Wales, through their Shoreline Management Plans, was an effective system.

### 4.2 Coastal Erosion Consultants

In the initial audit, coastal LAs reported on who advises them about coastal erosion control options. They responded as follows:

- OPW (2/19)
- Consultants (6/19)
- In-house staff (19/19)
- State agencies (19/19)
- Some combination of the above (8/19)
- NA (3/19)

The telephone interviews highlighted the following expert consultants as advisors on erosion control options:

- Aquafact
- Arup
- Byrne Looby
- University of Ulster at Coleraine
- Doran
- Malachy Walsh
- Roughan and O'Donovan
- RPS



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The above consultants could play a role in the development of national guidelines and/or training of LA personnel given their expertise.

### 4.3 Erosion Control Options

Approaches to responding to coastal erosion defence vary across LAs. The most common approach is reactive management: dealing with erosion issues as they arise, such as damage resulting from storm action. Some LAs have a more comprehensive approach; for example, Sligo choose what is suitable on a case by case basis, weighing up all solutions (both soft and hard engineering) that are best suited to a specific coastal area.

Four local authorities stated they assess future risk of erosion. Conversely, only three LAs indicated they have actively predicted areas likely to be subject to future coastal erosion. Interviews revealed that whilst these coastal erosion hotspots are recorded through the knowledge of core personnel and/or in the CDP the locations tend not to be stored in a database or GIS. As mentioned earlier, this becomes problematic when there is a staff turnover.

### 4.4 Approach to Private Property

In the second audit, LAs were asked: “How many private residences are considered at risk of coastal erosion in the medium term (15 years) in your county”? Answers ranged from 0-261 (See table 2.2). The operational approach in dealing with private property at risk of coastal erosion varies significantly (See Table 4.2). This study revealed LAs do not have a written policy outlining how to deal with private property at risk or affected by coastal erosion. Currently there is no clear obligation for LAs to protect private properties from the impact of coastal erosion (Department of Communications, Marine and Natural Resources, 2004). Legislation does not clearly state who is ultimately responsible for dealing with private property impacted by coastal erosion (Irish Government, 1963). The presumption, however, is that primary responsibility rests with the property owner regardless of who that may be (Brady Shipman Martin, 1994). Consequently, some LAs include private property in their practice and policies, and others do not. Five LAs said they have provided advice in dealing with coastal erosion when approached by private landowners.

Clare	<i>Clare County Council generally provides for the protection of public property. There are a number of areas where such public property, roads, walls informal defences, etc. are protecting access to and private property. We have been involved in repair of these areas a number of times in the past and in particular in January /February 2014 and in February 2016. Generally, flood defences to protect these areas have not yet been built. In a small number of places we have been requested politically to get involved with protecting agricultural land, which was done via the OPW minor works scheme and at Shannon Airport which is owned by the Shannon Group, once again this was done via the OPW minor works scheme.</i>
Cork City	<i>Not Relevant to Cork City</i>
DLR	<i>Private Matter</i>

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Donegal	<i>Generally private property not dealt with however applications have been made to OPW for funding to carry out studies for coastal areas with golf clubs and community centres. Development of Coastal Erosion Strategy will assist and guide development.</i>
Dublin City	<i>The City Council is focused on fluvial flooding and flood risk management. Flood defence infrastructure relates to works in specific areas along the rivers – which includes some coastal areas and coastal influenced areas.</i>
Fingal	<i>Carry out option assessments for private properties at risk and seek funding from OPW to carry out coastal defence works were deemed appropriate and viable. Provide emergency accommodation in case of loss of property due to erosion. Enforcement action where homeowners are dumping construction waste at back of property to protect against coastal erosion.</i>
Galway City	<i>There is no specific approach relating to private property.</i>
Galway County	<i>Minimal with regards to Private Property other than the provision of sand bags etc. where flooding has occurred due to storm damage</i>
Kerry	<i>Assess areas where properties or infrastructure most at risk annually. Where properties have been subject to coastal flooding or erosion, Council provided emergency supports, assistance with the community in addressing their immediate needs and sought funding for state assistance. Currently have mapped all areas at risk of flooding from coastal erosion and intend to seek funding for the engagement of consultants to carry out a coastal impact study of any measures that may be necessary to mitigate against erosion at specific locations.</i>
Leitrim	<i>The Local Authority would have to be dependent on a Coastal Erosion Grant from OPW to engage a Specialist Consultant for Design and Scoping of Project and on OPW for funding any Proposed Scheme</i>
Limerick City and County	<i>The Coastal Area in Limerick is Estuarine - which is less erosive than open sea areas; there are some restrictions on new development close to the estuary (S9.3 of County Dev Plan)</i>
Louth	<i>The Councils approach is to seek match funding from the OPW to carry out remedial works. Successful application must demonstrate compliance with OPW requirements which includes a cost benefit analysis. The cost benefit analysis makes no distinction between private and public property.</i>
Mayo	<i>Include, if possible, into public scheme</i>
Sligo	<i>Advice from engineers, hopefully sensible approach regarding planning applications as necessary</i>
Waterford	<i>The council does not deal with private property issues.</i>
Wexford	<i>In terms of Local Authority funding, Wexford County Council has indicated that funding may be available where there is public benefit to be derived from a scheme, provided it can be shown that the scheme is cost beneficial or where works are essential to maintain public access e.g. to maintain a public roadway. However, where private property is at risk and there is no other public benefit to be gained, Local Authorities, including Wexford County Council are not obliged to carry out any works or to provide funding assistance for such works.</i>
Wicklow	<i>There is no written policy in relation to coastal erosion. Individuals such as a District Engineer may seek OPW funding under their Minor Works program to alleviate coastal erosion/flooding where the potential damage to private property may be taken into account in the cost benefit analysis. Usually there is some element of infrastructure such as a road included in the cost benefit analysis.</i>

Table 4-2 Responses to: "Aside from the Development Plan, what is the operational approach to coastal erosion as it relates to private property"?

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Results show LAs, in the past, have not been involved in offering to buy-out houses/property due to coastal erosion. More than half of the LAs involved (10/19) are aware of landowners taking their own preventative measures to protect the property. These preventative measures include retaining walls, rock armour, gabions, straw bales, sand bags, and dumping of construction waste to make an impromptu concrete barrier (see Table 4.3).

LA	Answer	Further Information
Clare	YES	<i>Small numbers of landowners have taken various measures including rock armour or coastal embankment construction - some in the form of repairs and some as new construction. Landowners have been pursued in respect of inappropriate new works in particular.</i>
Cork City	NO	<i>N/A</i>
Cork County	DON'T KNOW	
Donegal	YES	<i>TBC</i>
Dublin City	YES	<i>Historically large tidal flood retaining walls were installed in 16 houses in Sandymount at the bottom of their gardens.</i>
Dun Laoghaire Rathdown	YES	<i>Timber breastwork - one case only</i>
Fingal	YES	<i>Dumping of construction waste and placing of make shift concrete barriers are most common measures. In Portrane, tonne bags of sand are also installed by local residents.</i>
Galway City	NO	
Galway County	DON'T KNOW	
Kerry	DON'T KNOW	
Leitrim	NO	<i>Some Developers have taken measures to protect their properties by installing non-structural designed retaining walls and barriers.</i>
Limerick	DON'T KNOW	<i>The policy to not allow development on the coast side of the N69 prevents this</i>
Louth	YES	<i>Hard engineering Solutions have been provided</i>
Mayo	YES	<i>Hard engineering solutions</i>
Meath	YES	<i>Retaining wall have been constructed</i>
Sligo	YES	<i>Gabions have been used. Rock armour has been used - poor result in one case due to poor design and construction. Straw bales were used - ineffective</i>
Waterford	DON'T KNOW	<i>Some land owners carry out small scale protection where required.</i>
Wexford	YES	<i>Hard engineering measures such as rock revetment or rock gabions</i>
Wicklow	NO	

Table 4-3 Responses to: "Do landowners take preventative measures to protect their houses and lands from coastal erosion in your county"?

Five LAs stated they enforced planning or waste legislation for measures undertaken without adequate planning permission or foreshore licencing. County Councils have powers under the Planning and Development Act, 2000 and Waste Management Act, 1996 to take enforcement actions where development is in breach of that legislation either through lack of compliance with

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planning permission; lack of planning permission or where the development is not exempted. Under the 2000 Act, if enforcement proceedings were initiated on or after 11th March 2002, the time limit is 7 years. Enforcement actions prior to that date should be completed within five years. The Enforcement Officer in the LA, following an inspection of the breach, can recommend the appropriate enforcement action including removal, demolition or alteration as deemed necessary.

In Fingal, Section 55 notices were issued to landowners where construction waste was placed as a form of coastal defence, no further action has been taken to date and the waste has not been removed (see Figure 4.1 and Figure 4.2). It has been suggested that this is due to the lack of available manpower in the Enforcement Section to properly pursue these cases.



*Figure 4-1 Private Landowners taking matters into their own hands in an attempt to protect their properties from coastal erosion.*



*Figure 4-2 Landowners illegally dumping construction waste in an effort to protect their property.*

#### 4.5 Coastal protection schemes undertaken in the last 15 years

Currently, no exhaustive catalogue of existing coastal protection schemes exists, further iterating the need for a database, which is kept up to date by LAs. A review of [coastal protection projects for which OPW funding has been approved](#) revealed that 67 projects have been funded since the introduction of the OPWs minor flood mitigation works and coastal protection scheme in 2009. A list of the individual projects can be found in Appendix VI. The average amount funded per project was €102,874. The total amount of funding allocated was €6,378,159; amount received per local authority is shown in Figure 4.3.

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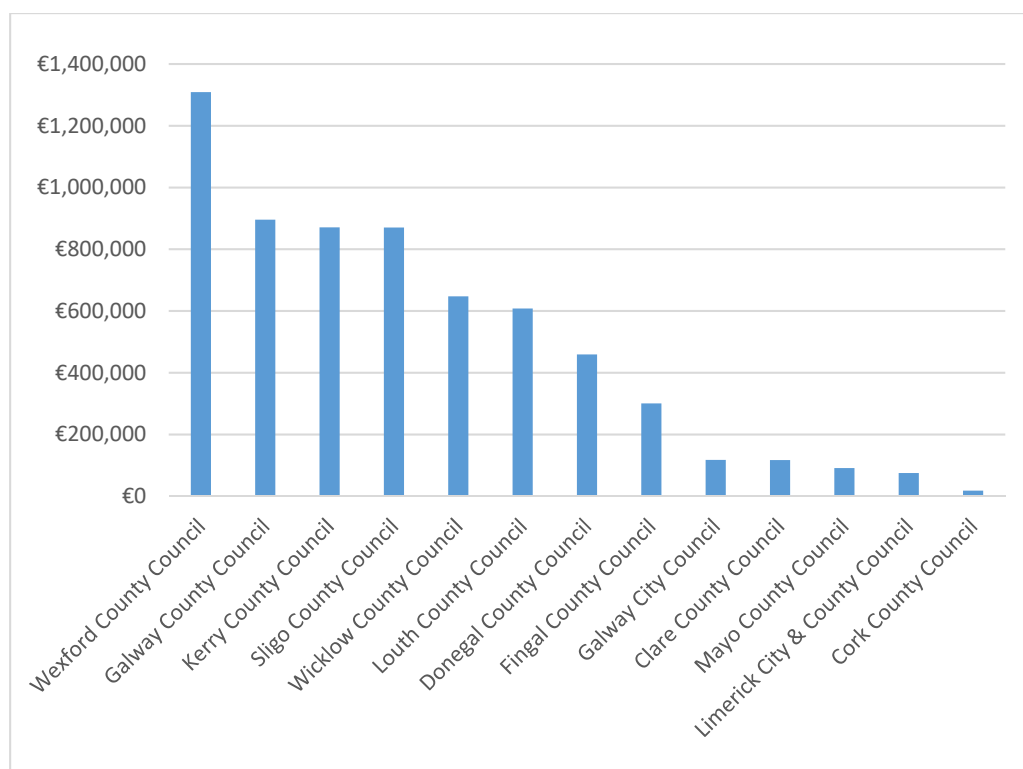


Figure 4-3 Graph showing OPW coastal protection works total funding allocation per coastal LA under the Minor Flood Mitigation Works and Coastal Protection Scheme - 2009-2017

### 4.6 Type of protection measures used

LAs tend to favour hard engineering solutions with 15 having employed these techniques, and only five LAs having employed soft engineering techniques (Sligo, Donegal, Mayo, Fingal and Wexford). Hard engineering solutions in place include: sea walls, rock armour revetments, gabion structures, and embankments. Soft engineering solutions in place include: Sand trap fencing, marram grass planting, railway sleepers in front of dunes, sand-ladder pathways, and sea buckthorn removal (Rooney, et al., 2009).

Reasons given for soft engineering solutions not being considered as appropriate include:

- Perceived as unsuitable for high wave action
- Requiring more frequent maintenance and works
- Considered less cost effective
- Larger footprint required
- Not enough in-house expertise
- Difficult to predict impact (specifically on SACs)
- Too susceptible to storm action

In relation to protection of natural defences such as beach sand, gravel, dunes, two thirds of LAs stated they actively manage and protect natural defences such as dune systems. However, LAs indicated there are few consequences for those who interfere with these environments. Methods

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used to protect natural defences include installation of boardwalks and car parks, fencing off dunes, and prohibiting access for vehicles.

### 4.7 Funding and Prioritisation of Coastal Defence Schemes

According to the interviews, the main coastal protection funding source for LAs is the OPW Minor Flood Mitigation Works and Coastal Protection Scheme. Others mentioned include general LAs funds; Roinn na Gaeltachta; Department of Agriculture, Food and the Marine; Department of Transport, Tourism and Sport; Department of Environment, Heritage and Local Government; and local landowners.

LAs prioritise schemes based on several factors:

- Cost-benefit, based on OPW guidelines
- Prioritisation of public infrastructure
- Ongoing coastal processes
- Human Impact

The OPW is the responsible government agency for both coastal erosion and flood risk management. In 2009, the OPW introduced the 'Minor Flood Mitigation Works and Coastal Protection Scheme' to provide up to 90% funding for projects with total costs less than €500,000 to LAs for both flood mitigation and coastal protection works. Due to flooding being a national priority, however, the statement of strategy 2015-2017 (The Office of Public Works, 2015) does not comment on erosion.

