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Dynamic Coast - National Coastal Change Assessment: Cell 4 - Duncansby Head to Cape Wrath

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National Coastal Change Assessment
Steering Committee

Coastal Change & Vulnerability Assessment

Dynamic Coast – Scotland's National Coastal Change Assessment

Executive Summary

- Cell 4 extends along the north coast from the Duncansby Head to Cape Wrath.
- In Cell 4 Mean High Water Springs extends to 560 km which makes up around 3% of the Scottish coastline. Of this length, 74% (416 km) is categorised as hard and mixed, 24% (137 km) as artificial and 1% (7 km) as soft coast.
- Within the historical period of 1890s -1970s (74 years) a little more than half of the soft shoreline has not changed significantly (53%), 24% has advanced seawards (accretion) and 22% has retreated landwards (erosion).
- The period from the 1970s to modern spans 37 years, so the historical period data has been normalised to 37 years to allow comparison with the modern period. When this adjustment has been applied the extent of erosion has increased from 10% historical period to 12% post 1970s, the extent of stability has increased from 78% to 80% and the extent of accretion has remained at 12%.
- This trend is consistent with the patterns expected in a cell dominated by rocky headlands that provide shelter for the soft coastal sections that exist. It is likely that the enclosed and isolated nature of the pocket beaches which are common in Cell 4 mean that the sediments are retained rather than being lost along or of shore.
- Both the average rate of accretion and retreat has quickened from the historical to the recent period.

Disclaimer

The evidence presented within the National Coastal Change Assessment (NCCA) must not be used for property level of scale investigations. Given the precision of the underlying data (including house location and roads etc.) the NCCA cannot be used to infer precise extents or timings of future erosion.

The likelihood of erosion occurring is difficult to predict given the probabilistic nature of storm events and their impact. The average erosion rates used in NCCA contain very slow periods of limited change followed by large adjustments during storms. Together with other local uncertainties, not captured by the national level data used in NCCA, detailed local assessments are unreliable unless supported by supplementary detailed investigations.

The NCCA has used broad patterns to infer indicative regional and national level assessments in order to inform policy and guide follow-up investigations. Use of these data beyond national or regional levels is not advised and the Scottish Government cannot be held responsible for misuse of the data.

Contents

Document Structure

This document outlines the Historical Change Assessments and Vulnerability Assessment for Scotland's soft coastline. The methodologies used within the NCCA are detailed in a separate report. The document is structured to conform to the Scottish coastal sediment cell and sub-cell boundaries that were first delimited by Ramsay and Brampton (2000) in a series of 11 reports. The concept of coastal cells as a science based management unit for the coast is based on a recognition that the processes that shape and alter the coast, while unrelated to administrative boundaries are related to changes in sediment availability and interruptions to that availability. As a management unit, the coastal cell can be seen to fulfil a similar function to that of a catchment area of a river for terrestrial flood management. Changes in erosion, accretion and sediment supply in one coastal cell are seen to be largely unrelated to, and unaffected by, conditions in adjacent coastal cells, and are therefore seen as self-contained in terms of their sediment movement. For example, at many sites net sediment movement is in one direction and may pass around a headland (the major cell boundaries) only in very small volumes. Within a cell, any engineering structures that interrupt alongshore sediment delivery on the updrift side of a coast may impact on the downdrift coast but not vice versa given the "one-way" nature of net sediment movement. As sediment sinks, estuaries might be suitable cell boundaries, however subdivision of an estuary where sediment may circulate freely between both banks is inconvenient and so the inner portions of major firths and estuaries have been defined as sub-cells (Ramsey and Brampton, 2000). Whilst the cell system is ideal from a scientific perspective, it remains that Local Authorities may straddle a cell boundary. The results and statistics for each Local Authority area and for Marine Planning Regions are contained in a separate report.

Commencing with a national overview, this report summarises key locations whose positions of Mean High Water Springs (MHWS) have changed between the periods 1890s to 1970s and 1970s to modern time, although the exact time of survey may vary slightly around those dates and between coasts. The locations are arranged within sub-cells, which progress around Scotland in an anticlockwise direction, followed by the Western Isles, Orkney and Shetland. A short narrative summarises the historical changes and current situation at each location, followed by a vulnerability assessment which considers the implications of assets adjacent to areas of erosion. This narrative is to allow the reader to appreciate the overall findings from the evidence on coastal changes. The report is concluded by a series of tables summarising the statistics for cell one. Each of the 11 coastal cells has a similar report to this, which sits alongside a national overview to collate the national picture and consider the implication for Scotland's coastal assets. Where appropriate, mention is made of the existence of a shoreline management plan for particular sections of the coast.

The full results of each cell are available on the webmaps (www.dynamiccoast.com) and have been designed to be highly accessible. Within the webmaps the user is able to navigate across the whole country, display various shorelines and click on each of the shorelines, to quantify the changes.

