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Dynamic Coast - National Coastal Change Assessment: Cell 5 - Cape Wrath to the Mull of Kintyre

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National Coastal Change Assessment
Steering Committee

Dynamic Coast – Scotland's National Coastal Change Assessment

Executive Summary

- Cell 5 extends from Cape Wrath to the Mull of Kintyre.
- In Cell 5 Mean High Water Springs extends 7,414 km which makes up 37% of the Scottish coastline. Of this length, 6,243km (84%) is categorised as hard and mixed, 1,143 km (15%) is soft and 28 km is classed as artificial (<1%).
- Within the historical period of 1890-1970s (74 years) almost half (56%) by length of the soft shoreline did not experience significant change. Accretion (advance) occurred on 27%, with 17% of the coast retreating (erosion).
- 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 in Cell 5 increased from 7% historically to 10% post 1970s, the extent of stability increased from 76% to 87% and the extent of accretion fell from 13% to 4%.
- In addition to the increase in the extent of erosion in Cell 5, there has been a small increase in the rate of erosion, with the fastest rates (30m+ over 37 years) now affecting 3% of the retreating shore, up from 2% historically.
- Accretion rates also fell although the fastest rates (30m+ over 37 years) now affect only 1% of the advancing shore, a fall from 3% historically.
- This trend is unsurprising for a coast dominated by rock headlands that provide shelter for shorter sections of soft coast.
- The trends in cell 5, although small, are consistent with a move from accretion (reducing), through a transitional condition of no change (increasing), toward erosion (retreat).

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.

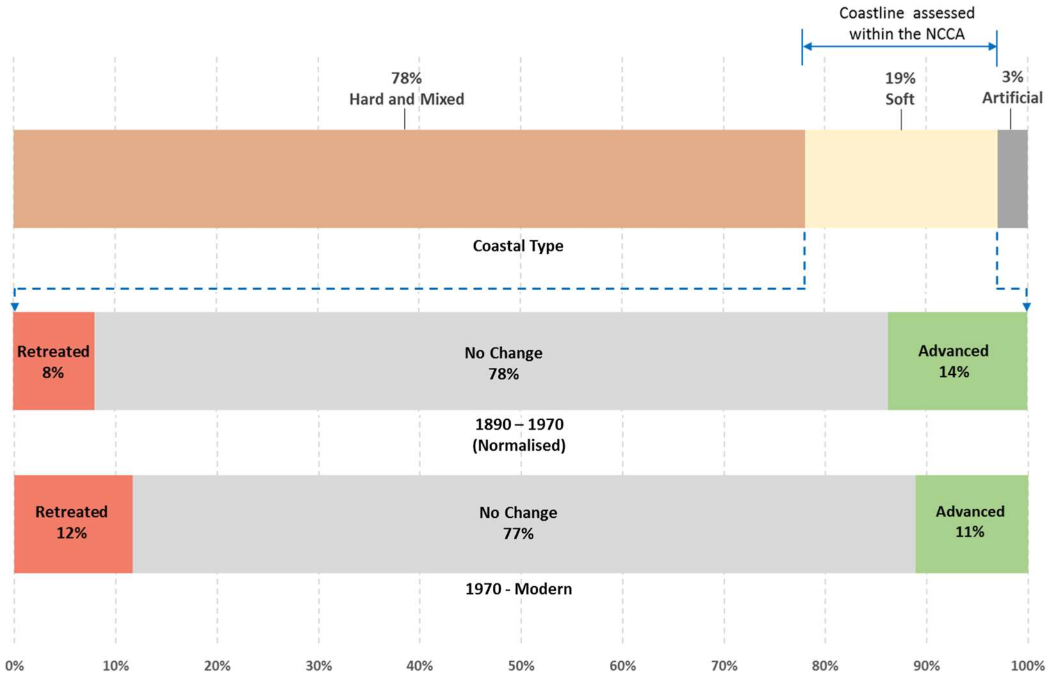

Figure 1: National coastal change results showing the proportion of soft coast retreating, stable and advancing within each change category in the historical (ca. 1890-1970 normalised for time period) and recent (ca. 1970-Present) time periods.

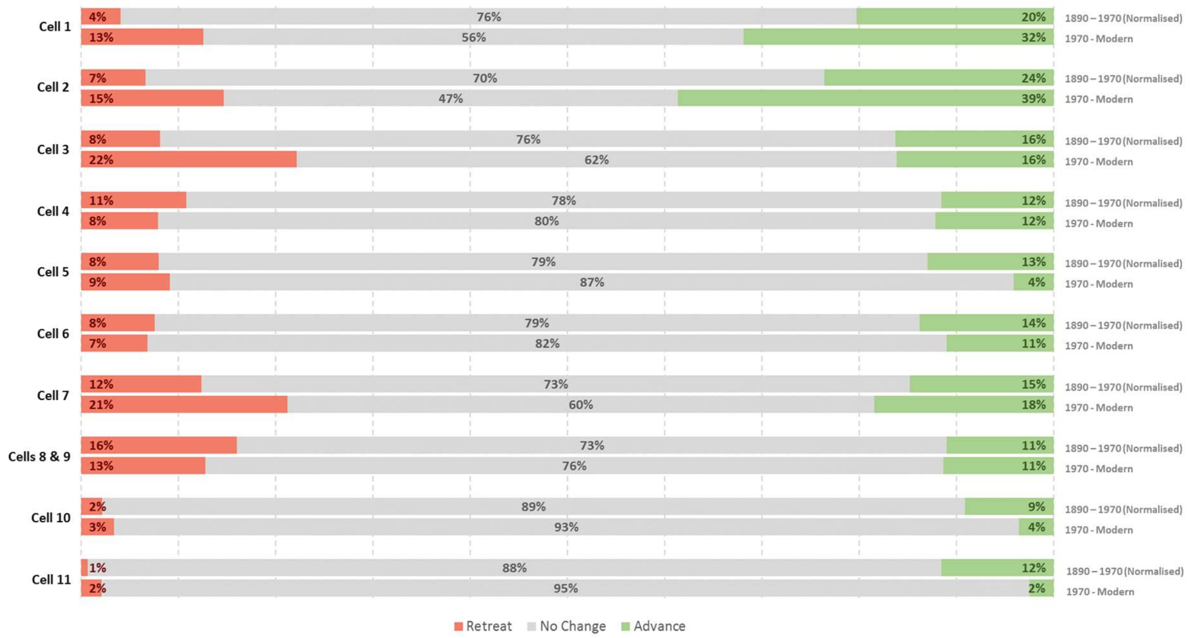

Figure 2: National coastal change results showing historical (ca. 1890-1970, normalised for time period) and recent (ca. 1970 Present.) % of coastal cell showing retreat (red), stability (grey) and advance (green) for soft coast within each cell.

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 5 – Cape Wrath to Mull of Kintyre

Cell 5 extends from Cape Wrath to the Mull of Kintyre, and includes three sub-cells (Figure 5.1). Further contextual information about the processes operating in Cell 5 can be found in Ramsay & Brampton (2000). The coastline of Cell 5 is characterised by long stretches of high and upstanding cliffs punctuated by long and deep fjordic inlets (sea lochs) that extend some distance inland. The coastline is dominated by the hardest and most ancient rocks in the British Isles and bears the legacy of multiple phases of intense glacial erosion that carved out and overdeepened pre-existing inlets that were then flooded by sea level rise. In general, the hardness of the rocks has resulted in limited sediment production and together with the largely crenulated nature of the coast gives limited opportunities and sites for beach production. The few exposed beaches and sections of coast that are potentially subject to rapid coastal erosion are therefore limited to pocket beaches at the heads of inlets or on the more exposed and low lying areas of the numerous offshore islands, such as Coll and Tiree.

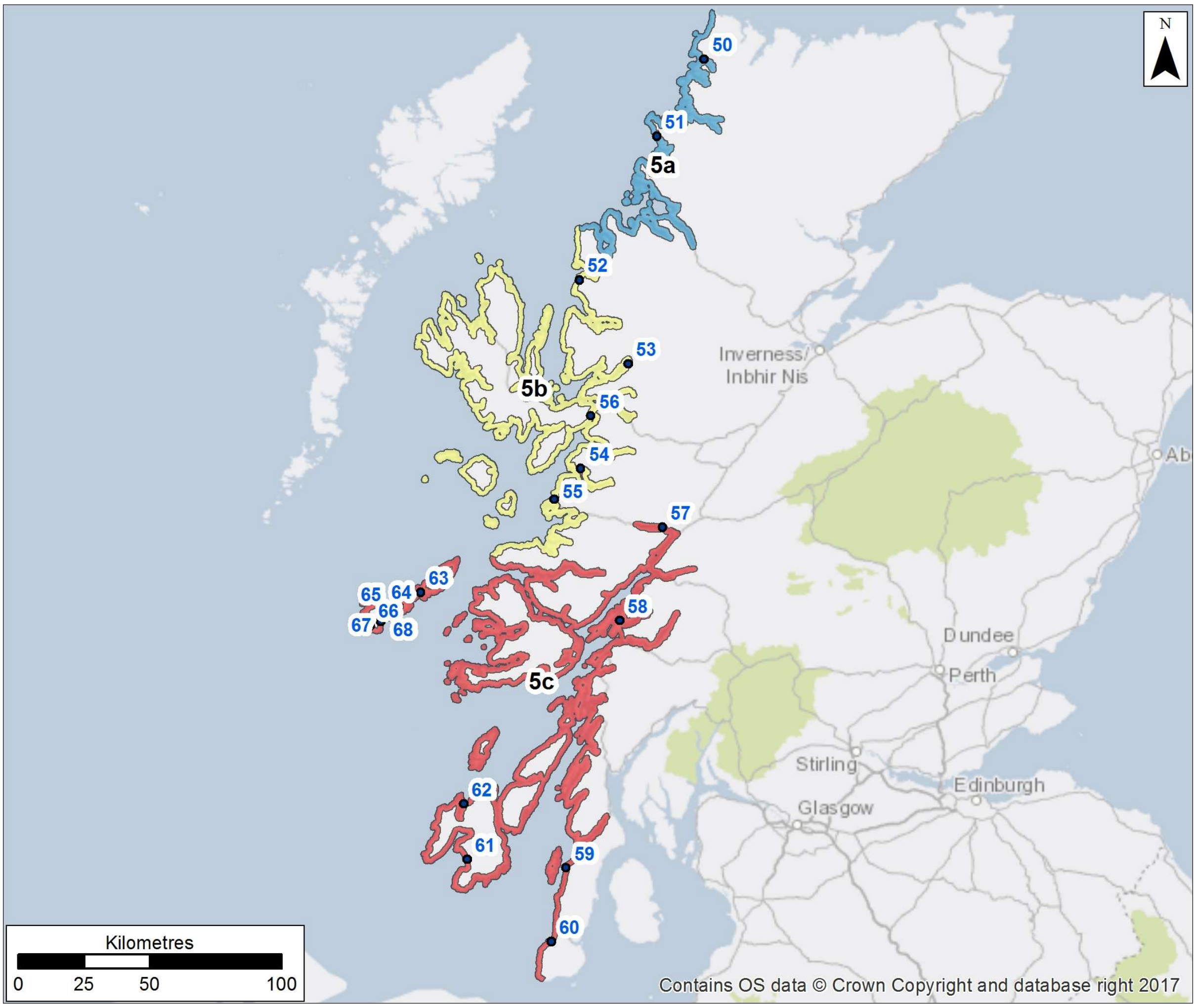

Figure 5.1: The sub-cell boundaries of Cell 5 and locations of sites discussed in this report (blue numbers).