### 4.8 Coastal Protection in designated sites

All coastal protection works proposed in or near<sup>4</sup> designated Natura 2000 sites must be conducted with permission from the Department of Arts, Heritage and the Gaeltacht (S.I. 94 of 1997 as amended by S.I. 233 of 1998 and S.I. 378 of 2005). Prior to carrying out such works, a formal screening process must be performed. Screening establishes whether the proposed works could have a significant effect on a Natura 2000 site, either on its own or in combination with other plans or projects. If there is potential for impact, an Appropriate Assessment is required, and a Natura Impact Statement (NIS) must be prepared. If the AA concludes there will be no adverse effects on the integrity of the designated site, the competent authorities (the regional authorities, the planning authorities and An Bord Pleanála) will decide on whether to grant or refuse permission for the proposed works.

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<sup>4</sup> In accordance with *Appropriate Assessment of Plans and Projects in Ireland – Guidance for Planning Authorities* (DEHLG, 2009), appropriate assessment is required where any Natura 2000 sites lie within the likely zone of impact (15km is the recommended radius) of a plan or project.

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Telephone interviews indicated such requirements have impeded some coastal LAs from carrying out works due to lack of funding or the resources to carry out the initial assessments and they perceive an increased risk as there is no guarantee that the proposed works will be allowed to proceed. In addition, LAs believe it is not always feasible to determine the potential impacts of coastal protection works to the degree of certainty required under the Habitats Directive, and its related case law, due to the dynamic nature of the coastal environment.

Ten coastal LAs<sup>5</sup> reported coastal defence works carried out within a designated Natura 2000 site. Some examples of such schemes include works in Ballagan, Whitestown, Bellurgan, Seabank, and Annagassan (County Louth); Strandhill (County Sligo); Tramore (County Waterford); and Wexford Harbour, Duncannon Beach, Barrystown, Ballyhack, St Helens, Kilmore Quay, Courtown, and Bastardstown (County Wexford). Two coastal defence proposals that were permissible based on the recommendations of an Appropriate Assessment Screening Report include works at Rampark, Co. Louth and Courtown, Co. Wexford and are outlined below.

### 4.8.1 Case Study: Rampark, Louth

In 2016, Louth County Council proposed emergency coastal protection works to prevent flooding and erosion in the townland of Rampark along the shoreline of Dundalk Bay. The Council argued that the works were necessary as there was a risk to human health in this location, as three residential properties were at risk. Works included:

- Excavating a 1m wide x 0.5m deep trench along the toe of the existing shoreline embankment, all excavated material to be filled onto the existing embankment.
- Placing of boulders, i.e. rock armour, within the trench.
- Placing of further adjacent rows of rock armour along the bottom of the embankment.

The site of the works was adjacent to two Natura 2000 sites – the Dundalk Bay Special Area of Conservation (SAC) and the Dundalk Bay Special Protection Area (SPA) – and within 15 km of several other designated sites. Louth County Council prepared the Appropriate Assessment Screening Report in February 2016. As per guidance provided by the Department of Environment, Heritage and Local Government (2009), the Council were asked a number of questions (see in Table 4-4).

Describe the individual elements of the project (either alone or in combination with other plans or projects) with the potential to give rise to impacts on any of the Natura 2000 sites in the vicinity of the proposed works.

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<sup>5</sup> Cork County Council, Donegal County Council, Dublin City Council, Kerry County Council, Louth County Council, Mayo County Council, Meath County Council, Sligo County Council, Waterford City and County, Wexford County Council



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<p>Describe any likely changes to the Natura site arising as a result of:</p> <ul style="list-style-type: none"><li>• Reduction of habitat area;</li><li>• disturbance to key species,</li><li>• habitat or species fragmentation;</li><li>• reduction in species density;</li><li>• changes in key indicators of conservation value (water quality);</li><li>• climate change.</li></ul>
<p>Describe any likely impacts on the Natura 2000 site as a whole in terms of:</p> <ul style="list-style-type: none"><li>• Interference with the key relationship that define the structure of the site,</li><li>• Interference with key relationship that defines the function of the site</li></ul>
<p>Provide indicators of significance as a result of the identification of effects set out above in terms of:</p> <ul style="list-style-type: none"><li>• Loss;</li><li>• Fragmentation;</li><li>• Disruption and Disturbance;</li><li>• Change to key elements of the site (e.g. water quality etc.)</li></ul>
<p>Describe from the above those elements of the project or plan, or combination of elements, where the above impacts are likely to be significant or where the scale or magnitude of impacts is not known</p>

Table 4-4 Queries sent to County Louth in Appropriate Assessment Screening Report for proposed coastal protection works at Rampark, Co. Louth.

In accordance with the 'Methodological guidance on the provision of Article 6(3) and (4) of the Habitats Directive 92/43', a Screening Matrix and Findings of No Significant Effects Matrix were completed and included in the report. Based on the results, the Council concluded that there were no likely significant impacts on the Natura sites due to the construction or operation of the proposed development. The application to carry out works, accompanied by the Appropriate Assessment Screening Report, was submitted to the DAHG in February 2017 and approved by the Minister the following month on the following condition:

*"The information supplied in the screening report submitted will be conditional for the granting of this application in relation to the handling, storage and disposal of hydrocarbons, invasive species, machinery daily maintenance, storage of raw materials are all to be stored and used in a way that will not contribute to damage any part of the Natura network of sites and a construction management plan is to be provided to the contractor in relation to any activity that may impact upon the Natura site"*

The works were duly completed by July 2017.

Similar works were approved at Courtown, County Wexford on the basis of an Appropriate Assessment Screening Report. Those works were part of the draft Courtown and Riverchapel Local Area Plan 2014-2020. Repair works at that site are currently ongoing.

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### **4.8.2 Case Study: Strandhill, Sligo**

In County Sligo, an Appropriate Assessment was required to carry out works on the Strandhill ETW Coastal Protection Scheme, which is adjacent to four designated areas. Plans included rock armour backed by a concrete footpath front a dune system, with a low-lying sewage plant in a dune slack. Prior to works being carried out, the Council worked closely with the NPWS and expert ecologists to ensure that proposed maintenance did not negatively affect the surrounding designated sites. Works were carried out at Strandhill from 2010-2012.

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According to LAs, Appropriate Assessments for coastal protection works, where required, tend to be funded by either the local authority, the OPW, or a combination of both.

Two key challenges of carrying out coastal defence works within designated sites, that emerged as part of the telephone interviews, are summarised as follows:

- Defence of residential properties - In County Wexford, residents have not been able to obtain the required permissions to defend their properties. In such situations, Wexford County Council were aware of residents, in fear of losing their homes, carrying out the work despite lack of permission.
- Clarity regarding what types of works are allowed or not allowed within designated sites - Eight LAs said it is not clear what can and cannot be done within designated sites, and 17/18 stated it would be useful to clarify this and include procedures in any future national policy of best practice guidelines.

### 4.9 Key Recommendations

- Coastal erosion should be a national priority
- National policy on coastal erosion would benefit from clarity with regard to defence works in designated areas.
- Further training in coastal erosion protection techniques should be provided to LAs, including but not limited to, assessing erosion, choosing areas to protect, the use of hard and soft engineering techniques, funding applications, defending the coast in SACs and SPAs, and dealing with private property and the public.
- LAs and private landowners need clarity on how to approach private property subject to coastal erosion.
- LAs need guidelines on how to manage coastal erosion in designated areas such as SACs.
- A national approach to coastal erosion would provide more value for money, rather than funding smaller projects individually.

### 5 International Literature

To assist in the development of a sustainable and viable coastal erosion policy or best practice guidelines for Ireland it is important to examine the approaches adopted in other countries with similar coastal issues. This section provides an overview of policies, procedures and funding approaches in a number of representative countries. Responses to coastal erosion from the Netherlands, United Kingdom (UK), USA, and Denmark were investigated and supplemented by a wider review of international practices. These countries are seen, though not exclusively, as having the most applicable coastal erosion approaches for Ireland.

It should be noted that direct comparison of policy and approaches between countries is often difficult, due to differences in legal frameworks, the economic environment and funding available, and social/community pressures for actions and societal acceptance. Investment in coastal infrastructures required in countries will also vary depending on a range of physical and linked environmental factors. These include:

- Coastline length
- Exposure to waves, extreme tidal regimes
- Sedimentary changes
- Geology
- Topography
- Coverage and condition of existing protection and defence schemes
- Land use type, intensity and future plans

(RPS, 2004)

It is evident from the literature the issue of coastal erosion is being addressed internationally using similar methods, though the history of ‘starting’ and the innovation of practices, financing, approaches and techniques does differ between countries (Pranzini & Williams, 2013; Devoy, 2015; García-Ruiz, et al., 2015; Williams, et al., 2017).

#### 5.1 Key Principles of National Coastal Protection Policy

##### 5.1.1 The Netherlands

In the Netherlands, coastal management (including erosion management) is steered by national and regional programmes and plans rather than by local authorities. The Ministry of Infrastructure and Environment is the overall body responsible for managing the coast and setting out policy. *Rijkswaterstaat* is the executive body of the Ministry, and they are responsible for the effective and efficient implementation of policy at the national level, including coordination, planning, contracting and knowledge development. Working closely with the *Rijkswaterstaat* are the coastal regional and local authorities – the water boards, provinces and

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municipalities. At the regional level, water boards are responsible for the management of flood risks and the construction and maintenance of coastal defences. Provinces and municipalities are primarily responsible for spatial planning and economic development. Apart from the requirement on provincial authorities to inspect the safety of primary and regional weirs on a regular basis, provinces and municipalities are not responsible for erosion management, although they are encouraged to engage with the regional and national authorities on coastal management and protection issues.

Collaboration between national, regional and local authorities on coastal protection is presently supported by the Delta Programme, a nationwide venture that promotes stakeholder engagement with the aim of ensuring safety against flooding and adequate freshwater supply. The Delta Programme was established in 2008, and it is the responsibility of a specifically appointed government official, the Delta Commissioner, to ensure coordination and implementation of the programme and to encourage stakeholder involvement. While the Minister of Infrastructure and the Environment has ultimate responsibility for the Delta Programme, the Ministries of Economic Affairs, Security and Justice, the Interior, and Finance are also involved in the programme.

With regard to coastal erosion, the Delta Programme employs the policy of 'dynamic preservation', which is based on the 'hold-the-line' principle. Under this policy, the Dutch coastline is to be maintained in its 1990 position. Every 5-6 years, this line is evaluated and adjusted, if necessary. Maintenance of the coastline is achieved primarily through sand nourishment, a method that fits with the natural physical characteristics of the Dutch coast. *Rijkswaterstaat* perform annual coastal surveys to check whether nourishment is required. Nourishment is carried out by international dredging companies under the direction of the *Rijkswaterstaat*. In line with the principles of the Delta Programme, *Rijkswaterstaat* always maintains contact with local authorities to determine the appropriate time to carry out works.

In addition to its role in the coordination, planning and contracting of coastal works, *Rijkswaterstaat* actively promotes knowledge development. For example, they began an innovative experiment in 2011 – the sand engine (de zandmotor). Sediment (21.5 million m<sup>3</sup>) was injected into the Delfland coast to determine if such a practice could lead to less frequent maintenance, thus reducing the overall cost of sand nourishment and resulting in less frequent destruction to coastal habitats. The project is presently in its sixth year and will end in 2021. A second major sand supplementation project was recently completed at Petten, where 35 million m<sup>3</sup> of sand was used to build a new beach and a new dune over an existing seawall to make this part of the coast more resilient.

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The policy framework for the Delta programme is the National Water Plan, which broadly sets out national water policy and the related aspects of spatial policy. The current plan is the National Water Plan 2016-2021 (Rijksoverheid, 2015). This continues to promote dynamic preservation, but now considers future projected changes in sea-level by adjusting the estimated volume of sand replenishments required to maintain the position of the coastline.

The National Water Plan 2016-2021 is based on the National Coastal Strategy (Delta Programme, 2013). The strategy is the result of close collaboration between the coastal municipalities, coastal water boards, coastal provinces and the national government, with input from civil society organisations, research institutions and the business community. It provides a strategic plan for the sustainable and long-term maintenance of the coast up to 2050, taking into account spatial and economic development in the coastal zone. The National Coastal Strategy is presently in the implementation phase.

Under the Delta Act (2012), *Rijkswaterstaat* must assess costs associated with the implementation of the National Coastal Strategy on an annual basis and plan maintenance work over a four-year period. Before such maintenance works are carried out, all local authorities must be consulted. At that time, they have the opportunity to give their input and make any requests they might have. Such requests are only granted if they are within the strategic boundaries and co-financed by the local authority.

With regard to the protection of private property from erosion, this is virtually a non-issue in the Netherlands. This is because *Rijkswaterstaat*, under the dynamic preservation policy, ensures that there is enough sand on the beach/foreshore to protect all properties – whether publicly or privately owned. If this is not possible, a hard approach may be necessary. In this case, it is the responsibility of the regional water board to construct and maintain such defences.

### Key principle

- Hold-the-line / dynamic preservation (sand nourishment)
- Clear coordination and lines of communications between national, regional and local levels of government

### Pros

- Proved successful in maintaining the position of the Dutch coastline
- Fits with natural physical characteristics of the Dutch coast
- Nourishment maintains beaches as public amenities

### Cons

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- Regular nourishment could potentially disturb coastal habitats
- May have negative consequences for navigation channels (due to sand moving back into the shipping channel)
- Maintenance can be costly

### 5.1.2 The United Kingdom

The United Kingdom coastal erosion schemes use a mix of bottom-up, top-down and mixed approaches to erosion management, although policy and legislation differs somewhat from country to country (e.g. England, Scotland, Wales, Northern Ireland). The approaches taken in the UK are perhaps the most relevant to the situation in Ireland (Republic), due to the similarity in their physical coastal environments, coastal process drivers and government administrative structures, particularly at the Local Authority level (Cooper, et al., 2016; Devoy, 2008).

The Department for Environment, Food and Rural Affairs (DEFRA) has overall national responsibility for policy on flood and coastal erosion risk management. Coastal erosion legislation is set out in the National Flood and Water Management Act (NFWMA) 2010, together with the Waters Act 2014 in England and Wales, with national variations in laws made for Scotland and Northern Ireland (McKibbin, 2016). The purpose of the NFWMA is:

- To establish the concept of flood risk management and the framework for the development of flood and coastal erosion risk management through national and local strategies,
- To establish new conceptual and technical definitions for future legal uses, e.g., of flood, coastal erosion, Risk Management Authorities, lead Local Flood Authority
- To establish the roles and responsibilities for the different risk management authorities (e.g., for coastal erosion).

Under the NFWMA, the Environment Agency is responsible for the development of 'risks' strategies for coasts and the operation of funded schemes. At the regional to local scales, plans are implemented through the organisation of coastal Local and Lead Local Authorities (LLAs), as appropriate (DEFRA, 2011). These include district councils, internal drainage boards, and regional flood and coastal committees. These agencies are required to develop coastal erosion management strategies in conjunction with the Environment Agency and consistent with the national strategy. England has 12 Regional Flood and Coastal Committees (McKibbin, 2016).