The National Context

For a full national overview of the aims, methodology, characteristics and underlying factors that control Scotland's coastline, the reader is directed to the National Overview report where a Whole Coast Assessment and results from the historical and recent changes are presented. Here only a short summary of the national changes identified are presented to place this individual coastal cell report into context.

Since the 1970s, 12% of the soft coast length across Scotland has retreated landwards (erosion), 11% has advanced seawards (accretion) and 77% stable or has shown insignificant change (Figure 1). National comparisons from the historical period (1890 to 1970) to recent period (1970-modern), accounting for the different time periods, show an increasing proportion of erosion (8% to 12%), similar stability (from 78% to 77%) and falling accretion (14% to 11%). Where coastal changes occur, they are faster than before. Nationally, average erosion rates after the 1970s have doubled to 1.0 m/yr whilst accretion has almost doubled to 1.5 m/yr.

The national pattern is an aggregation of different results from different parts of the country (Figure 2). The more exposed mainland east coast cells (1,2,3) and Solway Firth (7) have greater proportions of soft coast erosion and accretion (i.e. significant change) and lower proportions of stability. On the rock-dominated cells (for example cells 8,9,10, 11), soft coast stability is far higher and the extent of erosion and accretion lower. Whilst the natural level of protection offered to the soft sections of coast by the surrounding rocky coast has not changed through time, the proportion of soft coast experiencing erosion and accretion has. Considering the changes through time, the exposed coastal cells of the east coast have seen greater increases in change, with more modest changes occurring on the rock-dominated cells.

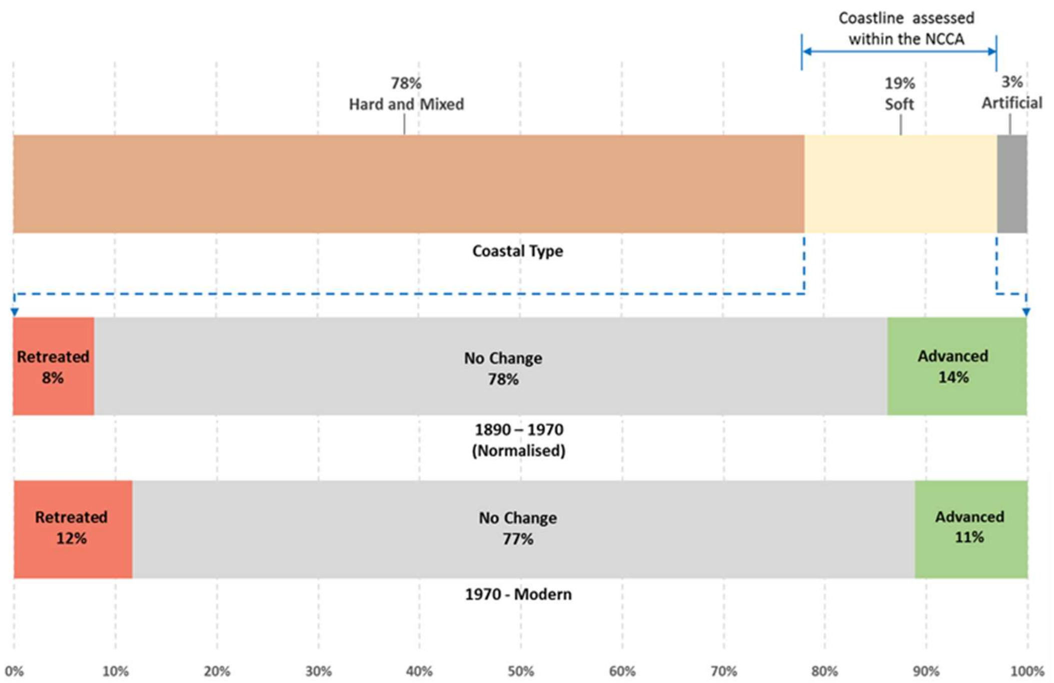

Figure 1: National coastal change results showing the proportion of soft coast within each change category in the historical (ca. 1890-1970) and recent (ca. 1970-Present) time periods.