Physical Overview

In Cell 5 Mean High Water Springs (MHWS) extends 7,414 km which makes up 37% of the Scottish coastline. Of this length, 6,243km (84%) is categorised as hard and mixed, 1,143 km (15%) is soft and 28 km is classed as artificial (<1%) (Table 5.1). Within the historical period of 1890-1970s (74 years) almost half (56%) of the soft shoreline did not experience significant change. Accretion occurred on

27%, with 17% of the coast retreating (Figure 5.2). 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 in Cell 5 increased from 7% historically to 10% post 1970s, the extent of stability increased from 76% to 87% and the extent of accretion fell from 13% to 4% (Figure 5.2). In addition to the increase in the extent of erosion in Cell 5, there has been a small increase in the rate of erosion, with the fastest rates (30m+ over 37 years) now affecting 3% of the retreating shore, up from 2% historically. Accretion rates also fell although the fastest rates (30m+ over 37 years) now affect only 1% of the advancing shore, a fall from 3% historically

This trend is consistent with a minor shift from accretion (reducing), through a transitional condition of no change (increasing), toward erosion (increasing) with the average rate of erosion increasing from the historical to the recent period. Further statistics for Cell 5 can be found in Table 5.2 and Table 5.3 at the end of this report.

Table 5.1: Proportion of each coastal type within Cell 5.

Modern Coastal Type	Length	
	km	%
Soft	1143.1	15%
Artificial	28.4	0%
Hard and Mixed	6242.6	84%
Total Length (excluding tidally influenced inlets)	7414.1	100%

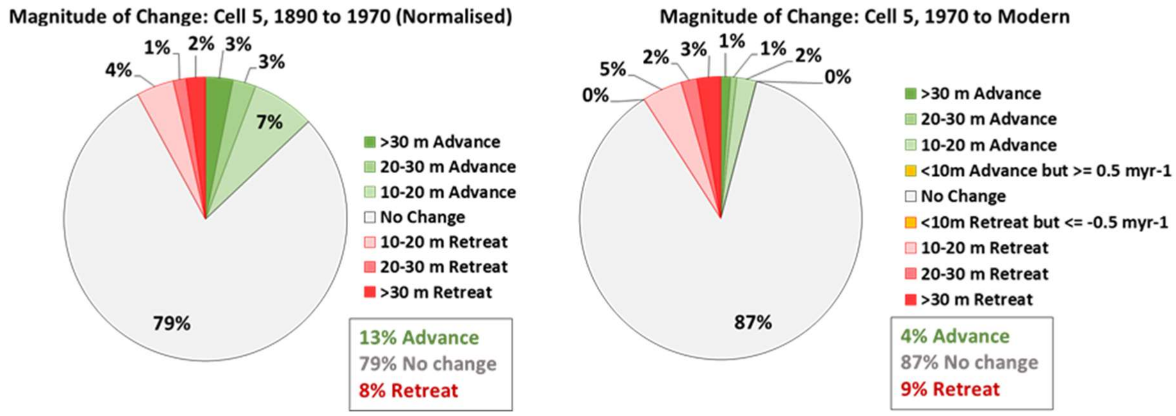

Figure 5.2: Coastal change results for Cell 5 showing the proportional amount of change in the historical (ca. 1890-1970 normalised) and recent (ca. 1970-Present) periods. Rounding errors may produce small % differences between Figure 2 and Figure 5.2.

Asset Vulnerability Overview

The Vulnerability Assessment methodology serves to project the known past erosion rates forward into the future to the year 2050 and is viewable on the online webmaps at www.dynamiccoast.com. Within Cell 5, a total land area of 84.6Ha, which supports various assets, is anticipated to be lost by 2050, this includes one non-residential proper. When areas that erosion may influence are included then an additional non-residential properties is anticipated to be affected by 2050. For a full summary of vulnerable assets see Table 5.4 at the end of this report.

Sub-cell Summaries

Sub-cell 5a - Cape Wrath to Rubha Reidh

5a.1 Kinlochbervie (Loch Clash) (Site 50)

Historic Change: There are two short sections of sand and gravel beach at Loch Clash that have receded by up to 20 m (0.4 m/yr) between 1961 and 2014 (Figure 5.3). The northern beach is approximately 150 m long and is backed by undeveloped grazing land. The southern beach is just short of 100 m long, the southern part of which is protected by a concrete sea wall that connects with a jetty. The beach is backed by a B road and some buildings.

Figure 5.3: MHWS position in 1890, 1970s, and Modern datasets at Kinlochbervie. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Figure 5.4: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Kinlochbervie. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Future vulnerability: The Vulnerability Assessment methodology serves to project the known past erosion rates forward into the future. It suggests that by the year 2050 this area within Loch Clash will experience erosion that will impinge on the viability of both the road that backs the beach and the cluster of buildings at its southern end (Figure 5.4). Given the low-lying nature of the land between Loch Clash and Loch Bervie, the extent of future erosion and that of the erosion influenced area give moderate cause for concern. This may require future protective measures given the economic importance of the fish landing and docking facilities at the head of Loch Bervie, an area that is currently heavily modified by concrete sea walls and jetties.

5a.2 Clachtoll (Site 51)

Historic Change: Clachtoll has two beaches separated by a rocky headland. The northern 170 m long sandy beach has an extensive backing machair system with very low dunes whereas the southern beach is a sand and gravel mix backed by cliff. The northern beach faces southwest and is subject to extensive wind blow and wave impact that has resulted in an eroding seaward edge and longitudinal erosion of the machair surface to the north. Clachtoll has long been an iconic west coast tourist destination, with subsequent vehicle and caravan access exacerbating the erosion of the machair surface adding to the local wind deflation that was noted by Ritchie and Mather (1969). In terms of the current 2017 situation, remedial works that were carried out on the machair surface and coastal edge in the 1970's along with restrictions on vehicle access has resulted in enhanced stability of the machair immediately behind the beach, although deflation is still an issue to the north close to the access road. However, some 14 m of erosion has occurred between 1970 and 2014 with the MHWS line moving landwards at an average of 0.4 m/yr but remains seaward of its 1890 position.

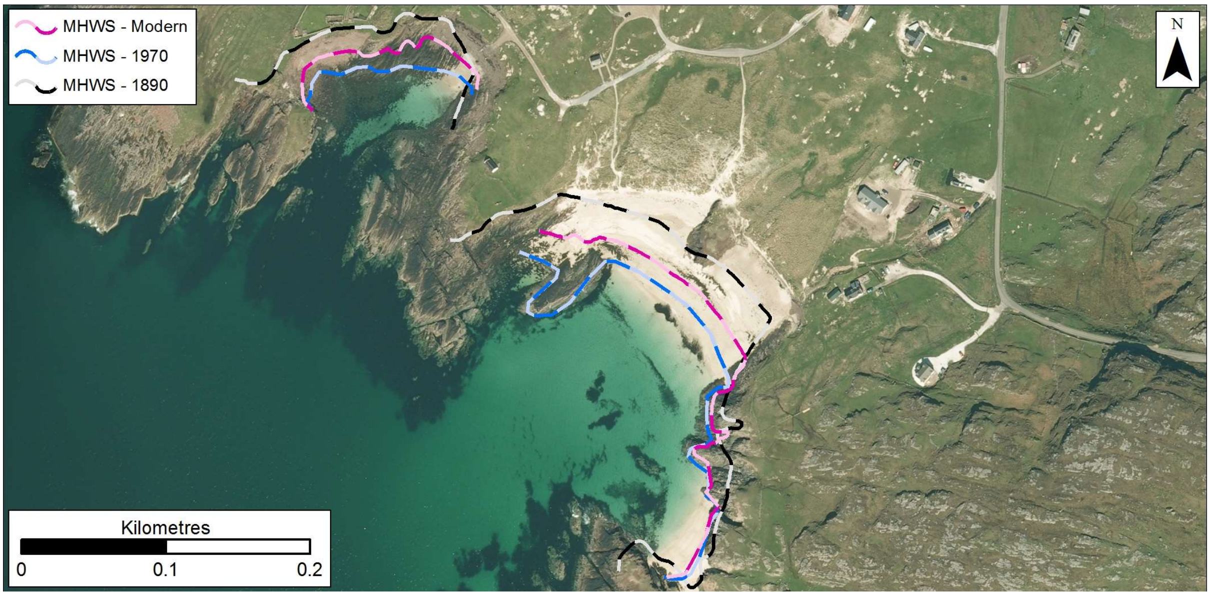

Figure 5.5: MHWS position in 1890, 1970s, and Modern datasets at Clachtoll. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Future Vulnerability: The Vulnerability Assessment anticipates that the entire shoreface at Clachtoll is set to recede by a further 22 m by 2050, with the erosion vicinity extending some 120 m inland. This will impact on two buildings in the south end of the beach but more importantly any erosional disruption of the upper beach/dune interface may allow wind erosion to recommence at this site and result in extensive blow-out and sand movement inland that may impact on its value as a tourist asset. The importance to the local economy of the popular campsite as an asset to the rear of the beach is a both a consideration and a cause for future concern.