Policy and methodological approaches to coastal erosion management in England and Wales are based on the development of Shoreline Management Plans (SMPs). These are operated at regional to local scales through Lead Local Authorities in England and Wales, for which 22 SMPs have been established. The SMPs are based conceptually on the coastal sediments cell (Marchand, 2010) and the sustainability of long-term coastal systems functioning. Development of this approach in

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shoreline planning and management has occurred through the application of more complex ecosystem type models (Cooper, et al., 2016). Together, these form part of an Integrated Coastal Management (ICM) approach to protecting the coast.

Approaches to shoreline management for specific stretches of coast (termed 'management units') are outlined within SMPs. These are based on 'strategy spectrum', from actively protecting the coast through engineered, or wider managed schemes (as existing or new). Options include no active intervention, hold the existing defence line, managed realignment, and advance the line. A public WebGIS (<https://goo.gl/evWMLA>) illustrates current management policies (up until 2030) (Environment Agency, 2017).

SMPs are developed by local authorities and the Environment Agency working together in Coastal Groups. The plans are agreed only after having engaged with interested organisations and local communities.

With respect to funding, England spends over £500m per year on coastal erosion and flood defence projects (CCC, 2014). Funding for projects and investment within flooding and coastal erosion management (FCERM) in England comes mainly from central government, through DEFRA. Between 2010 and 2015 £3.2bn has been spent on FCERM from this source, with a further £2.5bn allocated for capital investments to 2021. Most of the funding is given as grant aid and is spent on projects initiated from national strategic planning through the Environment Agency. Some of central government funding is devolved to local levels and includes grants for investment in capital works. Local Authorities also receive funding from the DCLG, as well as from non-government sources (commercial interests, private beneficiaries of projects), local level taxation and service charges. The Partnership for Funding Scheme (Grant et al., 2015) contributed additionally >£140M (2011 - 2015) to local level projects. Within the other three devolved administrations this pattern of primarily centralised funding is repeated, but with variations in the administrative structures and governing legislation (McKibbin, 2016; Environment Agency, 2010). Figure 5-1 illustrates the main sources of funding for flood and coastal erosion risk management.



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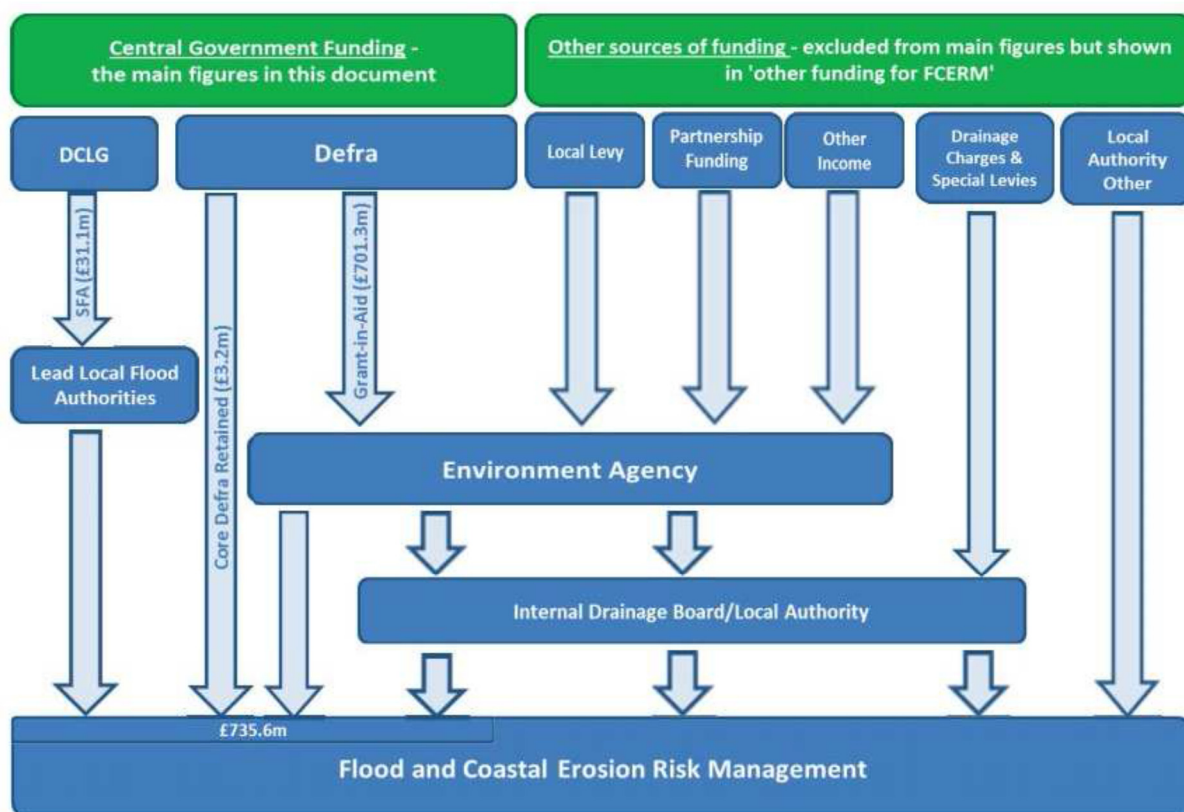


Figure 5-1 Diagram of FCERM funding (Department for Environment Food and Rural Affairs - UK, 2015)

Under the DEFRA policy on Flood and Coastal Resilience Partnership Funding (May 2011), the amount of flood and coastal erosion risk management grant in aid (FCERM GiA) available to any capital project directly relates to the outcomes the project delivers.

According to DEFRA (2011), outcome Measures (OM) include:

OM1 - The average cost-benefit ratio across the capital programme based upon the present value whole life costs and benefits of projects delivering in the CSR10 period.

OM2 - Number of households moved out of any flood probability category to a lower category; Number of households for which the probability of flooding or coastal erosion is reduced from the very significant or significant category to the moderate or low category; Number of households in the 20% most deprived areas moved from the very significant or significant flood probability category to the moderate or low category.

OM3 - Number of households better protected from coastal erosion; Number of households protected against loss in 20 years from coastal erosion; Number of households in the 20% most deprived areas protected against loss in 20 years from coastal erosion.

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OM4 - Hectares of water dependent habitat created or improved to help meet the objectives of the Water Framework Directive; Hectares of intertidal habitat created to help meet the objectives of the Water Framework Directive for areas protected under the EU Habitats/Birds Directive; Kilometres of rivers protected under the EU Habitats/Birds Directive improved to help meet the objectives of the Water Framework Directive.

OM5 - The proportion of households and businesses in highest risk areas that receive the Floodline Warnings Direct (FWD) service.

OM6 - Proportion of residential units within planning decisions where the application has been refused or has been amended in line with Environment Agency advice.

Outcome measures are used to determine the amount of grant aid available to a project. Businesses are able to contribute to coastal erosion defence schemes. As a result, they may pay less corporation or income tax as the partner project contribution is tax deductible.

### *The Pathfinder Project*

In 2009, DEFRA introduced the Coastal Change Pathfinder programme, which aimed to road test new and cost-effective approaches to planning for and managing coastal change. The project awarded grants to 15 local authorities who demonstrated the best and most innovative ideas for dealing with and adapting to coastal change. The scheme encouraged working with local communities to adapt to coastal erosion.

Out of the 15 participating local councils, there were five large projects (each receiving  $\geq$  £1 m) and ten small projects. The large projects explored, and in some cases implemented, were:

- (1) Rollback and buy and lease back schemes<sup>6</sup>,
- (2) Amenity, tourism and business solutions, and
- (3) Community engagement and partnership working.

Table 5-1, adapted from a DEFRA-commissioned evaluation of the projects (Regeneris Consulting, 2011), provides an overview of these projects.

All five large Pathfinder projects trialled rollback schemes to varying degrees of success. The North Norfolk Pathfinder project, the largest of the 15 projects, is an example of a project that successfully tested this approach. As part of that project, the local council offered planning permission for residents at immediate risk of erosion to build elsewhere. The residents had the option of selling the planning permission and their property to the council in return for

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<sup>6</sup>. 'Rollback' is the re-location of assets inland away from threats posed by coastal change. 'Buy and lease back' is the purchase of at-risk property by the local council. The property is then either rented by the previous owner or an unrelated tenant or used as a holiday let.

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approximately 50% of the market value of their home if it were not at risk. Nine families used the scheme, all of which sold their properties and planning rights to the local council. The Council demolished the homes and built a car park and a toilet block, which could more easily be moved inland should the coast retreat further. The unused planning rights were sold to developers, and with the money, the council set up a fund for future adaptation schemes. This self-funding model could potentially be successfully applied in Ireland.

Another promising idea, arising from the East Riding Pathfinder project, is the development of a consistent definition of 'imminent risk.' This has ensured consistency, allowed transparency, and helped to prioritise the most vulnerable residents, which in turn has led to greater acceptance of decisions amongst the community. The approach, however, requires that a coastal monitoring programme be in place.

'Buy and lease back' schemes were considered as part of the five large Pathfinder projects. These schemes, however, could not be tested due to the costs involved and the lack of interest from private landlords. This approach was therefore generally deemed to be unfeasible.

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Project Approach	Tendering (£1m)	Scarborough (£1m)	East Riding (£1.2m)	Waveney (£1.5m)	North Norfolk (£3m)
<b>Rollback and Buy and Lease Back projects</b>	<ul style="list-style-type: none"> <li>Buy and demolish 4 properties at Jaywick</li> <li>Considered buy and lease back but no Registered Social Landlords (RSL) interested</li> </ul>	<ul style="list-style-type: none"> <li>Work to relocate 9 properties at Knipe Point through provision of a serviced site.</li> <li>Households then use insurance payment to fund development.</li> </ul>	<ul style="list-style-type: none"> <li>Rollback review and links to the local development framework (LDF) to consider how business properties can be assisted</li> <li>Agreed approach for prioritising communities at risk</li> <li>A relocation and adaptation package to support communities at risk and provide them with an incentive to move</li> <li>Also considered buy and lease back</li> </ul>	<ul style="list-style-type: none"> <li>Rollback of 9 households at Easton Bavents.</li> <li>Council purchases a site and households fund property and infrastructure.</li> </ul>	<ul style="list-style-type: none"> <li>Relocation of 9 properties at risk. Council provides financial contribution to households to move (to any location), purchases a site for rollback and uses planning policy to realise an economic value which part funds process.</li> <li>Consideration of buy and lease back options</li> <li>Business plan to support rollback of Manor Caravan Park</li> <li>Rollback of Trimmingham Village Hall</li> </ul>
<b>Amenity / Tourism / Business Projects</b>	<ul style="list-style-type: none"> <li>Brooklands Gardens – derelict land affected by coastal erosion bought back into use</li> <li>Crag Walk, 150m rock revetment allows visitors to view effects of coastal erosion and provided protection to some properties (Naze Tower, Cafe, Car Park)</li> </ul>		<ul style="list-style-type: none"> <li>Business Package under small grants scheme</li> </ul>	<ul style="list-style-type: none"> <li>A range of projects to increase the vitality of Corton as a destination for residents and visitors e.g.: Improved access to beach CCTV</li> <li>Toilets, kiosk/cafe at beach</li> <li>Cliff top erosion study and improvements</li> <li>Nature Walks and interpretation at Corton Woods</li> </ul>	<ul style="list-style-type: none"> <li>Cliff top enhancement project at Happisburgh (car park, toilets, access ramp, removal of beach debris)</li> <li>Coastal Heritage Project at Happisburgh</li> <li>Business Support projects including <i>Tourism Audit</i> of East Norfolk Coast</li> <li>Realignment of <i>Marams Footpath</i></li> <li>Removal of beach debris at Beeston Regis</li> </ul>

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<b>Community Engagement and Partnership Working</b>	<ul style="list-style-type: none"> <li>Community Development Worker to work with residents to raise awareness of coastal erosion</li> </ul>		<ul style="list-style-type: none"> <li>Partnership working and group structures to put in place support structures for those at risk of coastal erosion</li> </ul>		
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*Table 5-1 Summary of key outputs and outcomes for 5 largest Pathfinder projects. Adapted from DEFRA (2011)*

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The ten smaller Pathfinder projects concentrated on community engagement, adaptation planning, and delivering adaptive solutions. Table 5-2 provides an overview of these schemes. Community engagement projects included, for example, the development of teaching and learning materials for schools, community workshops, and community education and information programmes. These types of projects are important because they help to increase public knowledge and understanding of coastal change and foster positive relationships between the local council and communities. Approaches to community engagement that worked well include the following:

- A community-led approach, whereby the community is involved in the decision-making process (e.g. through community workshops organised by the local council)
- The development of a wide range of communication tools, including scenario planning, visualisations of coastal change and timelines or stories of change
- Research into spatial planning and coastal change (e.g. the Selsey Coastal Trust model provided a means of raising local contributions to defence schemes)

The Pathfinder Projects emphasise the use of different economic, property and other market schemes in financing, allowing many more flexible and small-scale funding sources to be involved. According to a report commissioned by DEFRA (2012), fourteen of the fifteen projects were determined to have delivered good value for money.