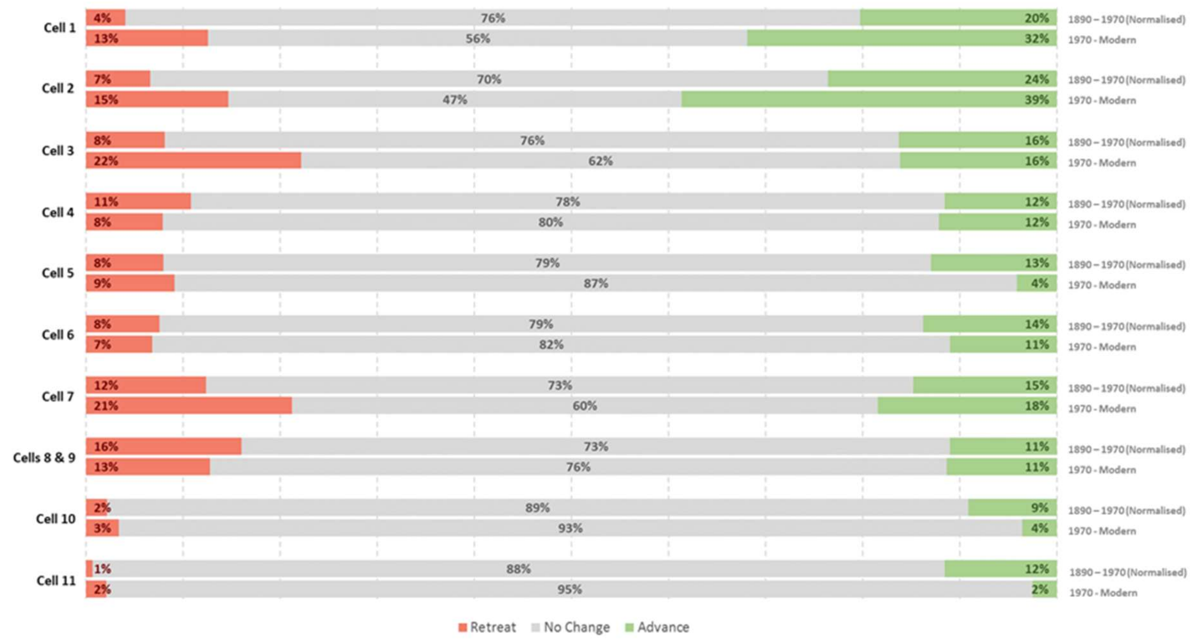

Figure 2: National coastal change results showing historical (ca. 1890-1970, normalised for time period) and recent (ca. 1970 Present.) % of coastal cell showing retreat (red), stability (grey) and advance (green) for soft coast within each cell.

Two other trends are worthy of mention here. The first relates to the propensity for the outer coast to be more exposed to wave impact than the inlets, bays and firths of the inner coast and so the potential for wave-driven erosion is greater along the outer coast. This is exacerbated by a reduction in sediment supply to the outer coast from the higher levels experienced a few thousand years ago. These outer coasts constantly lose sediments to inlet infilling via longshore drift (currents that transport sediment from a source area updrift to an accepting area downdrift). As such, erosion has progressively become the dominant trend on the outer coast in all places except where the import of longshore drift sediments feeds downdrift beaches. Conversely inlets, embayments and firths are sediment sinks that accept soft coastal sediments derived from erosion of the outer coast (the sediment sources) in addition to sediment freshly delivered by rivers. The result is that whilst the inner coast has a bias toward accretion, the outer coast, hard or soft, has a bias toward erosion.

A second trend is the close coincidence between coastal defences and erosion of the adjacent coast. Unsurprisingly, the insertion of defences is in response to a coastal erosion or flooding event, yet there are many instances where the defences themselves have exacerbated the pre-existing erosional condition, either on-site or on adjacent coastline downdrift. The reasons are three-fold. First, a defence structure is aimed at halting or slowing an existing erosion condition and so a successful structure not only halts erosion but also the supply of eroded sediment that had previously reached the fronting beach. The result is a reduced sediment supply and beach lowering. Second, most structures reflect wave energy and, indirectly, sediment leading to beach lowering. Third, the insertion of a defence structure on a coast that is affected by longshore currents not only prevents the supply of sediment to the fronting beach, it also reduces the supply of sediment previously exported leading to downdrift beach lowering and erosion.

Cell 4 - Duncansby Head to Cape Wrath

Cell 4 extends along the north coast from Duncansby Head to Cape Wrath. No sub-cells exist within this cell (Figure 4.1). Further contextual information about the processes operating in Cell 4 here can be found in Ramsay & Brampton (2000). Cell 4 is dominated by a predominantly rocky coastline composed of a variety of rock types and structure interspersed by a series of generally small sandy beaches backed by sand dunes that front only limited amounts of assets and infrastructure. Most of these are pocket beaches and are independent beach units that do not affect each other.