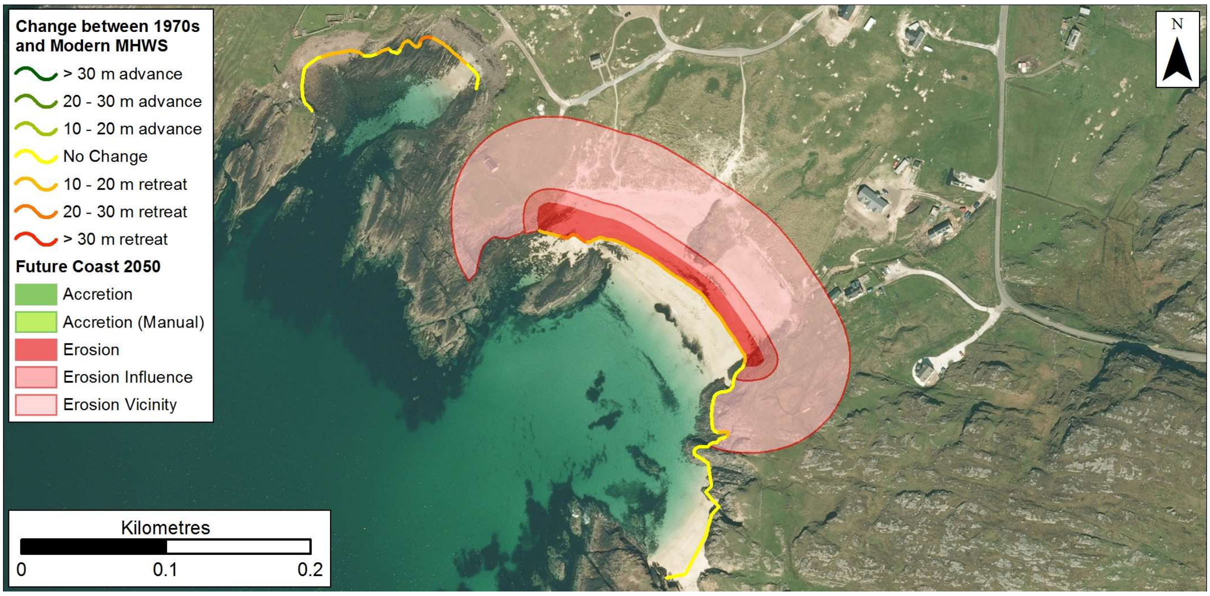

Figure 5.6: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Clachtoll. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Sub-cell 5b - Rubha Reidh to Ardnamurchan Point

5b.1 Opinan (Site 52)

Historic Change: The 340 m long sand beach at Opinan is backed by an eroding dune edge punctuated by blow-outs that allow sand to blow over extensive dune areas inland. Between 1967 and 2014 some 36m of erosion has occurred at a rate of 0.7 m/yr, with a further 16 m to the edge of the eroding dunes to the back of the beach (Figure 5.7). Crofts and Mather (1971) noted erosion of the beach and dune edge at Opinan and describe subsequent attempts to stabilise the blow out areas by brushwood sand fencing. No assets currently lie landward of the beach although both beach and dune system is a recreational asset with the dune serving as common grazing land.

Future Vulnerability: The Vulnerability Assessment anticipates that the entire shoreface at Opinan may retreat by 33 m by 2050 with the erosion influenced area extending a further 60 m inland (Figure 5.8). However, since there are no fixed assets that lie within these zones in the north, there is only limited vulnerability concern, this relating to the impact on the extent of valuable grazing land and the potential for enhanced wind blow as erosion of the beach/dune interface progresses. In the south, two houses lie close to the erosion vicinity zone.

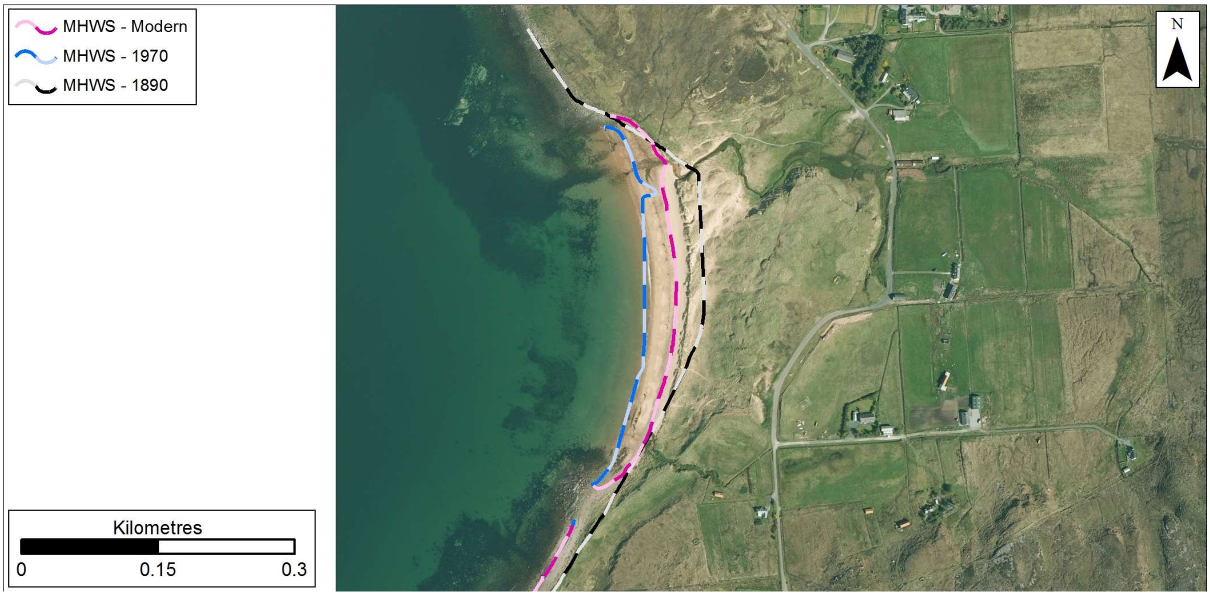

Figure 5.7: MHWS position in 1890, 1970s, and Modern datasets at Opinan. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Figure 5.8: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Opinan. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

5b.2 Loch Carron (Attadale) (Site 53)

Historic Change: Loch Carron is a long and narrow sea loch that is relatively well sheltered from wave activity entering from the open ocean. However, the coastal edge here is unconsolidated glacial tills and glacifluvial sand and gravels that are relatively easily eroded by short steep waves from the southwest and north. This has resulted in a 1km length of the southern shore, just north of Attadale, being subject to up to 18m of landward movement of MHWS between 1971 and 2014 at a mean rate of 0.4 m/yr (Figure 5.9). The land behind is mainly agricultural grazing land but crucially the main rail line from Inverness to Kyle of Lochalsh runs parallel to the shoreface and only a few metres inland of it.

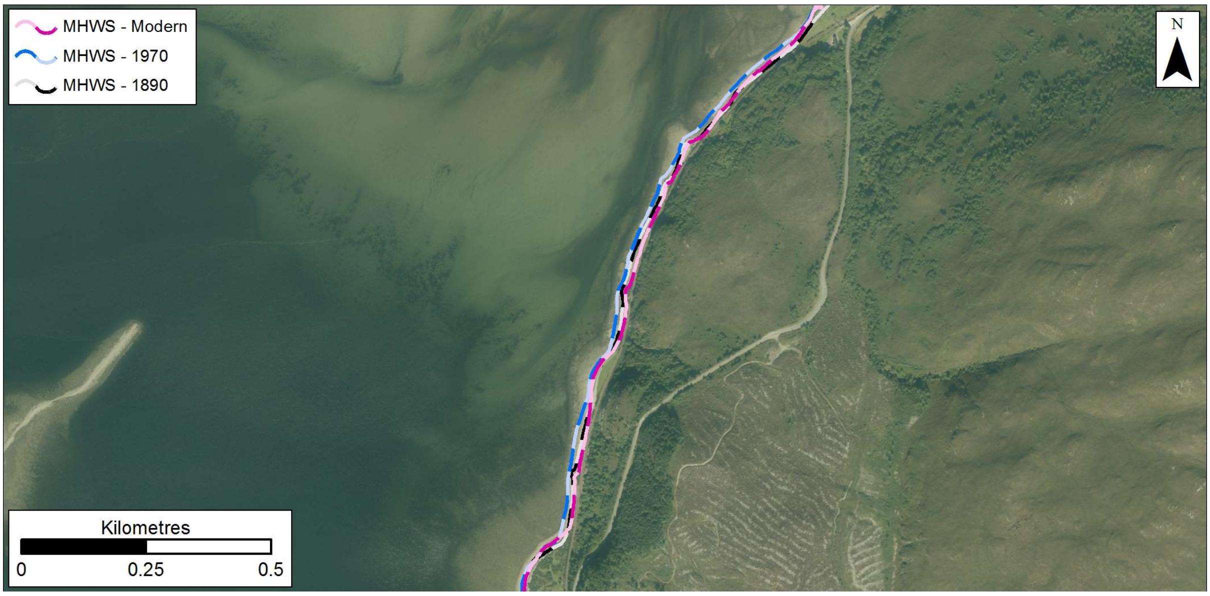

Figure 5.9: MHWS position in 1890, 1970s, and Modern datasets at Loch Carron. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Figure 5.10: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Loch Carron. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Future Vulnerability: The Vulnerability Assessment anticipates that the entire 1 km length of shoreface at Attadale will be subject to a further 15 m of landward movement by 2050 with a further 60m lying within the erosion influenced zone (Figure 5.10). Along this stretch of eroding coast, the main railway line runs close and parallel with the rail bed being within 5 m and the track within 7 m of MHWS in 2014. Part of this stretch appears to be protected by loosely packed boulders or rip rap but other sections remain unprotected. Given the rate of past erosion and projecting this into the future then there is concern for the future viability of the rail line given its current alignment and protection provision, well before 2050.

5b.3 Inverie (Knoydart) (Site 54)

Historic Change: 1.5 km to the west of the township of Inverie, two short stretches of coast have been subject to erosion rates of 24 m between 1972 and 2014 at rates of up to 0.6 m/yr (Figure

5.11). The westernmost section is 105m long and backed by a residential property. The eastern section is 220 m long and backed by an unprotected access track to a residential property whose shorefront is protected by a 50 m long concrete wall, with a short jetty at its eastern end.