Other more recent approaches to the management of coastal change in the UK can be found in individual shoreline management plans. Some additional innovative approaches that could be transferred to Ireland include:

- The development of an online tool to help monitor and protect shingle beaches, commissioned by the New Forest District Council (HR Wallingford, 2016)
- The use of discarded Christmas trees to reinforce sand dunes in Wales, a joint venture managed by Denbighshire and Flintshire County Councils (Forgrave, 2016)
- The organisation of coastal management workshops (e.g. *Resilient coastal communities: innovation in coastal management and infrastructure*, held in 2015) – see <https://www.thecrownestate.co.uk/media/451413/ei-resilient-coastal-communities-innovation-in-coastal-management-infrastructure-flyer.pdf>

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Project	Community engagement	Adaptation planning	Delivering adaptive solutions	Other outputs
Lincolnshire (£810k)	<ul style="list-style-type: none"> <li>Coastal awareness campaign to increase flood risk awareness and emergency preparedness</li> <li>Targeted testing of engagement techniques to increase flood risk awareness</li> <li><i>Mablethorpe Case Study</i>, which will deliver a range of awareness raising activities based in a new community information hub building</li> </ul>	<ul style="list-style-type: none"> <li>Developing principles and potential spatial planning options through a <i>Coastal Study</i></li> <li>Mass evacuation research, resulting in improved plans for evacuation of vulnerable groups;</li> <li>Improved knowledge of “hidden” caravan community</li> </ul>		<ul style="list-style-type: none"> <li>Economic coastal model testing impacts of economic development, investment, climate change adaptation and housing market changes in the coastal region</li> <li>Design solutions e.g. handbook of flood resilience solutions; toolkit for developers in flood risk areas</li> </ul>
Chichester (£450k)	<ul style="list-style-type: none"> <li>Development of <i>Coastal Literacy</i> programme of engagement and awareness raising</li> <li>Set up <i>Coastal Change Grants Scheme</i> (supported 12 community projects)</li> </ul>	<ul style="list-style-type: none"> <li>Adopted <i>Towards ICZM</i> as an aspirational plan and material planning consideration</li> </ul>	<ul style="list-style-type: none"> <li>Re-instatement of beach access ramp at Selsey</li> </ul>	<ul style="list-style-type: none"> <li><i>Selsey Coastal Trust</i> (testing whether a trust could manage regeneration projects on publicly owned land, with profits funding coastal defence activity)</li> <li><i>Manhood Peninsula Destination Management Plan</i> setting out key issues and actions for those interested in the local visitor economy</li> </ul>
Jurassic Coast/Dorset (£376k)	<ul style="list-style-type: none"> <li>Scenario planning workshops in six case study areas, leading to development of adaptation options</li> <li>Training for community leaders</li> <li>Exchange visits for communities</li> <li>Facilitator training for public servants</li> <li>Public exhibition showing workshop conclusions</li> <li>Baseline and follow-up public opinion surveys in six case study areas (follow-up survey showed no significant change in awareness of coastal change)</li> <li>Education project to embed coastal change in the Geography curriculum in local schools</li> </ul>	<ul style="list-style-type: none"> <li>Research into how spatial planning can best support sustainable adaptation to coastal change</li> </ul>	<ul style="list-style-type: none"> <li>Community Adaptation Fund – to support adaptation options identified at workshops</li> </ul>	
Sefton (£337k)	<ul style="list-style-type: none"> <li>Formby Point visualisation</li> <li>Car park study</li> <li>Caravan park engagement</li> </ul>	<ul style="list-style-type: none"> <li>Dune slack study</li> </ul>	<ul style="list-style-type: none"> <li>Boardwalk construction</li> </ul>	

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	<ul style="list-style-type: none"> <li>• Dissemination activity</li> </ul>			
Scratby/Great Yarmouth (£296k)	<ul style="list-style-type: none"> <li>• Community education and information programme</li> </ul>	<ul style="list-style-type: none"> <li>• Research into equity release and equity transfer schemes</li> <li>• Research into funding sources for rollback</li> <li>• Exploration of rollback options</li> <li>• Development of a Community Adaptation Management Plan</li> </ul>		
Hampshire (£254k)	<ul style="list-style-type: none"> <li>• Community engagement on <i>Coastal Change –past, present and future</i></li> <li>• Structured workshops to identify, assess and prioritise adaptation opportunities (e.g. Lepe Country Park);</li> <li>• Education/ awareness raising events involving ten schools and colleges</li> </ul>	<ul style="list-style-type: none"> <li>• Adaptation plan covering Beaulieu to Calshot</li> </ul>	<ul style="list-style-type: none"> <li>• Feasibility study on possible access improvements in Lepe Country Park</li> </ul>	
Cuckmere/East Sussex (£250k)	<ul style="list-style-type: none"> <li>• Consensus achieved on way forward for the estuary</li> <li>• Development of <i>Friends of Cuckmere</i> to help take forward preferred option (defence in the short term and reactivation of the meanders in the long term)</li> </ul>	<ul style="list-style-type: none"> <li>• Research completed on the economy, visitor profile, landscape and heritage of the estuary, including visual modelling of the options</li> </ul>		
Somerset (£235k)	<ul style="list-style-type: none"> <li>• Scenario planning tool – using future scenarios to identify adaptation measures (Porlock Weir)</li> <li>• One-year funding for a community engagement officer (Stear) )</li> <li>• Development of a community coastal change monitoring initiative (Brean and Berrow)</li> <li>• DVD on Somerset"s changing coastline;</li> <li>• e-game for all Somerset primary schools to enable children to learn about and explore the coast</li> </ul>	<ul style="list-style-type: none"> <li>• Development of an adaptation action plan for Porlock Weir</li> </ul>		
Hastings (£116k)	<ul style="list-style-type: none"> <li>• Consultation with fishermen – consensus reached on the initial options presented on adapting to accretion</li> <li>• Historical record of the impact of coastal change upon the fishing community</li> </ul>	<ul style="list-style-type: none"> <li>• Shingle movement study and development of adaptation options – study on reasons for and impacts of climate change on shingle movement in the harbour, and recommended</li> </ul>	<ul style="list-style-type: none"> <li>• Small fund to help deliver the preferred option(s)</li> </ul>	



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		options to reduce its impact on the fishing industry		
Slapton Line/South Hams (£38k)	<ul style="list-style-type: none"> <li>• <i>Coastal Change Adaptation Toolkit, Timelines and the changing coast</i> archive photographs, articles and videos</li> <li>• Schools outreach and engagement, including a programme of 'Learning with a Changing Coast'</li> </ul>			<ul style="list-style-type: none"> <li>• Activity related to business and tourism adaptation and resilience, focusing on interpretation points</li> </ul>

Table 5-2 Summary of key outputs and outcomes of 10 small Pathfinder projects. Adapted from DEFRA (2012)

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### 5.1.3 The United States

In the United States, federal, state and local (county and municipal) government agencies have responsibility for erosion management. Table 5-3 outlines the functions of these bodies. The role of the federal government is to set out policy, provide funding, and provide technical assistance

Government body	Role
Federal government	<ul style="list-style-type: none"> <li>• Sets out national policy</li> <li>• Approves state programmes</li> <li>• Coordinates national interagency actions</li> <li>• Ensures national interests are protected</li> <li>• Provides technical assistance and federal funding to approved State programs</li> </ul>
State government	<ul style="list-style-type: none"> <li>• Defines State interests in their coastal zone</li> <li>• Develops and implements coastal management programmes</li> <li>• Coordinates state interagency policies</li> <li>• Provides matching State funds</li> <li>• Ensures state policies are consistent with national policy</li> <li>• Provides technical assistance to local governments</li> <li>• Ensures public participation in all phases of management</li> </ul>
Local (county and municipal) government	<ul style="list-style-type: none"> <li>• Develops and enforces local regulations over land and water uses</li> <li>• Coordinates local interagency activities</li> <li>• Supports outreach and education</li> <li>• Provides a forum for public participation on relevant issues</li> </ul>

Table 5-3 Role of US government in erosion management, after Olsen & Ricci (2011)

to state governments. The chief federal agencies responsible for protection from shoreline change include:

- United States Army Corps of Engineers (USACE)
- Federal Emergency Management Agency (FEMA)
- National Oceanic and Atmospheric Administration (NOAA)
- United States Geological Survey (USGS)
- Minerals Management Service (MMS) of the Department of the Interior

The primary policy framework for erosion management in the US is the Coastal Zone Management Act (CZMA) of 1972. The goal of the CZMA is to “preserve, protect, develop and where possible, to restore or enhance the resources of the nation’s coastal zone.”

The Act established three national

programmes with relevance to erosion management:

- The National Coastal Zone Management Program – a programme that encourages States to develop and implement coastal zone management plans (CZMPs),
- The National Estuarine Research Reserve System - a programme for the establishment of a system of designated zones designed to protect and study estuarine systems, and
- The Coastal and Estuarine Land Conservation Program (CELCP) - a programme for funding the purchase of threatened lands or obtaining conservation easements.

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Twenty-nine out of thirty coastal states currently participate in the National Coastal Zone Management Program<sup>7</sup>. Participation in the program is voluntary, but it is in most states interests to do so in order to access federal funding. Governments of participating states must ensure that the policies outlined in the CZMP are consistent with that of the federal government (otherwise, they will be denied funding). The program does, however, give states the flexibility to design unique programs that best address their coastal challenges and regulations.

US states employ a range of approaches to coastal erosion management, including structural (e.g. seawalls, rip rap, etc.) and non-structural (e.g. dune stabilisation) solutions (NOAA, 2016). While structural protective measures may be effective in protecting properties at immediate risk, they are expensive to build and maintain and may have negative unintended consequences for adjacent coastal areas. For example, historical seawall and revetment construction over several decades in Oahu, Hawaii has resulted in the narrowing or loss of almost a quarter of the island's originally sandy shoreline (Fletcher, et al., 1997). The USACE has repeatedly highlighted this issue, emphasizing the need for states to consider non-structural solutions. In Oregon, legislation is in place that requires that alternative considerations to the employment of hard structures are considered first. In North Carolina, there is an outright ban on the construction of hard structures for coastal protection, although the policy remains controversial.

Popular non-structural methods for controlling erosion in the US include:

- beach nourishment,
- dune stabilization with fences and vegetation,
- protecting, nourishing or constructing dunes,
- wetland protection, and
- habitat restoration.

Beach nourishment is common practice in the US, especially along the eastern seaboard where beaches are popular tourist destinations. There is growing recognition, though, that it is not a viable solution to coastal erosion in the long term. Not only is it expensive – for example, it cost in excess of \$10 million to re-nourish Virginia Beach following Hurricane Sandy – but can also be unsustainable - *e.g.* Gares et al. (2006). Virginia Beach, prior to Sandy, was re-nourished 48 times since 1951 (Muka, 2015).

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<sup>7</sup> American Samoa, the Northern Mariana Islands, Guam, Puerto Rico, and the Virgin Islands also have CZMPs.

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A third approach to coastal erosion management in the US, alternative to structural or re-nourishment solutions, is managed retreat<sup>8</sup>. Like the rollback approach trialled in some of the UK pathfinder projects, managed retreat is a strategy that allows the shoreline to move inland. As part of the implementation of this policy, state and local authorities encourage demolition or relocation of structures threatened by erosion and discourage new development in these areas. This may be achieved through the formal designation of shorefront no-build areas, e.g. areas where new developments are prohibited (NOAA, 2012). Restricted development in no-build areas is typically achieved through one or more of three mechanisms – shoreline setbacks, rolling easements, and/or zoning.

### *Setbacks*

Shoreline setbacks place restrictions on development within a given distance from the shoreline. They may be based on a fixed distance or the long-term annual erosion rate. In South Carolina, setbacks limit development from the shoreline to a distance forty times the average annual erosion rate.

### *Rolling easements*

Rolling easements limit future development to allow for the natural migration of shorelines in response to coastal change. Easements are usually delineated by a physical feature, such as the vegetation line, and may move or “roll” landward in response to changes in water levels. In Texas, a rolling easement coinciding with the line of natural vegetation is used to define the limit of a public beach.

### *Zoning*

Zoning is a mechanism for regulating land use that divides jurisdictions into zones or districts. Zoning laws can define setbacks and/or rolling easements or designate no-build areas. In some cases, zoning laws permit development in no-build areas on the condition that the property owner (and not the government) will be responsible for removing these structures if and when they become threatened by coastal erosion.

Relocation, buy-back, and buy-out programs may also be used to achieve managed realignment. Under these programs, federal and state governments offer incentives, such as subsidies or grants, for property owners to relocate. Funding is provided for this purpose under the CELCP. States that actively encourage public acquisition of coastal lands for conservation include Maine,

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<sup>8</sup> Also known as managed realignment

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Massachusetts, North Carolina, Virginia, and Florida. Some examples of significant managed retreat projects are the [Surfers' Point Project](#) (Ventura, CA) and [Pacifica State Beach](#) (Pacifica, CA).

Managed realignment is not always a popular coastal erosion control option, though, especially in highly developed coastal areas. Some property owners are resistant to change, and no amount of coaxing by federal, state or local governments can convince them otherwise (Cooper & Pile, 2014). An example of resistance to managed retreat in the US is the case of the [Riggings condominium development](#) in North Carolina, which has resulted in a lengthy legal battle between homeowners and the state. In many States, it is hoped that raising public awareness of erosion-related issues will change attitudes toward erosion management. Examples of educational initiatives include the development of [educational materials](#) by the South Carolina Department of Natural Resources and the South Carolina Geological survey as well as the development of a [web-based coastal atlas](#) in Oregon.

In relation to private property, state and federal funded insurance programs subsidise high-risk shoreline development. However, some of these programs are massively in debt and have been criticised as not being fiscally sound (King, 2011; Leatherman, 2017). States have different laws in place in relation to dealing with private property. In Rhode Island, if more than 50% of a structure is destroyed due to storm damage, rebuilding of the structure on the property is prohibited.

For many states, compliance with legislation requires that coastal monitoring activities be undertaken on a regular basis. Various divisions of the National Oceanic and Atmospheric Administration use a combination of light detection and ranging (LiDAR) and satellite and aerial imagery to monitor coastal change. More detailed surveys may be undertaken by the United States Geological Survey (USGS), the USACE, or state agencies, such as state departments of natural resources.

### Key principles

- Non-structural solutions increasingly being employed
- Growing recognition that attempting to “hold the line” is not feasible here (Folger & Carter, 2016)
- Managed realignment achieved through protection/restoration of natural areas, setbacks, rolling easements, zoning, and/or relocation and buy-back and buy-out programs

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### Pros

- Growing awareness and use of policies and programs in the US to **proactively** address coastal erosion issues (*e.g.* Pacifica and Ventura managed retreat projects in CA)

### Cons

- Maintenance can be expensive where hard structures are employed, and there may be negative consequences for adjacent shorelines
- Beach nourishment maintenance costs can be high and nourishment may negatively affect adjacent coastal areas and/or disrupt coastal habitats.
- There can be public resistance to managed realignment.

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### 5.1.4 Denmark

Erosion management in Denmark is, for the most part, carried out by coastal landowners (Dronkers & Stojanovic, 2016; Kystdirektoratet, 2015). The responsibility of the national government is to provide them with guidance and tools (*e.g.* the [Coastal Analysis WebGIS](#)). National policy is set out in the Coastal Protection Act, which is based on the first Dike Act of 1874 and subsequently on the Coastal Defences Act of 1922. Under this Act, property owners must apply to and gain permission from the Danish Coastal Authority (Kystdirektoratet) to undertake coastal protection activities. The decision to grant permission is based on the following considerations:

1. The need for coastal protection,
2. financial considerations,
3. technical and environmental quality of the coastal protection measure,
4. conservation of the coastal landscape,
5. the free expression of nature,
6. recreational exploitation of the coast,
7. securing existing access to the coast and
8. Other matters of major importance for coastal protection.

(Kystdirektoratet, 2017)

The considerations are not prioritised, but landowners must at a minimum demonstrate that there is a need for coastal protection, the proposed works comply with coastal planning regulations, and, if in or near a Natura 2000 site, they do not have a negative impact. If permission is granted, landowners must bear all costs relating to construction, operation and maintenance of the proposed activities.