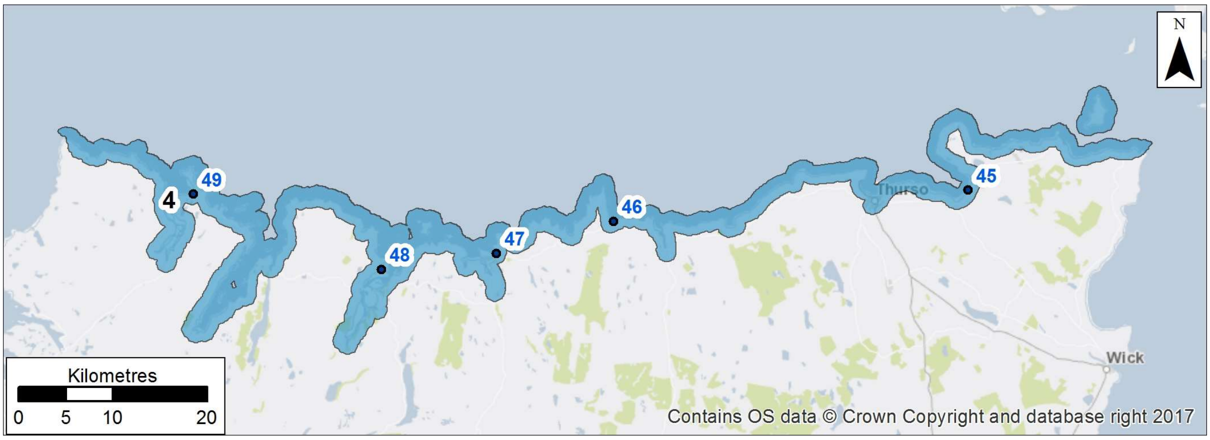

Figure 4.1: The cell boundaries of Cell 4 and locations of sites discussed in this report (blue numbers).

Physical Overview

In Cell 4 Mean High Water Springs (MHWS) extends to 560 km which makes up around 3% of the Scottish coastline. Of this length, 74% (416 km) is categorised as hard and mixed, 24% (137 km) as artificial and 1% (7 km) as soft coast (Table 4.1). Within the historical period a little more than half of the soft shoreline has not changed significantly (53%), accretion has occurred along 24% of soft coasts with erosion occurring along 22% (Figure 4.2). The period from the 1970s to modern spans 37 years, so the historical period data has been normalised to 37 years to allow comparisons with the modern period.

When this adjustment is applied the extent of erosion has increased from 10% historically to 8% post 1970s, the extent of stability has increased from 78% to 80% and the extent of accretion has increased remained at 12%. In addition to these changes in Cell 4, there has been an increase in the rate of change with erosion increasing from 0.4 m/yr to 6 m/yr and accretion increasing from 0.4 m/yr to 1.7 m/yr (Figure 5.2).

The trends above are consistent with other rock-dominated cells offering the surrounding soft coast greater protection. Further statistics for Cell 4 can be found in Table 4.2 and Table 4.3 at the end of this report.

Table 4.1: Proportion of each coastal type within Cell 4.

Modern Coastal Type	Length	
	km	%
Soft	136.7	24%
Artificial	6.9	1%
Hard and Mixed	416.2	74%
Total Length (excluding tidally influenced inlets)	559.8	100%

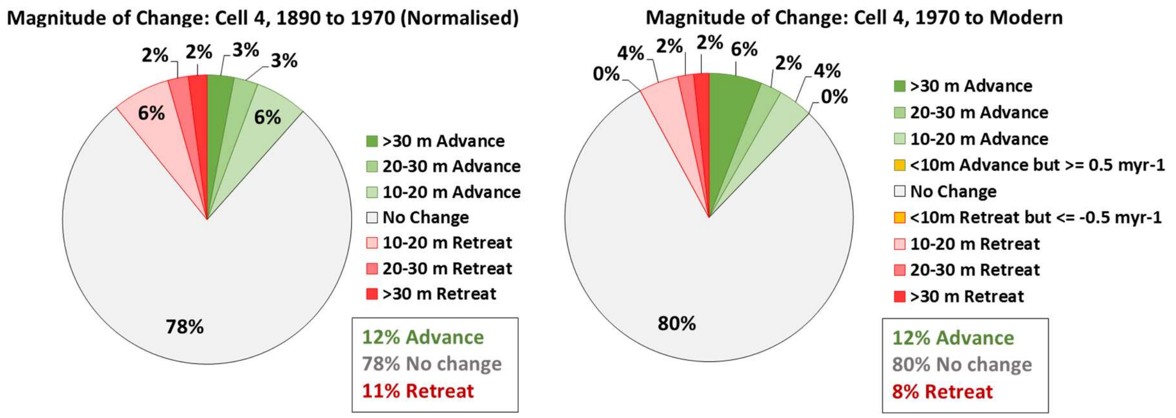

Figure 4.2: Coastal change results for Cell 4 showing the proportional amount of change in the historical (ca. 1890-1970 normalised) and recent (ca. 1970-Present) periods. Rounding errors may produce small % differences between Figure 2 and Figure 4.2.

Asset Vulnerability Overview

The Vulnerability Assessment methodology serves to project the known past erosion rates forward into the future to the years 2050, and is viewable on the online webmaps at www.dynamiccoast.com. Within Cell 4 a total land area of 4.7 Ha, which supports various assets, is anticipated to be lost by 2050. However, no residential and non-residential properties are situated within the areas expected to be lost. When areas that erosion may influence are included, again, no residential and non-residential properties are anticipated to be affected by 2050. For a full summary of vulnerable assets see tables at the end of this report.