Figure 5.11: MHWS position in 1890, 1970s, and Modern datasets at Knoydart. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

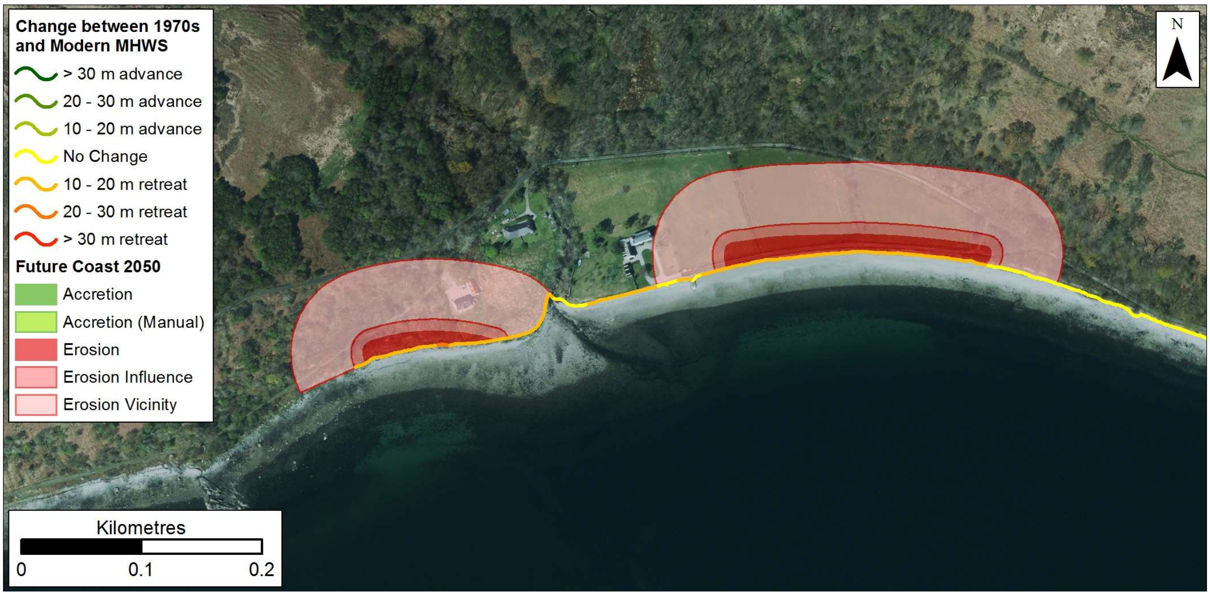

Figure 5.12: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Knoydart. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Future Vulnerability: The Vulnerability Assessment anticipates that a further 20 m of erosion over both these stretches of shore will occur by 2050 and will impact on the access track to the easternmost property and the erosion vicinity will overlap onto a short stretch of the coast road to Sandaig in the west as well as two of the properties in the bay. (Figure 5.12).

5b.4 Arisaig (Back of Keppoch) (Site 55)

Historic Change: Some 500 m of sheltered sandy beach at Back of Keppoch to the north of Arisaig has been eroded by up to 16m between 1973 and 2014 at rates of up to 0.4 m/yr, with the dune edge showing signs of undercutting and wind-blown erosion (Figure 5.13). The land in the north is largely devoted to grazing pasture and camp sites whilst in the south, residential houses and crofts are accessed by a roadway.

Figure 5.13: MHWS position in 1890, 1970s, and Modern datasets at Back of Keppock. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

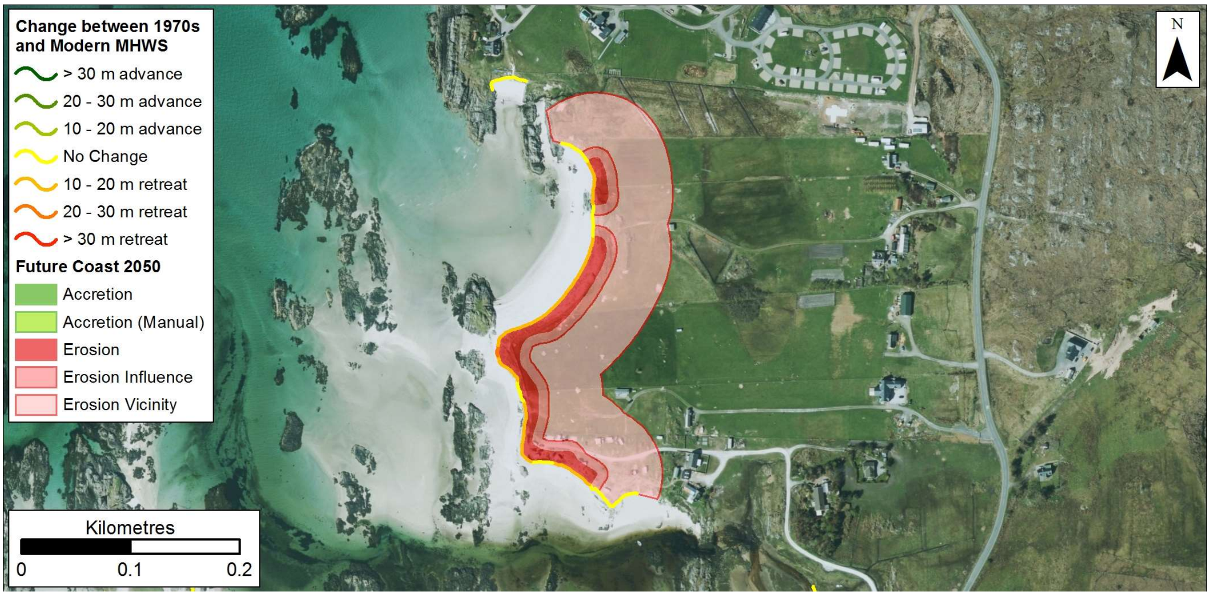

Figure 5.14: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Back of Keppoch. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Future Vulnerability: The Vulnerability Assessment anticipates that a further 20 m of erosion will affect all this coastal stretch. Since most of the beach is backed by wind-blown dune sand and machair that's given over to grazing and seasonal campsites then the level of vulnerability to the coastal assets is more significant than would be first assumed (Figure 5.14). In the south where the zone of anticipated erosion affects seven houses and their outbuildings as well as the seaward end of the access roadway. The erosion vicinity extends to double this number of houses and some 100 m of the access roadway. The other important aspect of this projected erosion is that this area is a popular tourist area that is used throughout the year, but especially heavily in summer and so is of importance to the local economy.

5b.5 Kylerhea (Isle of Skye) (Site 56)

Historic Change: Some 250 m of sheltered sand and gravel beach to the south of the Skye ferry jetty at Kylerhea has been eroded by up to 17 m between 1963 and 2012 at rates of up to 0.3 m/yr (Figure 5.15). Given the very sheltered nature of this coast, these rates are surprising. The narrows of Kyle Rhea is however, noted for its strong tidal currents as water is forced to flow between the mainland at Glenelg and the Isle of Skye and this will impact on any unconsolidated shoreface. At Kylerhea, the dune edge shows signs of undercutting and wind-blown erosion. The land in the north is largely devoted to pasture and grazing whilst in the south, residential houses and crofts parallel the coast at this point and are accessed by a roadway.

Future Vulnerability: The Vulnerability Assessment anticipates that a further 16 m of erosion may occur to 2050 and this will impact directly on five residential properties along the shore (Figure 5.16). All the adjacent coastal land is given to pasture and since there is a limited amount of suitable pasture nearby, the loss of such land is likely to be of concern for the future viability of the crofts here.

Figure 5.15: MHWS position in 1890, 1970s, and Modern datasets at Kylerhea. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Figure 5.16: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Kylerhea. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Sub-cell 5c - Ardnamurchan Point to Mull of Kintyre

5c.1 Loch Eil (Corpach) (Site 57)

Historic Change: To the west of the pulp and paper mills of Corpach, the north shore of Loch Eil has receded in five places by up to 14m between 1972 and 2011 at rates of up to 0.4 m/yr (Figure 5.17). Two of these sections of shore are 100 m in length with the other three being approximately 50m long. Much of the shoreface is gravel and backed by rising ground along which are routed both the main Inverness to Mallaig rail line and the A830 trunk road.

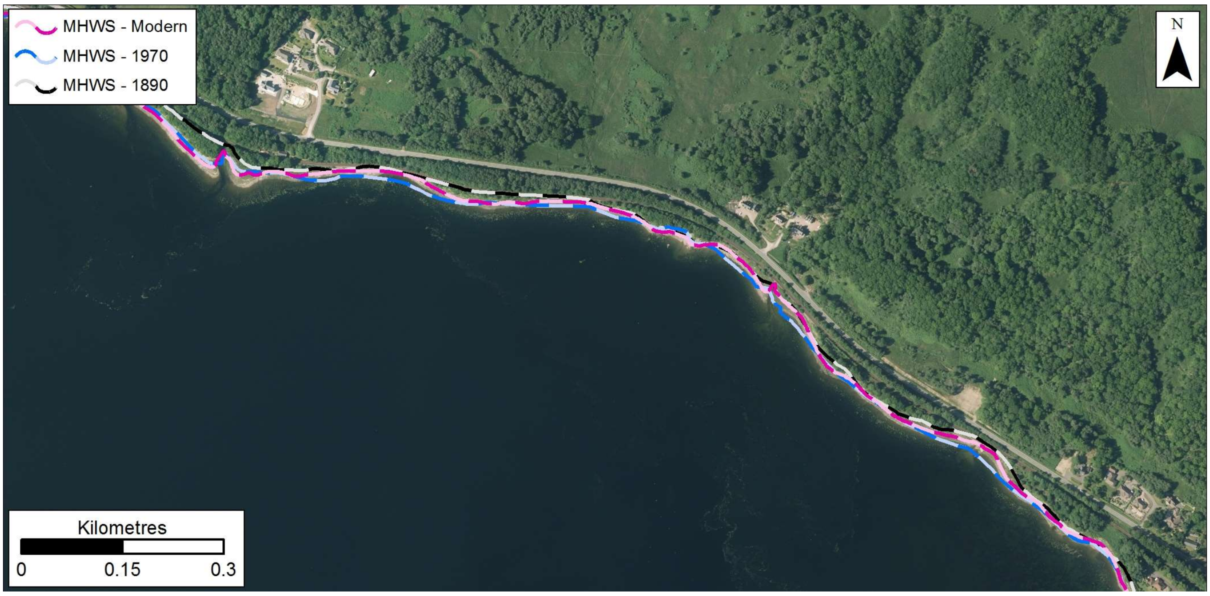

Figure 5.17: MHWS position in 1890, 1970s, and Modern datasets at Corpach. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Figure 5.18: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Corpach. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Future Vulnerability: The Vulnerability Assessment anticipates that a further 20 m of erosion may occur to 2050. This will impact directly on the viability of the rail line which in places is 4 m from the

2011 MHWS, albeit that these points are protected by short concrete seawalls (Figure 5.18). In other places the line is unprotected and is thus vulnerable to future erosion. If the erosion influenced and erosion vicinity areas are included then these lengths of potential vulnerability roughly double and encroach upon the carriageway of the A830 itself.