In relation to proposed projects in Natura 2000 sites, Kystdirektoratet is responsible for assessing whether the designated site will be significantly affected by a proposed project. This is done through a screening process. The first stage of screening involves a review of the application and consultation with any other agencies that may be affected by the works. If, based on this initial appraisal, the Kystdirektoratet cannot rule out that the project will have a significant impact on the designated area, an impact assessment must be performed, which is paid for by the applicant (landowner). The project will only go forward for further consideration if the impact assessment shows that it will not have a significant impact on the designated site (Kystdirektoratet, 2017).

There are some cases where the protection of the coast is in the national interest. In these instances, the government will participate in the construction and operation of coastal protection.

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For example, since 1983 the Danish Coastal Authority has worked with local municipalities along a 110 km stretch of coast from Lodbjerg to Nymindegab to carry out protection works. These works include slope protection, building breakwaters, and beach nourishment with some 59 million m<sup>3</sup> of sand. Where municipalities initiate coastal protection projects, they must (like landowners) apply for permission from the Danish Coastal Authority. Such projects are financed with local taxes or through public-private partnerships (European Commission, 2009). Local municipalities may also play a role as facilitator, broker or mediator between landowners when there is a need to protect large stretches of coast (Esben & Pedersen, 2017).

In the past, coastal protection in Denmark was primarily limited to the construction of hard structures, such as dikes, revetments, groynes, breakwaters, jetties and other constructions (Kystdirektoratet, 2015). Recently, though, the Danish government has recognised the need for ICZM, and, in 2011, the Danish Coastal Authority launched a national coastal protection strategy (Kystdirektoratet, 2011) based on ICZM principles. Landowners are now encouraged to consider softer alternatives - beach nourishment, in particular - and to remove inefficient existing protection, such as damaged concrete structures and construction waste (Kystdirektoratet, 2015; Kystdirektoratet, 2011). The new national strategy specifically emphasises the need to ensure coastal protection projects do not affect downstream coasts and provides landowners with suggested options for their consideration. It also encourages stronger coordination amongst the authorities administering coastal activities and improved cooperation between landowners and authorities.

The Danish model of erosion management has some drawbacks, particularly where, according to Environment and Food Minister, Esben Lunde Larsen, and Chairman of the Technology and Environment Committee in KL<sup>9</sup>, Jørn Pedersen, “landowners do not understand (or accept) the allocation of responsibilities” (Esben & Pedersen, 2017). While public forums have been set up by the government, Esben and Pedersen suggest more action is required, and assured that the government would explore ways in which the state can play a more active role in erosion management; For instance by taking more responsibility to coordinate efforts, exploring whether existing legislation is sufficient to solve the challenges faced by climate change, and determining whether there is a need for new legislation.

### Key principles

- Landowners responsible for carrying out protection works, with some exceptions

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<sup>9</sup> KL (Local Government Denmark) is the association and interest organisation of the 98 Danish municipalities



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- Relatively recent development of a national coastal strategy based on ICZM principles

### Pro

- Government not responsible for funding (most) protection works

### Con

- Policy has created friction between landowners and government

## 5.2 EC Recommendation on ICZM (2002/413/EC)

The European Commission recognises that an integrated approach is needed to tackle the issue of coastal erosion in Europe (EC, 2016). As such, the European Parliament and Council introduced the EU Recommendation on Integrated Coastal Zone Management, which was adopted on 30 May 2002 (2002/413/EC). The voluntary policy, supported by an expert group comprised of representatives from the European Commission, Member States, Candidate countries and relevant European coastal interest or stakeholder groups, outlines steps which Member States should take to develop national strategies for ICZM. It encourages a holistic approach to erosion management, which does not single out, for example, erosion or flooding as isolated issues, but treats them as issues that should be addressed in a wider context. In relation to coastal erosion and ICZM, the European Commission states: "To tackle coastal erosion an integrated approach is needed. This approach should include practical measures (preserve dune strength, maintain beach width, allow retreat of shoreline in a controllable way) as well as the elaboration of management plans" (European Commission, 2016). The EC Recommendation on ICZM sets out eight principles for integrated coastal zone management. These are:

1. Adopt a broad and holistic perspective (thematic and geographic)
2. Take into account local specificity
3. Use adaptive management (learning by doing)
4. Work with natural processes
5. Take a long-term perspective
6. Involve all parties concerned
7. Ensure the support and involvement of all relevant bodies
8. Use a combination of instruments – *e.g.* legal and regulatory, economic (fines/penalties), voluntary, technology, research, etc.

EU Recommendation on Integrated Coastal Zone Management ([2002/413/EC](#))

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### 5.3 EU Coastal Erosion Research

Many large-scale coastal erosion research projects have been carried out at EU level including, for example, iCOAST and EUROSION. The EUROSION project, completed in 2004, provides a pan European view of the status of erosion along EU coasts, with an erosion data inventory and maps for different countries. The EUROSION study also deals with coastal erosion approaches. Importantly, it emphasises the need to have one overarching management body accountable for coastal erosion in a country, providing clarity on responsibility and acting as the key national contact point with readily available information for LAs. During the study, the following barriers to effective coastal erosion management were highlighted:

- Considerable fragmentation of data repositories and host institutions
- Duplication of data production efforts
- Reluctance to release key information
- Poor archiving and dissemination capacity

(EUROSION, 2004)

The ECOPRO project (Environmentally Friendly Coastal Protection) provides a detailed guide to the different methods for coastal erosion assessment and protection; primarily for Ireland, but of use internationally. One of the main outcomes of that work was the development of a Code of Practice, which follows a logical step-by-step path guiding users through the assessment and solution of an erosion problem. A key feature of the code of practice was the development of decision support flowcharts, which are user-friendly and practical ways for coastal managers to address complex erosion-related issues. The layout of the code of practice is illustrated in Figure 5-2.

Another valuable feature of the work is the establishment of sensitivity indexing for a coast's vulnerability to erosion. The index provides the non-specialist with a method of assessing the vulnerability of the coast to erosion and to help identify its causative factors. This was integrated into the decision support system described above.

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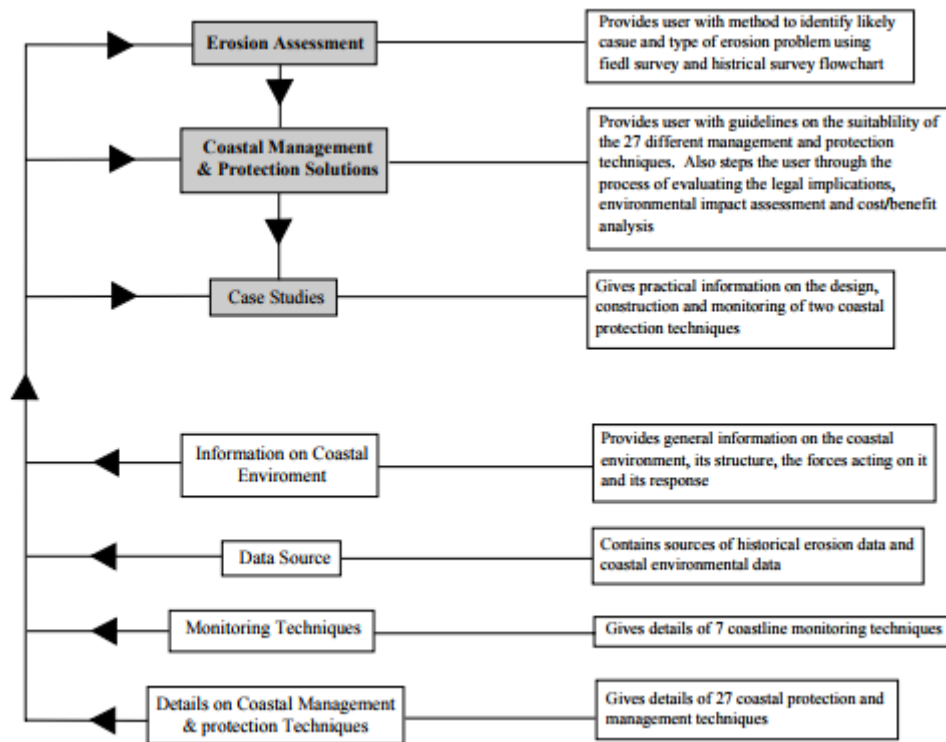


Figure 5-2 ECOPRO Code of Practice. The code of practice is intended to guide the user through the assessment and solution of an erosion problem

The contemporaneous EU project CONSCIENCE, provides more recent conceptual and methodological material, together with an alternative framework for managing erosion. This has the approach of sediment balance as its core, developing four key issues to managing erosion raised in the EUROSION project, of:

- coastal resilience
- coasts as sediment cells
- the current sedimentary characteristics of coasts (accumulation – loss – flux)
- future availability of sediments.

This coastal process – functioning based approach also establishes a structural framework for coastal erosion management, comprising:

- strategic policy and governance
- data gathering, from coastal monitoring and modelling, together with the use of coastal state indicators (e.g., beach width, volume, beach barrier crest height and position)
- erosion management techniques, both hard and soft engineered options.

Other useful reviews of approaches to coastal erosion are accessible in the EU FP6 Project CONSCIENCE, 2007-2011 (Marchand, 2010).

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The iCOAST project researched the innovation of rapid response techniques in providing coastal protection, particularly urban coasts, though the approaches established can be applied to any coastal situation. The report provides several relevant conclusions and observations on approaches to deal with the issues and management of coastal erosion. The use of rapid response protection techniques (QDM/QAM) is recommended as part of a planned approach in meeting and coping with the impacts of erosion and wider coastal vulnerability. The suggested guidelines in implementing this approach can be found in (iCoast, Integrated Coastal Alert System. [www.icoast.eu](http://www.icoast.eu)). This suggests 5 sequential steps, as follows:

1. Establish a detailed coastal process understanding for a site, together with the set-up of a monitoring system of coastal functioning. This forms the basis for the subsequent development of coastal modelling and projections of coastal changes
2. Set-up a coastal stakeholder/ user group, to address issues of community *awareness building* and the development of appropriate governance structure(s) for managing the coast. This should be linked to the dissemination within the wider community of knowledge and understanding of coastal responses to environmental and linked process changes, consequent management needs and other issues, together with a framework for further community interactions
3. Provide an Early Warning system (including the development of morpho-hydrodynamic modelling) for the forecasting and tracking of extreme events in coastal and contiguous marine areas (the system linked to 'step' 1.)
4. Undertake 'cost-benefit' type analyses for the coastal setting (e.g., an urban coast), under varying projections of future environmental changes and extreme event impacts.
5. Develop a strategy of QDM/ QAM use, as outcomes of 1. and 4., and as part of the local - regional management and planning policy for coastal protection, in which the short - long-term appropriateness and viability of fixed protection structures are assessed

The iCOAST report provides both a review of the measures, at different spatial, and temporal scales used to protect coasts from erosion, and an extensive listing of supporting references.

### 5.4 Proposed Irish Future National Coastal Protection Guidelines

National coastal erosion policy should have two principle components – a strategy framework, led by the Department of Communications, Climate Action and Environment, and a structure programme, delivered by local agencies (e.g. local authorities, and where their remit extends, the OPW and the NPWS). The policy, in essence, should have a link-type framework, e.g. nationally coordinated from a strategy perspective and locally integrated from a delivery aspect (a locally integrated, nationally coordinated-type model). Steering of coastal policy at the national level has proved very effective in the Netherlands (Mulder, et al., 2011; van Koningsveld & Mulder, 2004).

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Effective collaboration between all agencies, however, is key to their success. According to the National Water Plan (2016-2021) the Dutch population is “scarcely aware of the risks and challenges associated with water and water management, because water management is so well-organised” (Dutch Ministry of Infrastructure and Water Management, 2015, p. 5).

A clear definition of what needs to be undertaken, supported with a rationale for same, needs to be prepared before the structure plan for implementation is developed. A first step toward the development of sound erosion policy in Ireland could be the development of a National Coastal Strategy, which perhaps should be expanded to deal with other coastal issues, particularly, flooding. The EU recommendation on ICZM, as well as the current literature on the subject, recommends that erosion not be dealt with in isolation, but in a holistic manner. The strategy should serve as the vision for coastal management in Ireland and should serve to inform national policy in relation to same, best-practice for which can be modelled after, for example, the Dutch system. It should be the result of close collaboration between all relevant government agencies, including the local authorities, planners, the OPW, and the NPWS, and should clearly define the roles of all agencies involved. Funding for *proactive* as well as *reactive* coastal management should be budgeted for and provided by the national government. It is important a specific functional role is allocated to the implementation of these tasks in each agency.

The National Coastal Strategy will have to address difficult matters, such as should Ireland employ a “hold-the-line” policy, as in the Netherlands, or will it be based on a “strategy spectrum”, as in the UK? Many parts of the Irish coast (*e.g.* soft and/or rocky cliffs) are not suited to the Dutch strategy due to differing physical characteristics, so the UK approach may be more appropriate. Another issue that must be considered is that of private property – who is, or will be, responsible for protecting it? Discussion of these issues could be facilitated through a national coastal erosion conference and/or a series of follow up workshops.

Once a strategy has been designed, it is recommended the Minister for Communications, Climate Action and Environment follow with national policy framework on ICZM. In the Netherlands, the coastal policy framework is laid out in the National Water Plan, which is published every 5 years.

To ensure national policy is effectively implemented on the ground and all agencies are working together, it may be useful to appoint a designated government official (for example, in the Dutch context, this is the role of the “Delta Commissioner”), operating in an advise-and-assist role to support the work of local authorities in the implementation of the newly developed coastal erosion strategy.

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### 5.5 Key Recommendations

- Policy on erosion management should be steered at the national level, as it is in the Netherlands, the US and Denmark
- A body should be established with responsibility for coordination, planning, contracting and knowledge development (e.g. coastal monitoring) in relation to coastal and erosion management
- Collaboration between national, regional and local authorities is vital
- Stakeholder engagement is essential
- There is a need for a common definition of “risk”
- At the national level, Ireland could benefit from the development of a National Coastal Strategy, as in the Netherlands
- At the local level, Ireland could benefit from the development of shoreline management plans, as in the UK
- The development of a public webGIS could be a useful management and communication tool (e.g. <https://goo.gl/evWMIa> in the UK and the Coastal Analysis WebGIS in Denmark)
- A soft engineering approach to controlling erosion (e.g. beach nourishment<sup>10</sup>, dune stabilization with fences and vegetation, habitat restoration etc.) should be considered rather than moving to the default hard engineering approach.
- Restricted development should be encouraged (and enforced). Mechanisms successfully employed in the US include setbacks, rolling easements and zoning
- Where residential properties are at immediate risk of erosion, local planning policies can be used to transfer land to the local authority, as in the Norfolk pathfinder project in the UK
- Ireland would benefit from following guidelines set out in EU recommendation on ICZM, however statutory instruments are required to successfully implement ICZM

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<sup>10</sup> Can be costly if not budgeted for

### 6 Key Barriers Identified by LAs

In the telephone interviews Local authorities were encouraged to highlight any barriers experienced in dealing with coastal erosion. This section summarises the responses.