Cell Summary

4a.1 Dunnet Sands (Site 45)

Historical Change: The wide expanse of Dunnet Sands extends over 3 km between the villages of Dunnet to the north and Castletown in the south. Whilst there are four small streams in the northern part of the bay, the aptly named Burn of Midsand lies towards the centre of the beach and is a useful marker to subdivide the beach in this report. Between 1905 and 1975 the beach and dunes to the south of the Burn of Midsand have seen up to 30m of erosion (0.5 m/yr) with sediment contributing to 45m accretion at the Burn of Garth, located at the southern end of the bay (0.7 m/yr) (Figure 4.3). However, north of here some 30 m of recession occurred before the Burn of Midsand reversed this to accrete by up to 120 m at its exit between 1905 and 1975. To the north of the Burn of Midsand area, the same time period saw some minor erosion peaking around 20 m (0.3 m/yr), with most of these areas having retreated between 10 and 20m. Between 1975 and 2013, the northern part of the bay has seen some accretion of up to 13 m (0.2 m/yr), with the central area around the Burn of Midsand remaining more or less stable. The southern part of the bay has experienced erosion of up to 15 m (Figure 4.3). Dunnet Links is a Site of Special Scientific Interest.

Figure 4.3: MHWS position in 1890, 1970s, and Modern datasets at Dunnet Sands. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Future Vulnerability: The vulnerability assessment projects the past rates into the future to give a sense of the potential impact in areas of increased risk by 2050. Only one small 60 m section of Dunnet Sands to the south of the Burn of Midsand shows as an area of concern in the future look analysis, with a further 100 m within the erosion vicinity. However, since the entire sweep of Dunnet Sands is backed by dunes with no fixed or built assets then any impacts are negligible. Natural heritage interests will be unaffected.

Figure 4.4: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Dunnet Sands. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

4a.2 Strathy Beach (Site 46)

Historical Change: The beach at Strathy is only 700 m long but is a popular recreational beach. Between 1904 and 1960 the beach accreted over its whole length by up to 50 m, except where the small stream exits in the west (Figure 4.5). By 1960 to 2009 this had reversed to an erosional trend over the whole beach and particularly in the west where the 1904 MHWS position was reoccupied (up to 50 m of erosion). The beach is part of the Strathy Coast Site of Special Scientific Interest.

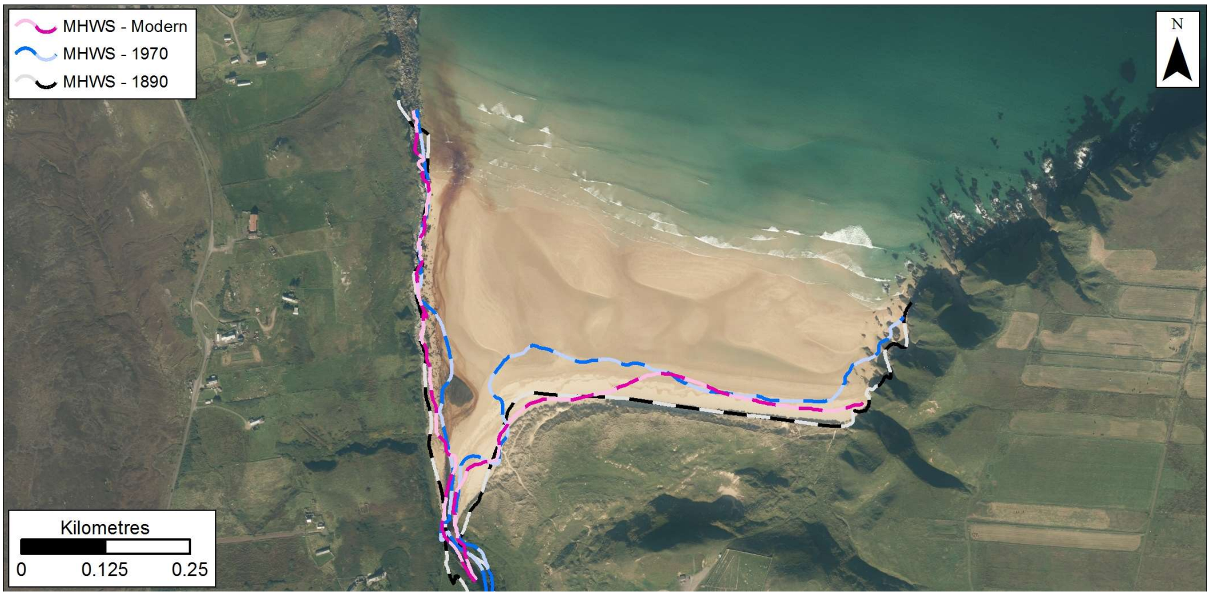

Figure 4.5: MHWS position in 1890, 1970s, and Modern datasets at Strathy Beach. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Future Vulnerability: The vulnerability assessment projects the past rates into the future to give a sense of the potential impact in areas of increased risk by 2050. The 50 m of erosion between 1960 and 2009 is reflected in the future look map which shows 40 m of erosion over 200m of beach and dune (Figure 4.6). The natural heritage interests however, will be unaffected by such future recession.