5c.2 Isle of Eriska (Appin) (Site 58)

Historic Change: Roughly 500 m of the northwest shore of Eriska has eroded between 1975 and 2011 by up to 19 m at a rate of 0.5 m/yr (Figure 5.19). The shore is largely composed of gravels and backed by low lying gravel emerged beaches, supporting heath and trees that sit to the seaward of the Isle of Eriska Hotel. The access road to the island also lies in an area of past erosion where the unprotected shore has receded by up to 15 m over a 250 m stretch between 1975 and 2011. The foreshore here is part of the South Shian and Balure Site of Special Scientific Interest.

Figure 5.19: MHWS position in 1890, 1970s, and Modern datasets at the Isle of Eriska. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

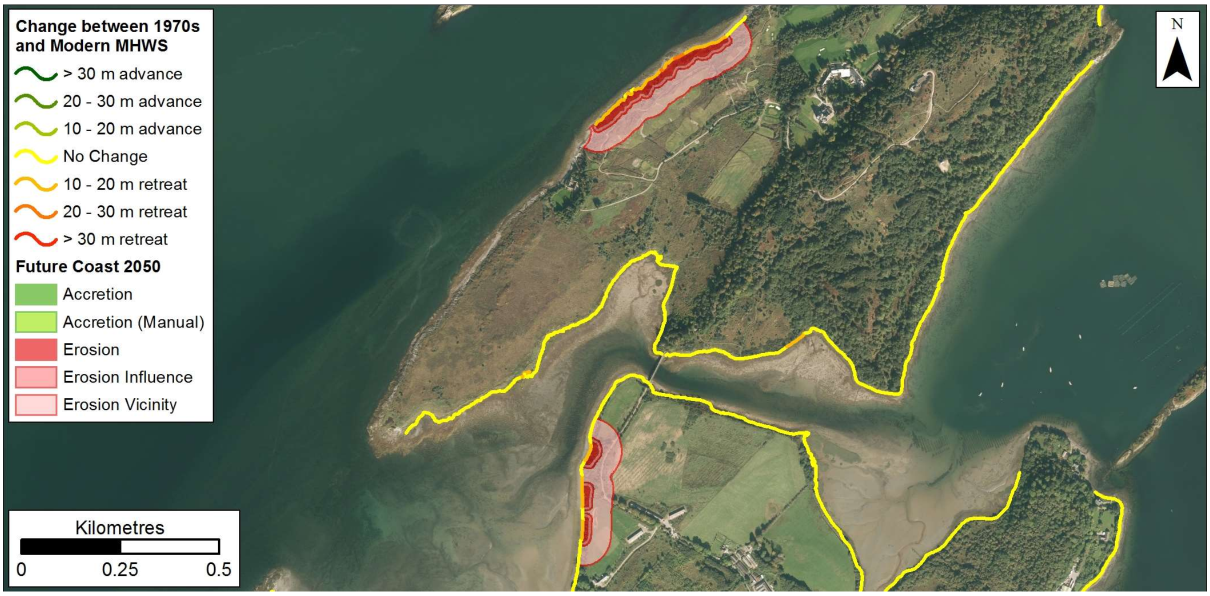

Figure 5.20: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data on the Isle of Eriska. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Future Vulnerability: The Vulnerability Assessment anticipates that a further 15 m of erosion may occur to 2050 and up to 75 m within the erosion vicinity over a length of 500 m. This will impact on the coastal strip that currently protects the golf course, however, the actual course footprint may not be impacted (Figure 5.20). Whilst the access road to the south is not expected to be directly affected by the further 17m of recession expected to 2050, the erosion vicinity overlaps approximately 100 m of the road and is cause for concern if these rates are exceeded in the future.

5c.3 Rhunahaorine Point (Kintyre) (Site 59)

Historic Change: Rhunahaorine Point in Argyll is a large emerged gravel foreland that juts out from the coast, its development a result of the shelter from westerly wave activity provided by the Isle of Gigha. Two sections of the point are subject to erosion (Figure 5.21). The southernmost section extends to 35 m and is backed by farmland. The northern section is 750 m long, backed by land that supports a caravan park where 25 m has been lost between 1979 and 2014 at a rate of 0.7 m/yr. At present, the shore remains unprotected as part of a management agreement between SNH and the landowner to allow erosion to release the underlying emerged gravels to recharge the shoreface. This shoreline makes up part of the Rhunahaorine Point Site of Special Scientific Interest.

Figure 5.21: MHWS position in 1890, 1970s, and Modern datasets at Rhunahaorine Point. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Future Vulnerability: The Vulnerability Assessment anticipates that a further 20-30 m of erosion may occur to 2050 with the biggest impact in the south of this section (Figure 5.22). The erosion influence area extends to 25-40 m inland with the vicinity doubling this extent. At present the impact is felt on the footprint of the caravan park and this is expected to continue with the caravan pitches being progressively moved inland. The present understanding is that there is a management agreement in place with SNH and the landowner that no protection is emplaced on this shore in order that the gravels stored within the underlying emerged beaches may be allowed to recharge the shoreface as erosion progresses.

Figure 5.22: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Rhunahaorine Point. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

5c.4 Machrihanish (Kintyre) (Site 60)

Historic Change: The south part of Machrihanish Bay in Argyll is characterised by a 6 km long extensive sand and gravel beach backed by a mature sand dune system. The southern 2 km of beach has undergone up to 24 m of landward migration of the MHWS position between ca 1980 and 2014 (0.7 m/yr) (Figure 5.23). For its entire length, the backing dunes are used for golf with two courses in place, the southernmost of which is mainly affected by the erosion of the beach. This shoreline makes up part of the Machrihanish Dunes Site of Special Scientific Interest.

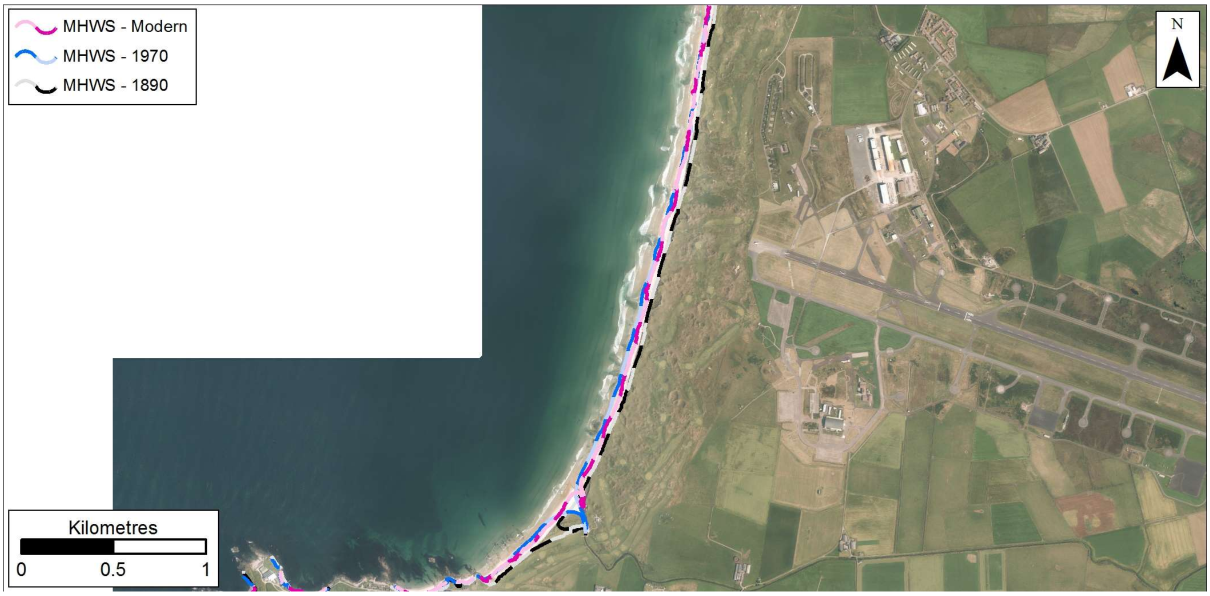

Figure 5.23: MHWS position in 1890, 1970s, and Modern datasets at Machrihanish. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Figure 5.24: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Machrihanish. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Future Vulnerability: The Vulnerability Assessment anticipates that a further 24 m of erosion may occur to 2050 with the biggest impact in the south of this section (Figure 5.24). The erosion influence and vicinity areas add another 60m to the footprint. Since much of the affected beach and dune is in low intensity use as golf courses, then the level of vulnerability is low. The newer and northernmost course already has contingency inbuilt so that the golf course is movable in the event of future erosion. No plans are in place to restrict the landward movement of the coast at the older course in the south, and it will be important that this remains the case into the near future, to maintain the flexibility of the coastal edge, if the anticipated erosion progresses.

5c.5 Laggan Bay (Islay) (Site 61)

Historic Change: The entire 7 km of Laggan Bay on the west coast of Islay has been subject to erosion of up 74 m to between 1979 and 2014, the most affected section being mid bay near the end of the airport runways. The rates of erosion are less in places, particularly at the north and south extremities of the beach. In the north, the beach is backed by an extensive dune system and in the south by a golf course. The central 2 km fronts the Islay airport whose main runway and two disused runways approach the shore. The end of the main runway lies 80 m from MHWS and 50 m from the coastal dune edge. The shoreline makes up part of the Laggan, Islay Special Protection Area and Laggan Peninsula and Bay Site of Special Scientific Interest.