LAs are concerned coastal erosion is not high on the agenda in terms of government funding and attention and feel that Ireland would benefit from coastal erosion being made a priority, LAs feel currently there is more of a focus on flooding and as a consequence, it is difficult to justify allocating resources to erosion.

*“Ireland is an island; the issue is not going to go away”*

*“There is a requirement to have an oil pollution plan but not a coastal erosion assessment or review.”*

Multiple LAs consider accretion to be an important parameter for this study. The need for dredging in coastal areas should be included as LAs are unsure where to put surplus materials; guidelines on dealing with accretion issues would be welcomed.

LAs believed there is a need to set up government strategy and hierarchy to tackle coastal erosion, and then filter this down to LAs. They believe clarity on responsibility is needed, and that this can be done through the creation of guidelines. All interested parties, however, should be involved with the writing of this new national strategy.

The scale of the problem is significant, LAs believe central government funding is needed to address the issue. They suggest a national pilot study be funded to identify blackspots for coastal erosion. Funding is a reoccurring issue, “costs of coastal defence are astronomical” and LAs don’t have the requisite financial resources. In practice LAs have to bring any project to a certain stage without guarantee of funding with one LA citing an example of a project where €250,000 of LA resource was required to secure the full cost of the coastal erosion defence scheme.

Due to the cost-benefit approach to funding, defence projects tend to be concentrated on areas of economic activity (piers and harbours) and sensitive urban areas. However, LAs state there are other areas which require investment, including blue flag beaches, and coastal roads. Some LAs suggest the OPW’s approach to funding should be more sympathetic in terms of what should be protected/defended.

*“The (coastal erosion) issue should be treated more sympathetically than simply as a cost-benefit ratio formula. We need to learn from past mistakes in terms of where planning may have been granted and shouldn't have been. Let policy going forward apply in areas where you can apply the policy and protect what's there already, especially where there's human impact; We are not*

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*talking about protecting people's houses, but people's homes so we need to be a little bit more understanding, learn from these situations and alter future developments accordingly"*

Others suggest landowners are responsible for their own property. LAs ask for guidelines to know what you can and cannot do for private property and who is responsible for defending the property. Private landowners are unsure what they can do also. One LA stated that a national debate is required to find a solution and create guidelines. The consensus is better stakeholder consultation is required at a local level. LAs believe landowners tend to be involved too late in the process which adds to confusion and tension.

LAs suggested fragmented governance and changes in department responsibilities has added confusion when facing coastal erosion noting that they are currently working with several departments and agency including: the Department of Communications, Climate Action and Environment; Department of Agriculture, Food and Marine; NPWS; and the OPW. LAs are unsure where to seek for guidance and funding due to the lack of coordination and would prefer a single department to co-ordinate coastal defence action. Several LAs suggest full responsibility should be given to the Department of Communications, Climate Action and Environment, as they would have the tools and expertise to take a more holistic approach. Further LAs desire a restructuring of the foreshore license application process as currently they perceive the procedure as a lengthy process. Additionally, LAs are concerned with the delayed update to the Foreshore Act. Some believe the Foreshore Act should give more authority to the local authorities. Overall, a complete review on how the coastal zone is managed is necessary.

LAs state the need collaboration between counties, as coastal defences will have knock on effects on adjacent jurisdictions. LAs also suggest a restructuring of the approach to coastal management, including the merging of coastal flooding and erosion management would be beneficial. The LAs jurisdiction felt that they should manage the coastal and marine areas as a single entity as this would support more sustainable and successful long-term planning.

LAs identified a lack of understanding and capacity coupled with a need for education and training across the board. This would include the LAs themselves but also Private landowners; Department of Communications, Climate Action and Environment; Department of Agriculture, Food and Marine; NPWS; and the OPW. This should provide ) clarity on responsibility, and for example include training on how to deal with coastal erosion, private property, SACs, harbours and piers.

LAs have gained expertise through experience; however feel they have not been given access to specific training for coastal erosion and guidance on erosion response in conservation areas. It



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was noted that training was provided in neighbouring countries including the UK and that Ireland would benefit from a rollout of this type of training. Telephone interviews highlighted that engineers usually deal with coastal erosion in LAs. Therefore, any future best practice guidelines or training material and courses should be geared towards personnel with an engineering background. This is not universal, however, and may be subject to change in the future, any programme will have to be suitable for a wider range of professionals with backgrounds including environmental science, coastal management and ecology.

There's a need for clarity on what guidelines to follow when dealing with coastal erosion, specifically in SACs. One LA suggests using near shore soft interventions to slow down erosion while enhancing the marine environment, with the aim to enrich the natural habitat while protecting the coast. In general, LAs believe one governing body needs to open communication between the NPWS, the LAs and the Public.

### 6.1 Key Recommendations

- Coastal erosion should be a national priority
- Accretion should be included in any coastal change national strategy produced
- Stakeholder consultation is required at both the local and national level
- Clarification is needed on the responsibilities of LAs and private land owners
- Due to coastal erosion being a large scale and widespread national problem, central government approach to funding would be preferred
- Pilot studies could potentially identify blackspots of coastal erosion and collect the appropriate baseline data to inform the development of a national erosion management strategy
- The cost-benefit approach to funding should be adapted to suit the Irish situation, for example coastal roads and blue flag beaches should be highlighted for priority consideration.
- There is a need to communicate that it is unrealistic to expect that LAs or indeed national government can protect the entirety of the Irish coastline from erosion.
- Responsibility for erosion management should be co-ordinated by a single government department, as the current situation where responsibility is shared across a number of departments and agencies is confusing for LAs
- The foreshore licence application should be amended so that applications are time bound.
- A complete review of how the overall coastal zone is managed should be considered
- Collaboration in transboundary areas will be key to the success of Irish coastal defence, including county borders and across the full coastal and marine domain and a holistic approach should be incorporated into the national policy to allow for sustainable and effective long term planning

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- Capacity building through education and training programmes is required for all parties concerned with coastal erosion and where relevant provide specialised training to LAs
- Ireland needs a uniform approach to dealing with coastal erosion in SACs and SPAs with clear guidance in place for all LAs to follow.

# 7 Local Authorities' Recommendations for Future Coastal Erosion Policy and Practice

The national audits and telephone interviews gave LAs the opportunity to comment on potential future actions addressing coastal erosion. Further, key objectives identified in the initial audits (See Appendix IV) were condensed into five key points, LAs were then asked to anonymously rank these from one to five. This section presents these results as well as responses relating to LAs opinions on future national coastal erosion guidelines and policy.

### 7.1 Level of interest in coastal erosion guidelines

All LAs state the development of national best practice guidelines for coastal erosion would be useful. Some LAs feel isolated when dealing with coastal erosion. They suggest guidelines similar to *The Planning System and Flood Risk Management Guidelines for Planning Authorities* would be useful. All LAs agree building restrictions should be considered near areas of known eroding shorelines. They also suggest coastal retreat and financial assistance for affected homeowners for relocation should be considered under certain conditions. Nine LAs said the purchase of private property at risk of coastal erosion should be considered under particular circumstances, however two out of these nine said this is only feasible if coupled with managed realignment. Fifteen LAs state procedures on how to deal with private property at risk should be included in future national policy and/or best practice guidelines.

Key elements to be addressed in national best practice guidelines/policy were identified and ranked as follows, with "1" graded the most significant:

1. Clarity on responsibility: including public/private properties, buffer zone designation and implementation, reactive defence, coastal erosion in SACs, protection of natural defences, downstream erosion issues.
2. Guidelines on coastal defence protocol: Suitable defence structures (hard/soft/natural), survey techniques, monitoring programs, cost-benefit analysis
3. Baseline information with maps of current erosion defence structures and practices
4. Funding: allocation of resources as well as guidelines on how to successfully obtain funding
5. Training for LAs as well as private property owners

### 7.2 Key Recommendations

- Guidelines on coastal defence protocol, similar to *The Planning System and Flood Risk Management Guidelines for Planning Authorities*, should be produced
- Procedures on how to deal with private property at risk should be included in future national policy and/or best practice guidelines
- Building restrictions should be considered near areas of known eroding shorelines

### 8 Recommendations

This section summarises the key recommendations arising from this study. These recommendations should be taken into consideration in any future pursuit of successful national coastal erosion management:

#### 8.1 Overarching Recommendations

Coastal Erosion must be made a priority in policy development at local to national scales, and should be incorporated with flooding and accretion under one title such as “Coastal Change”. National best practice guidelines on coastal erosion practice should be created and based on international best practice (Auckland Regional Council, 2000) (Department for Environment Food & Rural Affairs - UK, 2015) (Department of Environment and Heritage Protection, 2013) (Kystdirektoratet - Danish Coastal Authority, 2015). Development of common practice and clarity on methodology of risk assessment, planning applications, protection applications will ensure a uniform approach

Establishing an overarching coastal management and administrative body, would provide clarity on responsibilities for coastal issues (including erosion).

Collaboration between LAs in the form of a bottom up approach where LAs take a unified approach towards coastal erosion would ensure cross county development is possible.

Communication networks should be established to facilitate collaboration between LAs.

A collaborative approach to data management is required. The ICPSS study previously stated that it is essential that information on the nature of the coast, the location, extent and condition of existing structures, and coastal process are readily available (RPS, 2004). The creation of a webGIS, similar to that operating in the UK (UK - Environment Agency, 2017), should be established. This will take the form of a single national repository containing information about erosion risk factors in the form of a GIS database, should be developed, maintained and regularly updated by a GIS expert to include hotspots of coastal erosion, existing coastal defence management, and the key contact point for the area. This would be especially useful for new staff, who may be unaware of all sites known to previous staff members.

Monitoring is essential for effective risk assessment and management however the requisite baseline information mentioned must also be available. Risk assessment must look at long term change, not only seasonal change, to ensure cyclical processes and offshore sediment budget are considered prior to the installation of coastal defence structures.

New developments in the coastal zone should be restricted and follow a national policy and where appropriate at the application stage that the developer should be informed that the structure will

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not be protected by government funding and any costs incurred in demolishing/removal of property will be at the cost of the developer (Kystdirektoratet - Danish Coastal Authority, 2015).. However, further protocol with regards the necessary removal of existing property undermined by coastal change must be drafted. Training and Education should be made available for LAs, as well as educational material to be made available to the public. Readily available material would provide clarity for public and government departments on who is responsible for the protection of various types of property, and approaches to protecting affected property. LAs should also have access to part time and full-time courses on coastal erosion management.

### 8.2 Detailed Recommendations:

Recommendations arising from this study have been summarised into Table 8.1, and organised into short term, medium term and long term recommendations.

#	Recommendation	Timeline	
S1	The term “risk” must be defined in order for comparable baseline information to be gathered.	Short term	
S2	Coastal erosion should be prioritised nationally in order for more resources to be made available. Due to coastal erosion being a large scale problem, central government funding will be needed. A national approach to coastal erosion would provide more value for money, rather than funding smaller projects individually.	Short term	
S3/M7	At the national level, Ireland would benefit from the development of a National Coastal Strategy. Policy on erosion management should be steered at the national level, as it is in the Netherlands, the US and Denmark. A complete review of how the coastal zone is managed should be considered.	Short term	Medium term
S4/M8	Stakeholder engagement both at a local and national level is essential throughout. Involving all stakeholders in forming a national government strategy and hierarchy is conducive to easier transition through to the LAs.	Short term	Medium term
S5/L8	National government needs to clarify what departments are responsible for dealing with coastal erosion, as the responsibility being dispersed over several departments is causing confusion for LAs. Ideally, a body should exist that is responsible for coordination, planning, contracting and knowledge development (e.g. coastal monitoring) in relation to coastal and erosion management.	Short term	Long term
S6/L9	The foreshore licence application should be amended so that applications are time bound.	Short term	Long term

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S7	Pilot studies could potentially identify blackspots of coastal erosion and collect the appropriate baseline data to inform the development of a national erosion management strategy	Short term	
S8/M11	Guidelines on coastal defence protocol, similar to The Planning System and Flood Risk Management Guidelines for Planning Authorities, should be produced.	Short term	Medium term
M1	A systematic approach to assessing erosion risk should be adopted by all coastal LAs. Three methodologies have been proposed, which may be applied separately or in combination with one another, where appropriate.	Medium term	
M2	Need for guidelines on dealing with coastal erosion and private property, for instance responsibility to protect/dismantle properties, aimed at both LAs and private landowners. International literature review highlighted some options including: Where residential properties are at immediate risk of erosion, local planning policies can be used to transfer land to the local authority, as in the Norfolk pathfinder project in the UK.	Medium term	
M3	National legislation is quite broad in terms of coastal defence, clarity of responsibility for dealing with coastal erosion is needed.	Medium term	
M4	Guidance on how to use planning as a key tool in lowering the impact of future coastal erosion should be considered. As previously, a uniform approach, which all LAs can adopt, is recommended. Where erosion control options are no longer viable, restricted development should be encouraged (and enforced). Mechanisms successfully employed in the US include setbacks, rolling easements and zoning.	Medium term	
M5	Ireland need a uniform approach to dealing with coastal erosion in SACs and SPAs. LAs need guidelines on how to manage coastal erosion in designated areas such as SACs. National policy on coastal erosion would benefit from clarity with regard to defence works in designated areas.	Medium term	
M6	The development of a public webGIS could be a useful management and communication tool (e.g. <a href="https://goo.gl/evWMLA">https://goo.gl/evWMLA</a> in the UK and the Coastal Analysis WebGIS in Denmark).	Medium term	
M9/L7	Collaboration between national, regional and local authorities is essential. Cooperation in transboundary areas will be key to the success of Irish coastal defence, including county borders and across the full coastal and marine domain and a holistic approach should be incorporated into the national policy to allow for sustainable and effective long term planning	Medium term	Long term

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M10	Government should consider including accretion, not only erosion, in any coastal change national strategy produced	Medium term
L1	A single national databank on coastal erosion risk/damage, and coastal defences in place should be considered. This could be integrated with recommendation M7. In house GIS expertise is required for the effective implementation of the databank.	Long term
L2	A single database on coastal landfill sites, accessible to coastal LAs, is required.	Long term
L3	Monitoring, using a uniform approach in each LA, is essential in long term planning for coastal erosion.	Long term
L4	Further training in coastal erosion protection techniques should be provided to LAs, including but not limited to, assessing erosion, choosing areas to protect, the use of hard and soft engineering techniques, funding applications, defending the coast in SACs and SPAs, and dealing with private property and the public. Any future best practice guidelines or training material and courses would be best targeted towards the engineering personnel, specifically civil engineering; Other staff to target training towards include environmental scientists, ecologists, and outdoor labourers	Long term
L5	Ireland would benefit from following guidelines set out in EU recommendation on ICZM, but statutory instruments are required to successfully implement ICZM.	Long term
L6	At the local level, Ireland could benefit from the development of shoreline management plans, as in the UK.	Long term
L10	There is a need to communicate that it is unrealistic to expect that LAs or indeed national government can protect the entirety of the Irish coastline from erosion.	Long term

Table 8-1 Table of Recommendations

These recommendations should be considered when developing any future Irish coastal erosion management research and/or policy.