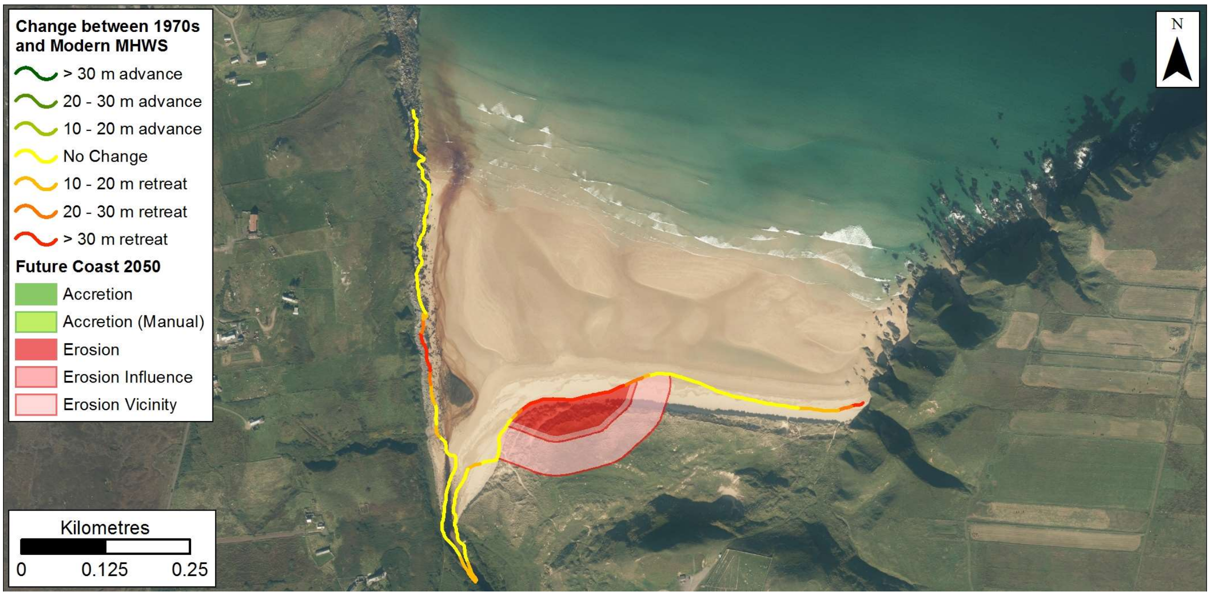

Figure 4.6: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Strathy Beach. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

4a.3 Bettyhill and Torrisdale Bay (Site 47)

Historical Change: 1904 to 1960 saw up to 60 m of accretion across the 500 m long beach at Bettyhill, a small pocket beach backed by a wide suite of climbing sand dunes that have migrated inland and up adjacent slopes. However, this trend was replaced by erosion over the period 1960 to 2014 when up to 26 m was lost over the entire beach frontage except where the small stream exits in the west (Figure 4.7). Nearby at Torrisdale the 1904 position of MHWS has been re-occupied by accretion in 2014, thus reversing losses that occurred between 1904 and 1960 over wide areas of the beach. One area in the east, to the rear of the wide sand spit, has undergone recession since 1960 of up to 140 m. Since this area is very sheltered from wind and waves then the cutting back of this section is likely related to deflection of the channel of the River Naver at high tide.

Future Vulnerability: The vulnerability assessment projects the past rates into the future to give a sense of the potential impact in areas of increased risk by 2050. The recent erosion trend over the beach at Bettyhill has resulted in up to 26 m loss over 54 years (0.5 m/yr), however the natural heritage interests of the beach and dunes should be unaffected. This is also the case at Torrisdale Bay.

Figure 4.7: MHWS position in 1890, 1970s, and Modern datasets at Bettyhill and Torrisdale. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

4a.4 Kyle of Tongue (Site 48)

Historical Change: In the period 1903 to 2014 the west shore of the Kyle of Tongue has seen substantial growth of an 800m long spit that extends out into the Kyle close to its entrance in the north. This is despite minor erosion in the southern part of the spit between 1903 and 1960 and up to 100m of loss between 1960 and 2014 in the south (Figure 4.8). However, this gain and loss pattern is almost certainly related to the development of a small spit in the south and its progressive migration north over the period 1903 to 2014. This is a result of sediment redistributed northward by the main channel meeting sediment moved southward and into the Kyle by ocean waves moving south.