Future Vulnerability: The Vulnerability Assessment anticipates that a further 88 m of land will be directly impacted by erosion by 2050 with the biggest impact being across the central part of the bay. The erosion vicinity may add a further 70m to these inland extents. Although the main operational runway lies within this 88 m footprint then there is a potential concern focused on the western extent of the runway, should erosion continue at its past rate or accelerate into the future. Eastward extension of the runway would be a strategic option for the future, rather than shore protection that may serve to accelerate erosion on adjacent stretches of beach.

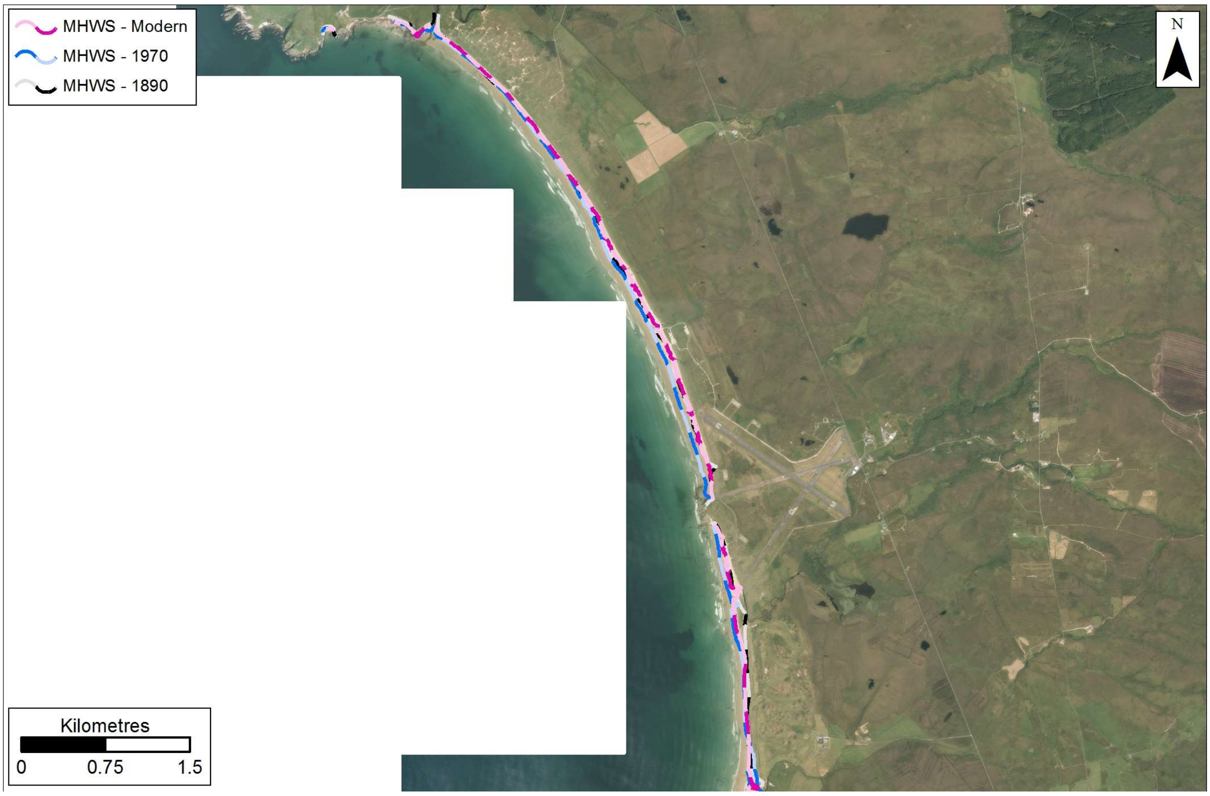

Figure 5.25: MHWS position in 1890, 1970s, and Modern datasets at Laggan Bay. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

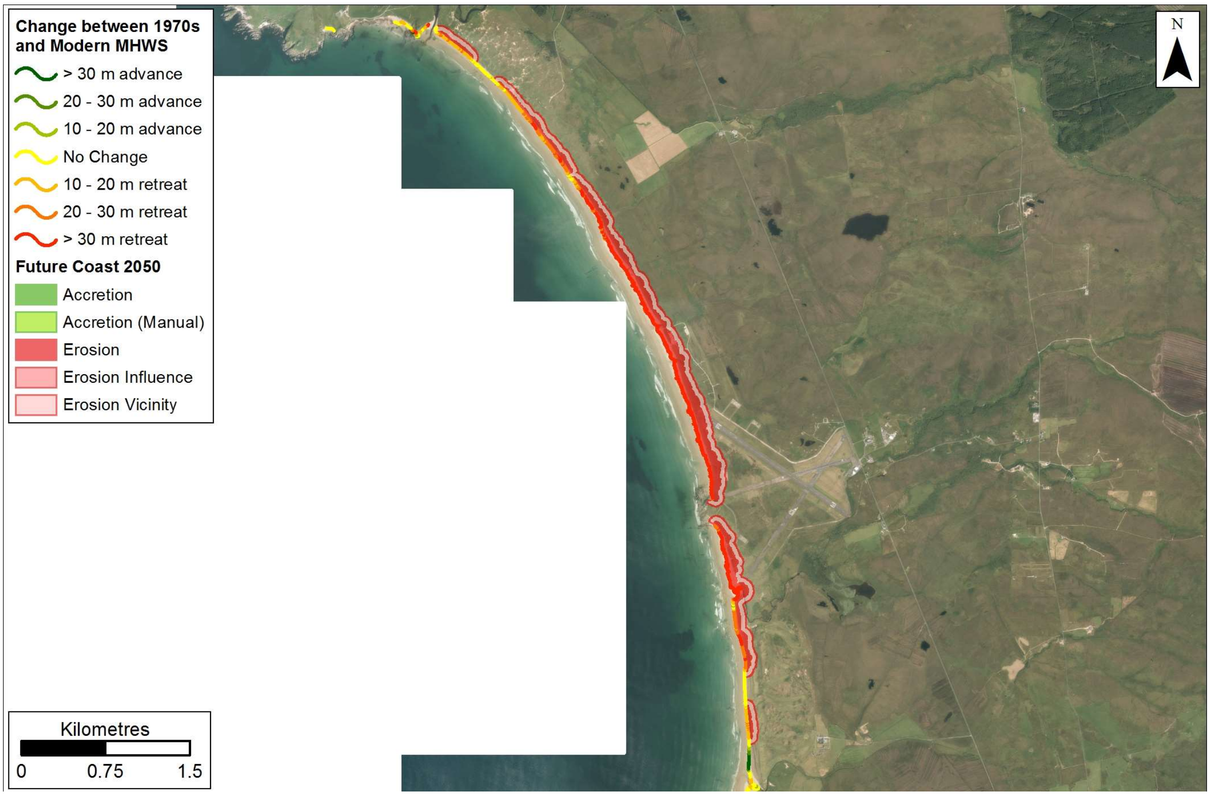

Figure 5.26: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Laggan Bay. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

5c.6 Killinallan Point (Loch Gruinart, Islay) (Site 62)

Historic Change: Over the period 1979 -2014, 2 km of Killinallan Point has undergone erosion rates of up to 30 m (although this reaches a maximum of 200 m at the Point itself due to changes in the ebb channels of Loch Gruinart). The entire dune system has no built assets so that the erosion here has and will progress in an unrestricted way. The shoreline here makes up part of the Gruinart Flats, Islay Special Protection Area and Gruinart Flats Site of Special Scientific Interest.

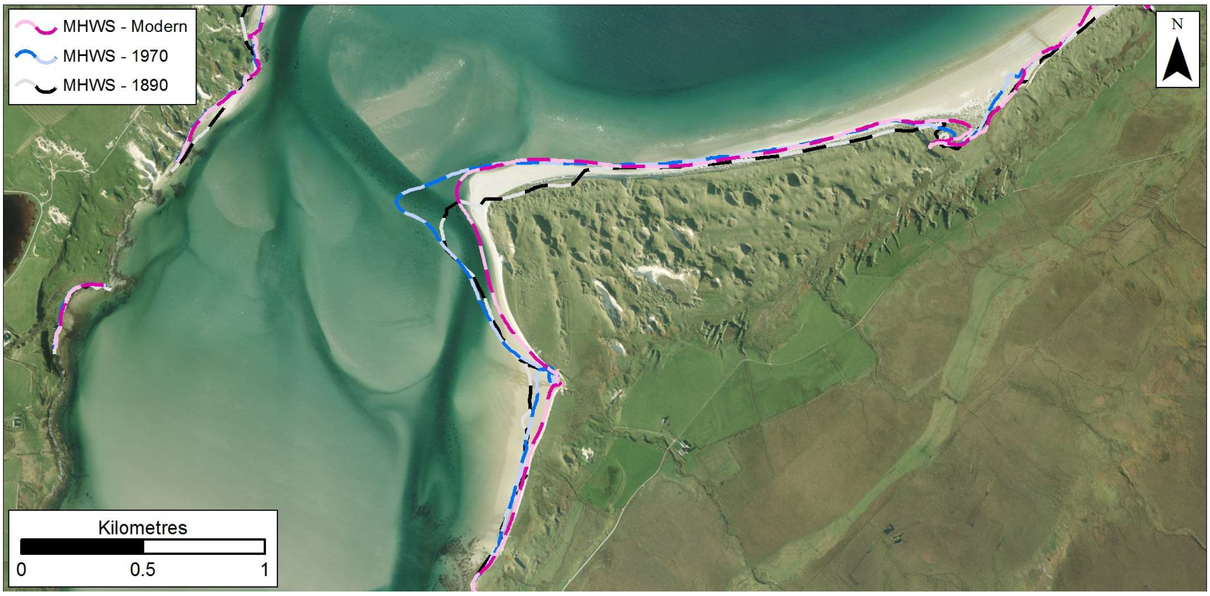

Figure 5.27: MHWS position in 1890, 1970s, and Modern datasets at Killinallan Point. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Future Vulnerability: The Vulnerability Assessment anticipates that a further 65 m of beach and dune will be directly impacted by erosion at the point but the vulnerability is low since there are no built assets nearby.

Figure 5.28: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Killinallan Point. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

5c.7 Hogh and Crossapol Bays, Loch Breachach (Coll) (Site 63)

Historic Change: Over the period 1975 -2011 (Hogh) and 2006 (Crossapol and Loch Breachacha), 24 m has been lost at Hogh (Figure 5.29) and Loch Breachacha, and 14 m from Crossapol (Figure 5.30). All of these beaches however, are backed by undeveloped dunes and pasture with no built assets. The dunes at Hogh are part of the Totamore Dunes and Loch Ballyhaugh Site of Special Scientific Interest, and those at Crossapol are part of the Crossapol and Gunna Site of Special Scientific Interest and the Coll Machair Special Area of Conservation.