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## Appendices

Appendix I: WebGIS as an erosion management support tool

Appendix II: Landfills

Appendix III: Telephone Interview Questions

Appendix IV: LAs Key Contact List

Appendix V: Key Objectives of Future National Guidelines

Appendix VI: Summary of Coastal Protection works carried out under OPW funding

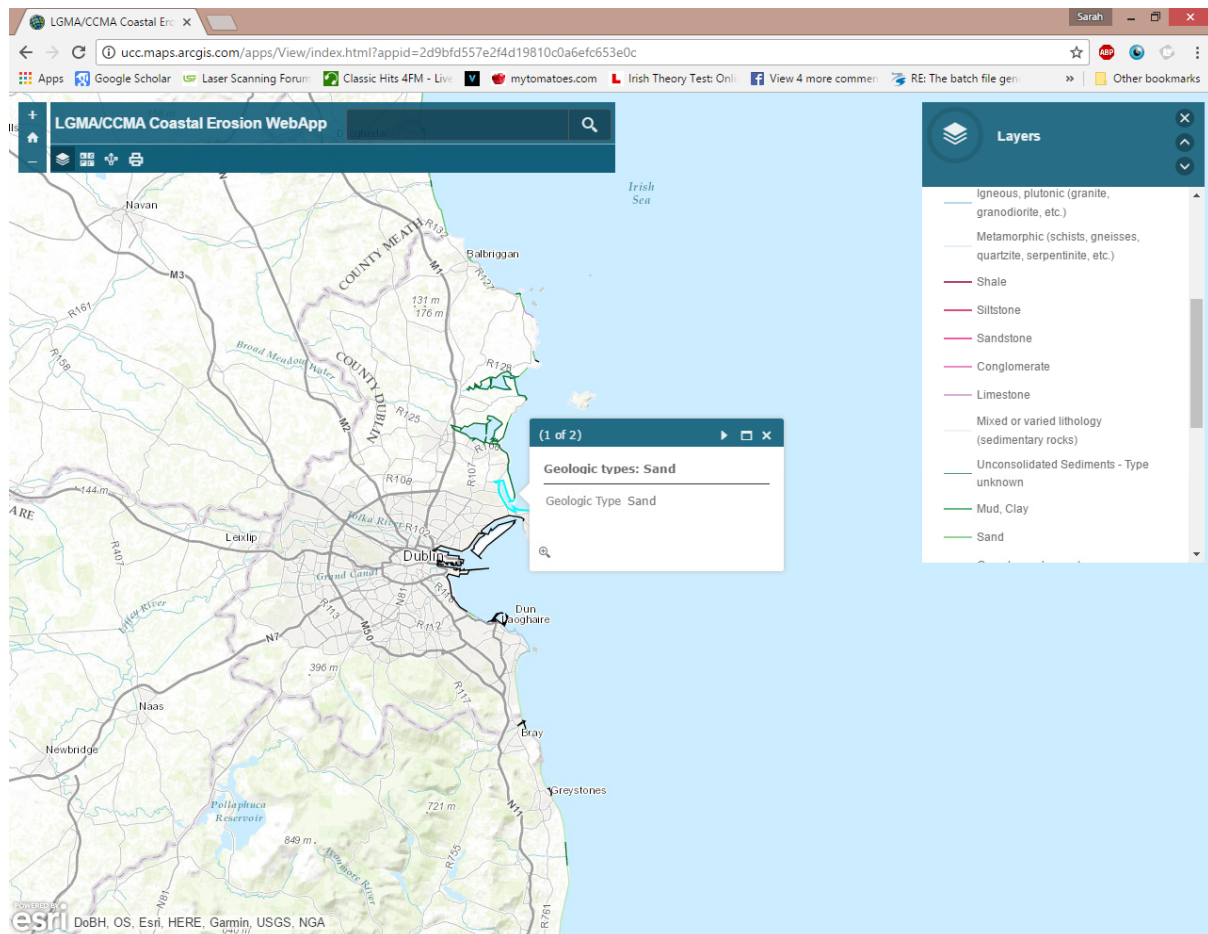
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### Appendix I – WebGIS as an erosion risk management support tool

Web-based GIS can serve as a useful erosion risk management support tool for coastal managers. Such tools aid in the dissemination and visual interpretation of information relating to coastal erosion risk management, such as coastal geology, landfill sites, and conservation areas. An example of the successful implementation of WebGIS to coastal erosion risk management is the US National Oceanic and Atmospheric Administration’s Digital Coast (<https://coast.noaa.gov/digitalcoast/>).

A Web Mapping Application was set up to share information about erosion risk factors that were integrated into the GIS database described in the main body of this report. The WebGIS application can be found at the following web address:

<http://ucc.maps.arcgis.com/apps/View/index.html?appid=2d9bfd557e2f4d19810c0a6efc653e0c>



**Figure I.1: Screenshot of WebMap Application illustrating the geological typology layer. The coastline selected, which is highlighted in blue, is classified as “Sand”, as is shown in the pop-up box, which appears when a feature is queried.**

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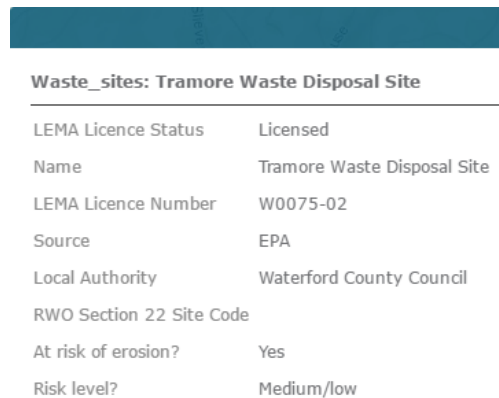
Within the WebMap, individual layers containing information about different geographical features can be turned on or off<sup>11</sup>, such that they can be overlain on top of one another and/or a basemap of Ireland for reference. It is also possible to zoom in and out of the map, thereby facilitating access to more or less detailed information about an area (e.g. at the national, LA, and local levels). Queries can be made about individual features by clicking on them, which prompts a pop-up to appear with information about that feature (called *attribute* information). The WebMap is hosted by ArcGIS online.

The layers mapped in the maps contained in the main body of this report are perhaps best viewed in this WebMap, as here features can be viewed and queried at all scales (e.g. Figure I.1). Information about specific parts of the coast can be obtained by either using the legend or clicking on the feature of interest.

Layers contained in the WebApp include:

- Coastal geologic types
- Coastal waste sites (waste sites within 300 m of the coast)
- Properties at risk of erosion (as assessed by coastal LAs)
- Roads at risk of erosion (as assessed by coastal LAs)
- National heritage and conservation areas (NHAs, SPAs, and SACs) within 300 m of the coast
- Coastal Local Authority Boundaries

In the WebApp, attribute information about individual features is displayed in the pop-up box that appears when a feature is queried (e.g. see Figure I.2). Table I.1 summarises the attribute information available for each of the layers.



Waste_sites: Tramore Waste Disposal Site	
LEMA Licence Status	Licensed
Name	Tramore Waste Disposal Site
LEMA Licence Number	W0075-02
Source	EPA
Local Authority	Waterford County Council
RWO Section 22 Site Code	
At risk of erosion?	Yes
Risk level?	Medium/low

**Figure I.2: Screenshot of pop-up box containing information about the Tramore Waste Disposal Site. Pop-up boxes appear when a feature is queried in the WebApp.**

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<sup>11</sup> To view the available layers, click on the  button. To view the map legend, click on the expand  button, to the right of the layer you wish to view.

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Layer	Attributes
Geologic types	<ul style="list-style-type: none"> <li>• Geologic type</li> </ul>
Coastal waste sites	<ul style="list-style-type: none"> <li>• LEMA License status</li> <li>• The name of the site</li> <li>• If it is a LEMA site, the Licence Number</li> <li>• The source of the data</li> <li>• The LA in which the site falls</li> <li>• If it is a Section 22 site, the site code</li> <li>• Whether or the site is considered at risk of erosion, as assessed during the telephone interviews</li> <li>• The level of risk, as assessed during the telephone interviews</li> <li>• The contact details of the person responsible for historic waste sites in the LA, including their name, position, e-mail, and telephone</li> </ul>
Properties at risk of erosion	<ul style="list-style-type: none"> <li>• The name of the location</li> <li>• Local Authority</li> <li>• Number of private properties at risk (if known)</li> <li>• Number of public properties at risk (if known)</li> <li>• Whether or not risk was estimated or based on an actual study</li> <li>• Where risk assessments had been undertaken (in the cases of Fingal and Waterford), links to those reports - These links can be accessed from the pop-up box that appears when you click on an individual feature (under the heading "Attachments").</li> </ul>
Roads at risk of erosion	<ul style="list-style-type: none"> <li>• The name of the road</li> <li>• The code for the road</li> <li>• The number of kilometres at risk</li> <li>• Whether or not risk was estimated or based on a study</li> <li>• Where more detailed information was available (<i>e.g.</i> for the N69, Limerick), links to that information - These links can be accessed from the pop-up box that appears when you click on an individual feature (under the heading "Attachments").</li> </ul>
National heritage and conservation areas (NHAs, SPAs, and SACs)	<ul style="list-style-type: none"> <li>• NPWS Site Code</li> <li>• Site name</li> <li>• County</li> <li>• Total area (in ha)</li> <li>• Link to URL with more information</li> </ul>
Coastal Local Authority Boundaries	<ul style="list-style-type: none"> <li>• Name of coastal LA</li> </ul>

**Table I.1 Attribute information for each layer contained in the WebGIS**



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### Appendix II - Landfills

Local Authority	Is the LA aware of any sites outside the EPA LEMA and RWO databases?	Are any coastal sites at risk of erosion?	Level of risk
Galway City Council	No	Yes – Southpark	Medium
Waterford City and County	No	Yes – Tramore	Medium/low
Wicklow County Council	Yes – Bray and Greystones	Yes – both, although both are protected	Medium to high
Cork County Council	Don't know	Don't know	
Dun Laoghaire Rathdown County Council	Don't know	Don't know	
Fingal County Council	Yes – Skerries and Rush	Yes – Skerries and Rush	
Louth County Council	Don't know	Don't know	
Meath County Council	No	Don't know	
Cork City Council	Did not participate in telephone interviews	Did not participate in telephone interviews	
Mayo County Council	None on the coast	n/a	n/a
Wexford County Council	None close to the coast	n/a	n/a
Donegal County Council	No	No	n/a
Galway County Council	Don't know	No	
Leitrim County Council	No	No	n/a
Sligo County Council	No	No – the only one near the coast is Finisklin, and it's protected by a bund wall	Low
Kerry County Council	Yes – Ahascra (Ballydonaghue)	No, only one that's close to the coast is Tralee (on the River Lee)	n/a
Clare County Council	Yes – Thaddy's Hill and Rinnanna South	Not aware of any	n/a
Dublin City Council	Yes – there are hundreds of historic landfill sites; virtually every park in the city was a landfill site; all of Sandymount was reclaimed, part of Clontarf, all of Dublin port, both sides of the Liffy and Santry rivers, the quarry at Stoneybatter, etc. 5-10% of the city has been reclaimed	For the most part, No – Dublin port is protected by walls. However, at the Ringsend Landfill, a 500m stretch of coastal land adjacent to Irishtown Park in South Dublin Bay, coastal erosion has moved rock armour and earth exposing underlying waste, which the LA is presently in the process of examining.	Low
Limerick City and County	Yes – Ballyanrahan, Ballyroe Lower, Coolroe, Griston Bog, Kilmoylan Lower, Knocklong, and Moohane	None of the landfills on the section 22 register are on the coast	n/a

**Table II.1: Summary of information obtained from LAs about landfill sites near the coast.**

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### Appendix III - Telephone Interview Questions

1. How many staff members are involved with coastal erosion? (Further ask if they are full time on coastal erosion, how they are linked to main decision makers, who decides what projects will be carried out). Longevity of staff.
2. What is their main department/s (background)?
3. Have you and other responsible staff members been provided with coastal erosion specific trainings or consultations?
4. What methodology was used to assess structures considered at risk of coastal erosion in the medium term? Is long term risk assessed as part of your policy/practice?
5. Is there a current method for choosing what coastal areas need defence? How are future coastal protection works decided on (i.e. hard or soft engineering structures)?
6. How do you record the areas at risk of erosion or with coastal protection? (List/map/GIS/word of mouth) Sources? What are your GIS capabilities? Inventory and mapping?
7. Are soft engineering structures an ongoing process or a once-off solution?
8. How are the current coastal protection structures monitored?
9. Is there a buffer zone where new developments are prohibited? If so what are its limits? What are the criteria for the buffer zone limits? Are these guidelines supported/adhered to by planners in your area?
10. How do you assess whether a coastal property can be adequately defended over its lifetime, without the need to construct additional or new coastal defences?
11. Are natural defences (such as sand dunes, beach sand, gravel) actively protected in your area? If so how is it policed/implemented, and who is responsible for this?
12. Are there plans for renewable energy in your county? If so, do they take into account possible downstream implications for coastal erosion?
13. What is your opinion on the current governance structure in planning in the coastal environment and dealing with coastal erosion?
14. Do you have an in-house list of historic landfill sites? If so may we please have access to them? (Provide EPA list – “you know your county better”)
15. What media are they in (map, list, addresses, word of mouth)?
16. Are you aware of any of these coastal landfills being in areas of coastal erosion?

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17. With regard to the historic landfill sites near the coast, could you categorise them according to risk of erosion - e.g. no risk, low risk, medium risk, high risk?
18. Any other comments?