Figure 4.8: MHWS position in 1890, 1970s, and Modern datasets at the Kyle of Tongue. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Figure 4.9: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at the Kyle of Tongue. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Future Vulnerability: The vulnerability assessment projects the past rates into the future to give a sense of the potential impact in areas of increased risk by 2050. The repositioning of the first spit in the 1970s to occupy the position of the current main spit has resulted in 250 m of shore indicted as potentially erosional in the future look analysis (Figure 4.9). No assets lie behind or within this zone and the natural heritage interests of the dunes and small area of grazing land are unaffected.

4a.5 Balnakeil and Kyle of Durness (Site 49)

Historical Change: The coast at Balnakeil on the peninsula (Faraid Head) that extends north from the village of Durness is characterised by two bays backed by spectacular sand dunes that have been blown over the high and rocky spine of the peninsula to cascade into the bay to the east. These dunes are designated within the Durness Site of Special Scientific Interest. In the period 1903 to 1960 both bays saw accretion, particularly in the south where up to 79 m occurred (Figure 4.10). Between 1960 and 2014 this seems to have slowed and stabilised. Erosion occurred in two places in the southern parts of each of the two beaches; affecting some 400 m in the north beach and just short of 200 m in the south beach.

To the south, at the Kyle of Durness at Keoldale, the 2014 MHWS has reoccupied the 1903 position after undergoing accretion up to 1960 and then erosion of broadly the same amounts of up to 25 m (Figure 4.11).

Future Vulnerability: The vulnerability assessment projects the past rates into the future to give a sense of the potential impact in areas of increased risk by 2050. The only asset affected by the future look analysis is likely to be the MOD access track via the beach and dunes to the MOD facilities at the headland to the north of Faraid Head (Figure 4.12). Since this is a long-lived issue, the management of future access raises few concerns. The natural heritage issues should be unaffected by any future erosion.

To the south at the Kyle of Durness, the tarmac access road to the pier for the Cape Wrath ferry and the farm access at Keoldale together with a house and farm buildings all lie with the 400 m long and 30 m deep area of erosion identified by the future look analysis (Figure 4.13).

Figure 4.10: MHWS position in 1890, 1970s, and Modern datasets at Balnakeil. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Figure 4.11: MHWS position in 1890, 1970s, and Modern datasets at Keoldale. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Figure 4.12: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Balnakeil. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Figure 4.13: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Keoldale. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Coastal Change Statistics for Cell 4

Within the soft sections of Cell 4, **24 %** has been **advancing** between **1890 and 1970**; compared with **12 %** between **1970 and modern data**.
Within the soft sections of Cell 4, **23 %** has been **retreating** between **1890 and 1970**; compared with **8 %** between **1970 and modern data**.
Within the soft sections of Cell 4, the **average rate of advance** is **0.4 m/yr** between **1890 and 1970**, and **1.7 m/yr** between **1970 and modern data**.
Within the soft sections of Cell 4, the **average rate of retreat** is **-0.4 m/yr** between **1890 and 1970**, and **-0.6 m/yr** between **1970 and modern data**.
Within the soft sections of Cell 4, **53%** has **not changed** significantly between **1890 and 1970**; compared with **80%** between **1970 and the modern data**.

Table 4.2: A summary of the average rates, average change distances, and lengths of advance, retreat, and no change within sub-cells of Cell 1.

Coastal Cell	Overall change (1)			Advance (2)			Retreat (3)			Insignificant change (4)		
	Average 1890 to 1970 Change on Soft Coast (m)	Average 1890 to 1970 Change Rate on Soft Coast (m/year)	Length of Soft Coast (km)	Average 1890 to 1970 Soft Coast Advance (m)	Average 1890 to 1970 Advance Rate on Soft Coast (m/year)	Length of Soft Coast Advance (km)	Average 1890 to 1970 Soft Coast Retreat (m)	Average 1890 to 1970 Retreat Rate on Soft Coast (m/year)	Length of Soft Coast Retreat (km)	Average 1890 to 1970 Soft Coast Insignificant Change (m)	Average 1890 to 1970 Retreat Rate on Soft Coast (m/year)	Length of Soft Insignificant Change (km)
Cell 4	0.5	0.02	142.5	24.9	0.40	34.3	-24.6	-0.35	32.2	0.2	0.00	76.0
	-	-	-	-	-	24.1%	-	-	22.6%	-	-	53.3%

Coastal Cell	Overall change			Advance			Retreat			Insignificant change (4)		
	Average 1970 to Modern Change on Soft Coast (m)	Average 1970 to Modern Change Rate on Soft Coast (m/year)	Length of Soft Coast (km)	Average 1970 to Modern Soft Coast Advance (m)	Average 1970 to Modern Advance Rate on Soft Coast (m/year)	Length of Soft Coast Advance (km)	Average 1970 to Modern Soft Coast Retreat (m)	Average 1970 to Modern Retreat Rate on Soft Coast (m/year)	Length of Soft Coast Retreat (km)	Average 1970 to Modern Soft Coast Insignificant Change (m)	Average 1970 to Modern Retreat Rate on Soft Coast (m/year)	Length of Soft Insignificant Change (km)
Cell 4	8.6	0.17	136.7	84.7	1.68	16.7	-24.4	-0.55	10.8	0.2	0.00	109.2
	-	-	-	-	-	12.2%	-	-	7.9%	-	-	79.9%