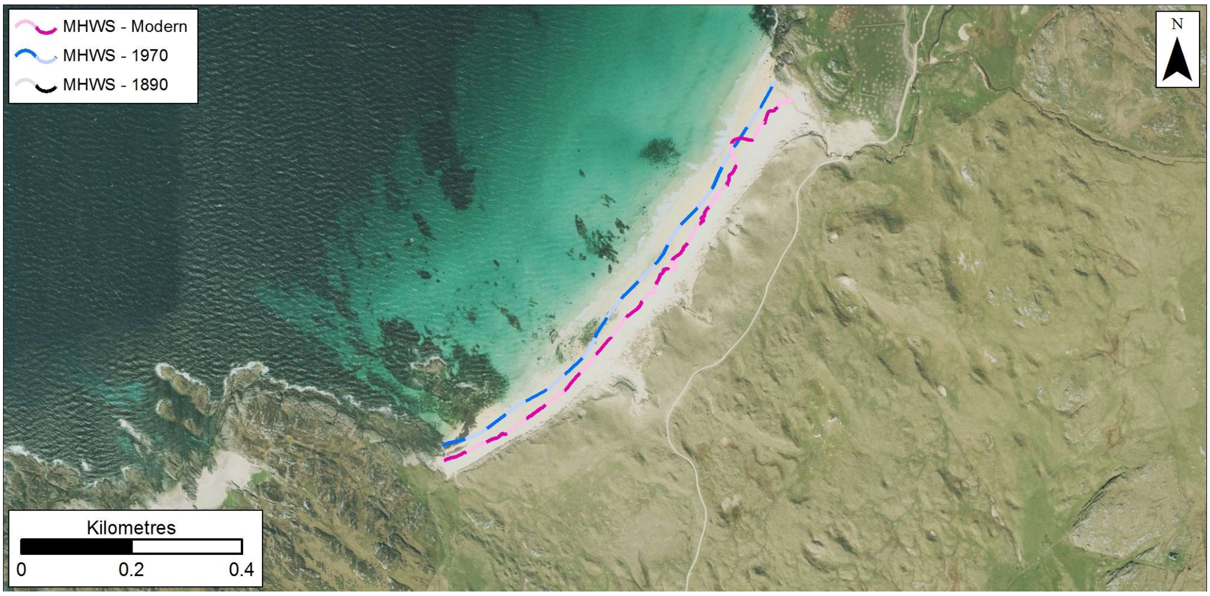

Figure 5.29: MHWS position in 1890, 1970s, and Modern datasets at Hogh. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Figure 5.30: MHWS position in 1890, 1970s, and Modern datasets at Crossapol Bay. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Future Vulnerability: The Vulnerability Assessment anticipates up to 30 m at Hogh will be directly impacted by erosion and that a further 25 m of beach (Figure 5.31) and dune at five lengths of beach at Crossapol amounting to 400m of the 2 km long beach (Figure 5.32). The vulnerability of all three beaches on Coll is low since there are no built assets nearby.

Figure 5.31: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Hogh. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Figure 5.32: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Crossapol Bay. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

5c.8 Traigh Mhor and Salum (Tiree) (Site 64)

Historic Change: Over the period 1975 to 2006, the beaches at Salum Bay on the north coast of Tiree have undergone 18 m of recession at rates of up to 0.6 m/yr across all the east part of the bay (Figure 5.33). Vaul Bay to the west has also eroded but by lesser amounts of up to 9 m. The coastal edge at Salum is markedly undercut particularly in the east. Both bays are backed by machair dune systems that are currently used as pasture, with no built assets. Both beaches have access tracks leading north. The dunes at Salum are part of the Sleibhtean agus Cladach Thiriodh (Tiree Wetlands) Special Protection Area.

Figure 5.33: MHWS position in 1890, 1970s, and Modern datasets at Salum and Vaul Bay. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Figure 5.34: MHWS position in 1890, 1970s, and Modern datasets at Traigh Mhor. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Due south of Salum, the 4 km long sandy beach at Traigh Mhor / Gott Bay (Figure 5.34) has been subject to erosion over the period 1975 and 2006. This has mainly focused on two sections in the central part of the beach: a 290 m section (10 m or recession) and a longer 1.6 km section in the central part (up to 25 m of recession). Both the eastern and western ends of the beach have accreted by small amounts, likely due to the shelter afforded by the bounding headlands that allow refraction to move a proportion of the eroded sediment from the centre into these more sheltered areas. The B8069 runs parallel, and in close proximity, to the dune edge at the rear of the beach along its entire length, this road providing the only current access to several croft houses and farms. The position of MHWS in 2006 lies about 40 m from the roadway, yet the coastal edge as marked by the undercut dune cliff lies about 5m from the road edge but in place this drops to 1 m. The shoreline at at Traigh Mhor / Gott Bay is part of Sleibhtean agus Cladach Thiriodh Site of Special Scientific Interest and Special Protection Area.

Future Vulnerability: The Vulnerability Assessment anticipates that a further 25 m of beach and dune will be directly impacted by erosion across 550 m of the central and eastern part of Salum (Figure 5.35). However, since both Salum and Vaul Bay have no built assets that lie within the anticipated areas of future erosion then the level of vulnerability remains low.

Figure 5.35: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Salum and Vaul Bay. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

The vulnerability situation at Traigh Mhor (Figure 5.36) differs from the northern beaches with greater rates of recession anticipated to impact on the B8069 that parallels much of the beach arc. Up to 40 m recession is anticipated across much of the central section with up to 80 m in the centre near the stream exit where an area of low-lying ground lies below MHWS directly to the rear of the beach. 1.3km of the road lies within the area of erosion anticipated by 2050 as well as five properties within the erosion vicinity area. This projected extent does not include the extended area that is anticipated to be subject to marine incursion due to a back-beach negative gradient leading to ground lying below MHWS in the central part of the bay.

Figure 5.36: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Traigh Mhor. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

5c.9 Balephetrish Bay (Tiree) (Site 65)

Historic Change: Balephetrish Bay is 1.6km long and lies on the north coast of Tiree (Figure 5.37). Over the period 1975 to 2006, Balephetrish has undergone approximately 26 m of recession at rates of up to 0.8 m/yr in both the east and west ends of the beach although the rates reduce in the central part to a mean of 0.3 m/yr. Backed by machair dune systems that are currently used as pasture, the B6068 hugs the coast for the western 1 km before swinging south and away from the coast. Eight croft houses lie close to the south side of the road. The road lies 19 m from MHWs and 6 m from the eroding dune edge for much of its 1 km length. At the extreme western end of the beach, coarse gravels lie at the toe of a 55 m long vegetated bund (of indeterminate composition, likely boulder cored) that protects the road junction of the B6068 and a minor road leading south. The shoreline at Balephetrish Bay is part of Sleibhtean agus Cladach Thiriodh Site of Special Scientific Interest and Special Protection Area.

Future Vulnerability: The Vulnerability Assessment anticipates that a further 40m of beach and dune will be directly impacted by erosion across 750m of the eastern part of Balephetrish, 160m of which is anticipated to impact on the road (Figure 5.38). The current rates of erosion in the area fronting the croft houses in the central area lies outwith the area of concern but to the west, at the junction of the B8068 and the minor road, 35 m of erosion by 2050 is anticipated to affect about 250 m of road including the road junction. Caution is noted here in that there may be some coastal defences within the vicinity of the property, which would have an influence on future erosion.

Figure 5.37: MHWS position in 1890, 1970s, and Modern datasets at Balephetrish Bay. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Figure 5.38: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Balephetrish Bay. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

5c.10 Traigh Bhi (Tiree) (Site 66)

Historic Change: Traigh Bhi / Balephuil Bay extends for 1.5 km on the southwest coast of Tiree and is backed by a wide cordon of dunes that increase in height inland to 10 m. This dune land is put to pasture with no built assets nearby. A single drainage channel leads from Loch a'Phuill to exit through the dunes at the centre of the sand beach. Over the period 1975 to 2006, some 36 m has been lost in the centre of the bay and in the west (ca 1.0 m/yr), with lesser amounts elsewhere toward the west where the beach is both sand and gravel, and in the east where the beach is sand (Figure 5.39). The undercut dune edge lies a further 30 m landward of the MHWS position. The dunes make up part of the Ceann a' Mhara to Loch a' Phuill Site of Special Scientific Interest.

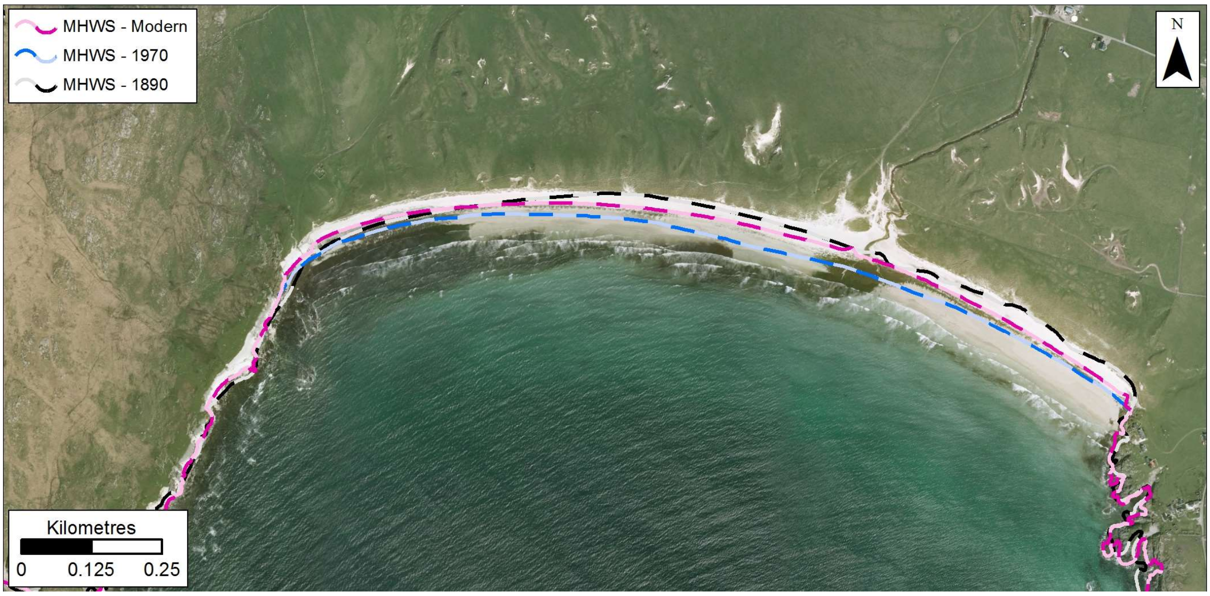

Figure 5.39: MHWS position in 1890, 1970s, and Modern datasets at Traigh Bhi. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Future Vulnerability: The Vulnerability Assessment anticipates that up to a further 55 m of beach and dune will be directly impacted by erosion across much of the central part of the bay with this falling to 15-20 m at the extremities of the beach (Figure 5.40). Since no roads or built assets lie behind Traigh Bhi and the land is in machair pasture then future vulnerability is assessed to be low.