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### Appendix IV – Contact List with key personnel in LAs

**Table IV.1: LA contacts**

LA	Name	Email	Phone Number
Clare Co Co	Tom Tiernan	<a href="mailto:ttiernan@clarecoco.ie">ttiernan@clarecoco.ie</a>	0656846214
Cork City Co	Eamon Walsh	<a href="mailto:eamonn_walsh@corkcity.ie">eamonn_walsh@corkcity.ie</a>	0214924047
Cork Co Co	Kevin Costelloe	<a href="mailto:Kevin.Costelloe@CorkCoCo.ie">Kevin.Costelloe@CorkCoCo.ie</a>	0214285563
Donegal Co Co	David Friel	<a href="mailto:dfriel@donegalcoco.ie">dfriel@donegalcoco.ie</a>	0877801596
Dublin City Co	Gerard O'Connell	<a href="mailto:gerry.oconnell@dublincity.ie">gerry.oconnell@dublincity.ie</a>	012224302
Dun Laoghaire Rathdown Co Co	Joe Craig	<a href="mailto:jcraig@dlrcoco.ie">jcraig@dlrcoco.ie</a>	012047922
Fingal Co Co	Hans Visser	<a href="mailto:hans.visser@fingal.ie">hans.visser@fingal.ie</a>	0871214641
Galway City	Daithi Flood	<a href="mailto:daithi.flood@galwaycity.ie">daithi.flood@galwaycity.ie</a>	091536556
Galway County	Ciaran Wynne	<a href="mailto:Cwynne@galwaycoco.ie">Cwynne@galwaycoco.ie</a>	091 509525 or 0876860091
Kerry Co Co	Gerry Riordan	<a href="mailto:gerry.riordan@kerrycoco.ie">gerry.riordan@kerrycoco.ie</a>	switchboard - 0667183500
Leitrim Co Co	Brendan Mc Kenna	<a href="mailto:bmckenna@leitrimcoco.ie">bmckenna@leitrimcoco.ie</a>	0719620805
Limerick City and County	Carmel Lynch	<a href="mailto:carmel.lynch@limerick.ie">carmel.lynch@limerick.ie</a>	061407507 or 0876594343
Louth Co Co	Patrick Connolly	<a href="mailto:paddy.connolly@louthcoco.ie">paddy.connolly@louthcoco.ie</a>	
Mayo Co Co	Iain Douglas	<a href="mailto:idouglas@mayococo.ie">idouglas@mayococo.ie</a>	
Meath Co Co	David Keyes	<a href="mailto:dkeyes@meathcoco.ie">dkeyes@meathcoco.ie</a>	0469097215
Sligo Co Co	Gary Salter C. Eng, BE, MSc, MICE	<a href="mailto:gsalter@sligococo.ie">gsalter@sligococo.ie</a>	0719111962
Waterford City and County	Pat McCarthy	<a href="mailto:patmccarthy@waterfordcouncil.ie">patmccarthy@waterfordcouncil.ie</a>	0761102051
Wexford Co Co	Gerry Forde and George Colfer	<a href="mailto:gerry.forde@wexfordcoco.ie">gerry.forde@wexfordcoco.ie</a> and <a href="mailto:george.colfer@wexfordcoco.ie">george.colfer@wexfordcoco.ie</a>	0539196311
Wicklow Co Co	Marc Devereux	<a href="mailto:mdevereux@wicklowcoco.ie">mdevereux@wicklowcoco.ie</a>	012744902 or 0866019465

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### Appendix V – Key Objectives of Future National Guidelines

Would it be useful to develop coastal erosion guidelines for Local Authorities similar to The Planning System and Flood Risk Management Guidelines for Planning Authorities?

Yes - ALL

What should be in them?

1. A clear national strategy/policy on how Ireland is going to deal with existing coastal erosion problems (fixing coast and/or coastal retreat) and how to avoid future coastal erosion problems
2. A best estimate overview of the scale of coastal erosion problems in Ireland (dwellings, commercial property at risk, public infrastructure at risk etc.)
3. Provide a map for each county (based on OPW study and local knowledge) showing the area subject to coastal erosion
4. Guidance on a national system of risk assessment then prioritising solutions if available,
5. Survey techniques to determine risk
6. Cost Benefit Analysis techniques.
7. Overview of how coastal erosion control efforts will be coordinated and implemented
8. Considerations to be given at Development Plan level
9. A set of policy statements regarding coastal erosion that each local authority can/should include in their county development plans to deal with existing erosion and how future coastal erosion is going to be prevented
10. Robust criteria to control residential and commercial development
11. Definitive guidelines on distances from shoreline where development is not permitted
12. What policies apply to replacements, refurbishments and extensions of existing properties on lands subject to coastal erosion?
13. What policies apply to new development on lands that are subject to coastal erosion?
14. Guidance on types of development to be accommodated
15. What policies apply to illegally build dwellings at eroding sites?
16. Define the legal role of the County Councils where private property is affected by coastal erosion

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17. How erosion of private property (residential, commercial and agricultural) is to be dealt with and options for same (buy out schemes and alternative solutions to be considered)
18. Guidelines could be provided on the degree of erosion where action must be taken
19. Define a danger zone when properties (both public and private) should be removed, who is responsible for this and how this should be funded (to prevent houses from collapsing on shore and into the sea and then having to clean it up)
20. A national funding strategy
21. A funding strategy on how the problems with existing public and private properties at risk are to be dealt with.
22. Types of studies required to inform on best types of defences
23. Recommendation on types of defences to be used (hard and soft)
24. When and where to consider Soft Engineering solutions
25. Innovative alternatives to rock armour and retaining walls.
26. Guidance on how to proceed with works in Designated Areas including identification of required procedures etc. and a protocol for engaging with NPWS or other statutory bodies.
27. Guidance for private owners of land subject to coastal erosion in terms of solutions, procedures and licences etc.

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### Appendix VI - Summary of coastal protection works carried out under the OPWs Minor Flood Mitigation Works and Coastal Protection Scheme from 2009-2017

<u>Minor Flood Mitigation Works and Coastal Protection Scheme</u> <u>Coastal Protection-Related Approved Funding to Local Authorities 2009-2017</u>				
<b>Year</b>	<b>Local Authority</b>	<b>Project Location</b>	<b>Project Details</b>	<b>Funding Allocation</b>
2009	Clare County Council	Lahinch, Miltown Malbay Road (Coastal)	Lahinch coastal protection 1	€45,000
2009	Kerry County Council	Fenit (Coastal)	Fenit Road (R558) Coastal Protection Scheme	€360,000
2009	Louth County Council	Baltry (Coastal)	Works	€18,000
2009	Louth County Council	Blackrock (Coastal)	Works - Repair to sea walls	€31,500
2009	Mayo County Council	Doolough (Coastal)	Works to sea wall	€45,500
2009	Mayo County Council	Downpatrick Head (Coastal)	Works	€45,500
2009	Sligo County Council	Rosses Point (Coastal)	Study	€40,500
2009	Wexford County Council	Clone Road, Clone Upper (Coastal)	Works	€90,000
2010	Cork County Council	Youghal Front Beach (Coastal) Phase 1A	Refurbish Sea Wall	€18,000
2010	Donegal County Council	Bundoran, Rogay Beach (Coastal)	Rock fall protection	€90,000
2010	Donegal County Council	Fahan Marina (Coastal)	Repair collapsed seawall	€18,000
2010	Donegal County Council	Inch Island Causeway (Coastal)	Strengthen existing wall and build new wall	€54,000
2010	Galway County Council	Doonlooughan Pier, Ballyconnelly, Conemara (Coastal)	Construct coastal protection to the public access road	€153,000
2010	Galway County Council	Inis ni Pier Roundstone, Conemara (Coastal)	Construct coastal protection to the public access road	€210,600

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2010	Kerry County Council	Fenit Road (Coastal)	Coastal Protection Scheme Phase 2 - Rock revetment and buttressing embankments	€405,000
2010	Louth County Council	Baltry (Coastal)	Construct/raise embankment wall	€180,000
2010	Sligo County Council	Strandhill (Coastal)	Beach revetment	€423,000
2010	Wexford County Council	Clone Road Phase 2 (Coastal)	Coastal Protection Works	€112,500
2010	Wexford County Council	St. Kiernan's Bannow Bay (Coastal)	St. Kiernan's Coastal Protection Consultancy Study	€18,000
2010	Wicklow County Council	Arklow Town (Coastal)	Coastal Protection Study	€81,000
2010	Wicklow County Council	North Beach - Arklow (Coastal)	Coastal Protection Works	€70,000
2011	Clare County Council	Tromara, Quilty (Coastal)	Design and build Gabion wall/mattress protection to beach dunes 100m long	€72,000
2011	Donegal County Council	Downings (Coastal)	Replacement of existing box culvert with larger box culvert; reinstatement of parapet walls; improvements to river channel	€63,000
2011	Louth County Council	Bellurgan Embankment (Coastal)	Study	€33,750
2011	Sligo County Council	Strandhill (Coastal)	South side coastal study to establish possible solutions and plans for future dune and shoreline management	€11,700
2011	Sligo County Council	Strandhill (Coastal)	Capital works to provide terminal protection works to heavily used main access way to dune area and southern beach	€47,700



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2011	Wexford County Council	Wexford Harbour (Coastal)	Several short critical sections of the existing erosion/flood defences around Wexford Harbour to be strengthened and raised in order to avoid/mitigate future flooding	€90,000
2012	Sligo County Council	Strandhill (Coastal)	To provide terminal protection works to heavily used main access way to major recreational dune area and southern beach	€290,000
2013	Donegal County Council	Downings Beach (coastal)	Rock armour protection to base of damaged embankment - restore embankment with granular material	€45,000
2013	Fingal County Council	Portrane / Rush (Coastal)	Coastal Erosion Risk Management Study	€57,800
2013	Louth County Council	Annagassan (Coastal)	To construct rock armour revetment	€10,800
2013	Louth County Council	Ballagan, Greenore (coastal)	To repair the sea armour	€18,000
2013	Louth County Council	Blackrock Sea Wall (coastal)	To repair the revetment and associated works	€27,000
2013	Louth County Council	Carlingford Promenade Sea Wall (coastal)	To repair the revetment and associated works	€9,990
2013	Louth County Council	Whitestown (coastal)	To repair the revetment and associated works	€7,200
2014	Fingal County Council	R127, Skerries Balbriggan Regional Road (coastal)	Emergency sea defence works - stonework pointing, replacement of existing wall, additional rock armour and re-instatement of damaged rock armour	€197,480
2014	Fingal County Council	Malahide Town Centre (Coastal)	Study	€45,000
2014	Galway City Council	River Corrib, Galway City (coastal)	Temporary flood defence measures- fenders, gates, etc.	€117,342

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2014	Limerick County Council	Foynes (coastal)	Appointment of consultants to survey the existing defences and to prepare a detailed design of proposed improvements to include costings and a Cost Benefit Analysis	€45,000
2015	Clare County Council	Cloughauninchy (coastal)	Coastal erosion and flood risk management study	
2015	Clare County Council	Doolin (coastal)	Coastal erosion and flood risk management study	
2015	Clare County Council	Kilbaha and New Quay (coastal)	Coastal erosion and flood risk management study	
2015	Clare County Council	Liscannor Bay (Clahane, Liscannor and Miltown Malbay) (coastal)	Coastal erosion and flood risk management study	
2015	Clare County Council	Quilty to Miltown Malbay (Quilty, Spanish Point and Whitestrand) (coastal)	Coastal erosion and flood risk management study	
2015	Galway County Council	Cloonamore- Inisboffin Island as a whole	Comprehensive coastal erosion and flood risk management study for Inisboffin Island as a whole	€90,000
2015	Galway County Council	Inisboffin- South Shore	New coastal protection barrier- in form of wall constructed from integrated PC block elements- as detailed in RPS report 2014 and being used for new or repair of existing damaged sections of walls at Southern Shore	€441,900
2015	Kerry County Council	Ballylongford (coastal)	Coastal flooding mitigation measures	€92,187
2015	Kerry County Council	Ballylongford (coastal)	Coastal flooding mitigation measures	€13,777

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2015	Limerick City and County Council	Askeaton (coastal)	The appointment of consultants to prepare a detailed design of proposed improvements to include costings and cost benefit analysis	€30,000
2015	Louth County Council	Annagassan (coastal)	Construction of rock armour revetment	€10,800
2015	Louth County Council	Bellurgan, Dundalk (coastal)	Placing of rock armour along embankment	€9,000
2015	Louth County Council	Bellurgan (coastal)	To facilitate the transport of and stockpiling of currently available embankment fill material for planned works in 2016	€45,000
2015	Louth County Council	Dundalk Bay (Greenore, Dillonstown and Blackrock) (coastal)	Coastal Erosion Risk Management Study	€81,000
2015	Louth County Council	Dunleer (coastal)	Detailed Flood Study	€58,500
2015	Louth County Council	Seabank Castlebellingham (coastal)	To repair the sea defence	€13,500
2015	Sligo County Council	Section of coastline from Deadman's Point to Rosses Point (Lower) to include the Sand Spit to the north of Rosses Point Lower (coastal)	Coastal erosion and flood risk management study	€57,055
2015	Wexford County Council	Rosslare Warren Middle (coastal)	Coastal erosion risk management study	€28,800
2015	Wicklow County Council	South Beach, Arklow (coastal)	The building up of an existing on-shore embankment.	€46,200
2015	Wicklow County Council	The Murrough (coastal)	To construct a rock armour ramp transition zone between the existing strand and the adjoining shoreline-details as outlined in the RPS Report of February, 2015	€135,000

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2016	Donegal County Council	Sloddan Port to Binbane Head (to include Pollan Strand, Ballyliffin and Five Fingers Strand (coastal))	Coastal Erosion Risk Management Study	€76,500
2016	Donegal County Council	Inver (coastal)	Installation of rock armour to protect the existing failing sea wall	€36,000
2016	Donegal County Council	Inishfree Bay (coastal)	Coastal Flooding and Erosion Risk Management Study	€76,500
2016	Louth County Council	Baltry (Coastal)	To repair the sea defence, including: realignment and raising of a 21m section of the existing promenade wall re-point and fill low level voids on seaward side to prevent further water ingress structural analysis of wall.	€54,000
2016	Wexford County Council	Arthurstown (coastal)	Coastal Flood Defence works, comprising raised sea walls, demountable barriers and foul and surface water pumping stations	€414,000
2016	Wexford County Council	Ballyhack (Coastal)	Coastal flood defence works, comprising raised sea walls, demountable barriers at opening in sea walls and foul pumping station (excludes works to provide new combined sewer)	€301,500
2016	Wexford County Council	Donaghmore Graveyard (Coastal)	Coastal flood defence works, comprising the placing of rock armour at the base of the cliff and the removal of three damaged structures from the top of the cliff	€254,078
2016	Wicklow County Council	The Murrough (coastal)	Coastal erosion rock revetment works	€315,000

Table VI.1