1 Overall change shows the mean value for the whole cell / sub-cell, averaging gains and losses.
2 Advance shows the mean value for the shoreline gains, where there has been greater than 10 m of change, or change which is faster than 0.5 m/yr.
3 Retreat shows the mean value for the shoreline losses, where there has been greater than 10 m of change, or change which is faster than 0.5 m/yr.
4 Insignificant change shows the lengths of coastline which have changed less than 10 m.
NB: Avoid comparing distances of change (i.e. km) but rather use proportions (i.e. %) to avoid cartographic differences between the years.

Table 4.3: A summary of the length of change within each change distance category in the historical (ca. 1890-1970) and recent (ca. 1970-Present) time periods in Cell 4.

1890-1970	**Cell 4**	
	Length (km)	**Length (%)**
>30 m Advance	9.0	6%
20-30 m Advance	8.0	6%
10-20 m Advance	17.4	12%
No Change	76.0	53%
10-20 m Retreat	19.2	13%
20-30 m Retreat	6.8	5%
>30 m Retreat	6.2	4%
Total length	**142.5**	**100%**

Max advance (m)	93.4	Castletown
Average change (m)	0.5	
Max retreat (m)	-196	Bettyhill

1970-Modern	**Cell 4**	
	Length (km)	**Length (%)**
>30 m Advance	8.1	6%
20-30 m Advance	3.3	2%
10-20 m Advance	5.3	4%
<10m Advance but >= 0.5 myr^{-1}	0.0	0%
No Change	109.2	80%
<10m Retreat but <= -0.5 myr^{-1}	0.0	0%
10-20 m Retreat	6.1	4%
20-30 m Retreat	2.4	2%
>30 m Retreat	2.3	2%
Total length	**136.7**	**100%**

Max advance (m)	673	Midtown
Average change (m)	8.6	
Max retreat (m)	-100	Bettyhill

Asset Vulnerability Statistics for Cell 4

Table 4.4: A summary of the number, length, or area of assets within the erosion, erosion influence, and erosion vicinity buffers of the future coastline projections for Cell 4.

Cell 4	Units	Modern to 2050				2050+			
		Erosion	Erosion Influence	Erosion Vicinity	Total	Erosion	Erosion Influence	Erosion Vicinity	Total
Community Services	Number	-	-	-	-	-	-	-	-
Non Residential Property		-	-	1	1	-	-	2	2
Residential Property		-	-	5	5	-	2	4	6
Septic Water Tanks		-	-	1	1	-	1	1	2
Utilities		-	-	-	-	-	-	-	-
Rail	Length (km)	-	-	-	-	-	-	-	-
Roads (SEPA)		-	-	-	-	-	-	-	-
Roads (OS)		0.1	0.0	0.2	0.3	0.1	0.0	0.2	0.3
Clean Water Network		-	-	0.2	0.2	0.1	0.0	0.3	0.5
Total Anticipated Erosion	Area (hectares)	4.7	2.7	19.9	27.3	10.5	3.2	21.9	35.6
Runways		-	-	-	-	-	-	-	-
Cultural Heritage		-	-	-	-	-	-	-	-
Environment		2.8	1.4	8.8	13.0	6.1	1.5	9.4	16.9
Flooding (200 year envelope)		2.3	0.4	1.4	4.2	2.6	0.3	1.3	4.2
Flooding (1000 year envelope)		2.5	0.5	1.6	4.5	2.8	0.3	1.4	4.5
Erosion within PVAs		-	-	-	-	-	-	-	-
Erosion outwith of PVAs		4.7	2.7	19.9	27.3	10.5	3.2	21.9	35.6
Battlefields		-	-	-	-	-	-	-	-
Gardens and Designed Landscapes		-	-	-	-	-	-	-	-
Properties in Care		-	-	-	-	-	-	-	-
Scheduled Monuments		-	-	-	-	-	-	-	-
Nature Conservation Marine Protected Areas		-	-	-	-	-	-	-	-
National Nature Reserves (NNR)		-	-	-	-	-	-	-	-
Special Areas of Conservation (SAC)		2.1	1.1	6.5	9.6	4.9	1.1	6.8	12.8
Special Protection Areas (SPAs)		-	-	-	-	-	-	-	-
Sites of Special Scientific Interest (SSSI)		2.8	1.4	8.9	13.1	6.1	1.5	9.5	17.1

References

Ramsay, D.L. and Brampton, A.H. (2000) Coastal Cells in Scotland: Cell 4 - Duncansby Head to Cape Wrath. Scottish Natural Heritage Research, Survey and Monitoring, Report No 146.

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