Figure 5.40: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Traigh Bhi. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

5c.11 Traigh Shorobaidh (Tiree) (Site 67)

Historic Change: Traigh Shorobaidh is the southern extension of Hynish Bay and stretches for 1.5 km on the south coast of Tiree. It is backed by a single low altitude, but 30 m wide, sand dune ridge. The land behind is low-lying machair pasture. Over the period 1975 to 2006, some 30 m has been lost in the centre of the bay and in the west (1.0 m/yr), with lesser amounts elsewhere (Figure 5.41). The B8066 approaches the west end of the beach where a small cluster of residential houses occur.

Traigh Shorobaidh is part of the Traigh Shorobaidh Special Area of Conservation and Site of Special Scientific Interest.

Figure 5.41: MHWS position in 1890, 1970s, and Modern datasets at Traigh Shorobaidh. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Future Vulnerability: The Vulnerability Assessment anticipates that a further 35 m of beach and dune will be directly impacted by erosion across approximately 600 m of the east end of the bay and 200 m in the extreme west close to the settlement of Crossapol. No houses however, lie within the anticipated directly affected zone and only three within the erosion vicinity although this zone also overprints onto 300 m of the B8066 (Figure 5.42). Traigh Shorobaidh thus is assessed to have low vulnerability by 2050.

Figure 5.42: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Traigh Shorobaidh. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

5c.12 Traigh Bhagh (Tiree) (Site 68)

Historic Change: Traigh Bhagh extends for 2 km on the south coast of Tiree surrounding Hynish Bay, backed by a single low altitude, but 50m wide, sand dune ridge. The land behind is low-lying machair pasture, except in the east where a substantial area (100 ha) of marshy ground slopes landward to below MHWS. It extends 2.7 km northward toward to within 600 m of Balephetrish Bay. Over the period 1975 to 2006, some 173 m was lost in the east (5.6 m/yr), with a lesser amount in the west of 15 m (0.5 m/yr) (Figure 5.43). The land to the north of the beach supports Tiree airport whose main runway west threshold lies at 9 m Ordnance Datum and 520 m from the eroding coastal edge and whose main runway east threshold lies at 6 m OD and within 300 m of the negative gradient land that lies below MHWS. The dunes and foreshore are part of the Tiree Machair Special Area of Conservation and Sleibhtean agus Cladach Thiriodh (Tiree Wetlands) Special Protection Area and Site of Special Scientific Interest.

Figure 5.43: MHWS position in 1890, 1970s, and Modern datasets at Traigh Bhagh. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

Future Vulnerability: The Vulnerability Assessment anticipates that a further 80 m of beach and dune will be directly impacted by erosion across much of the eastern part of Traigh Bhagh (Figure 5.44), reducing to 20 m in the west. The eroded area is anticipated to directly affect one commercial building in the bay centre, currently used as an outdoor pursuits base and the erosion vicinity footprint includes one community building and car park (The Island Centre) in the west. It is anticipated that the B8065 roadway will not be affected by 2050 if these erosion rates continue as in the past up to 2006.

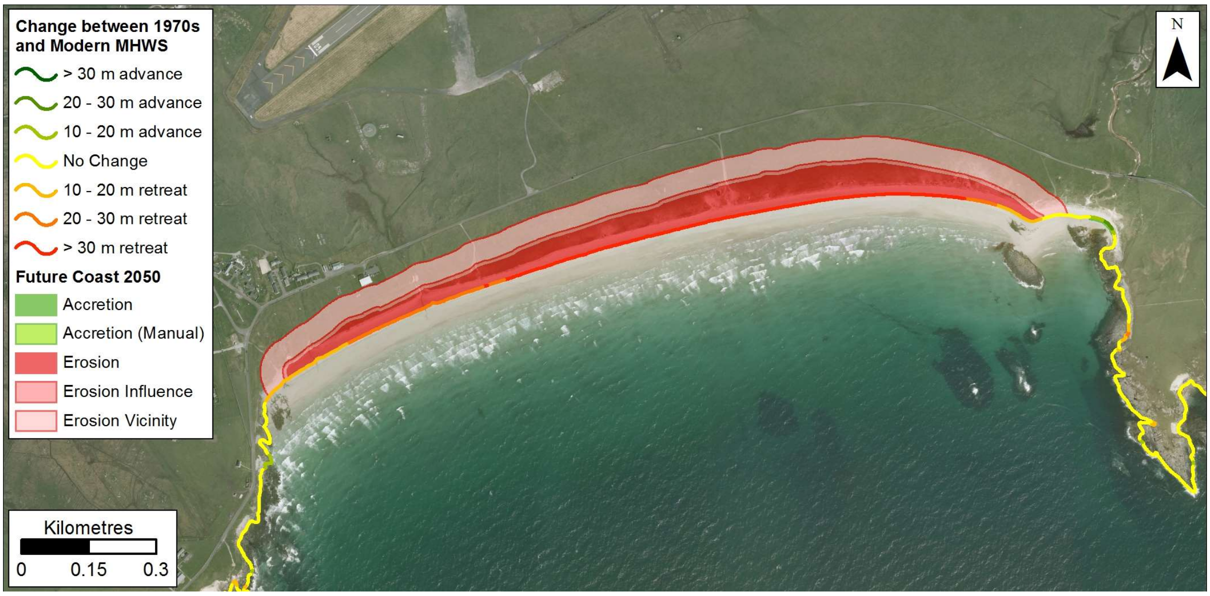

Figure 5.44: Possible future coastline position in 2050 based on rates between 1970 and Modern MHWS data at Traigh Bhagh. Getmapping are our current providers of Scotland-wide digital aerial imagery© Getmapping plc.

One issue is the predominantly low-lying status of the entire strip of land that lies between Balephetrish and Traigh Bhagh (called An Riof) that supports Tiree airport as well as the two main island roads; B8068 and B8065. Since both north and south beaches have undergone past erosion that is projected to continue, and the interbeach area is flanked in the east by an extensive area of land currently lying below MHWS, then this area is vulnerable to both flooding and erosion into the future, especially since the area of potential future flooding is dependent on the ongoing integrity of the current dune cordon.

Coastal Change Statistics for Cell 5

Within the soft sections of Cell 5, **27%** has been **advancing** between **1890 and 1970**; compared with **4%** between **1970 and modern data**.
Within the soft sections of Cell 5, **17%** has been **retreating** between **1890 and 1970**; compared with **9%** between **1970 and modern data**.
Within the soft sections of Cell 5, the **average rate of advance** is **0.4 m/yr** between **1890 and 1970**, and **0.7 m/yr** between **1970 and modern data**.
Within the soft sections of Cell 5, the **average rate of retreat** is **-0.7 m/yr** between **1890 and 1970**, and **-0.8 m/yr** between **1970 and modern data**.
Within the soft sections of Cell 5, **56%** has **not changed** significantly between **1890 and 1970**; compared with **87%** between **1970 and the modern data**.

Table 5.2: A summary of the average rates, average change distances, and lengths of advance, retreat, and no change within sub-cells of Cell 5.

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)
Sub-cell 5a	2.4	0.04	137.7	26.1	0.39	31.3	-25.4	-0.39	20.8	0.4	0.01	85.7
Sub-cell 5b	0.1	0.00	356.4	27.2	0.39	90.5	-30.9	-0.44	80.8	0.3	0.00	185.0
Sub-cell 5c	4.7	0.06	623.2	27.3	0.34	180.0	-27.3	-0.34	83.6	0.9	0.01	359.5
Cell 5	2.9	0.04	1,117.3	27.1	0.36	301.8	-28.7	-0.39	185.2	0.7	0.01	630.2
	-	-	-	-	-	27.0%	-	-	16.6%	-	-	56.4%

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 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)
Sub-cell 5a	0.2	0.00	136.9	24.0	0.51	6.4	-25.3	-0.54	6.8	0.3	0.01	123.7
Sub-cell 5b	-2.3	-0.05	371.8	37.2	0.89	16.9	-34.1	-0.80	38.9	-0.5	-0.01	315.9
Sub-cell 5c	-2.0	-0.06	634.7	21.2	0.65	23.5	-26.7	-0.83	58.9	-0.3	-0.01	552.3
Cell 5	-1.8	-0.05	1,143.4	27.4	0.72	46.8	-29.4	-0.79	104.5	-0.3	-0.01	991.8
	-	-	-	-	-	4.1%	-	-	9.1%	-	-	86.7%

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 5.3: 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 5.

1890-1970	Cell 5		Sub-cell 5a		Sub-cell 5b		Sub-cell 5c	
	Length (km)	**Length (%)**	**(km)**	**(%)**	**(km)**	**(%)**	**(km)**	**(%)**
>30 m Advance	72.7	7%	7.8	1%	20.9	2%	44.1	4%
20-30 m Advance	61.3	5%	7.1	1%	20.5	2%	33.6	3%
10-20 m Advance	167.8	15%	16.4	1%	49.1	4%	102.3	9%
No Change	630.2	56%	85.7	8%	185.0	17%	359.5	32%
10-20 m Retreat	99.7	9%	12.9	1%	39.0	3%	47.8	4%
20-30 m Retreat	34.2	3%	3.0	0%	16.0	1%	15.1	1%
>30 m Retreat	51.3	5%	4.9	0%	25.8	2%	20.6	2%
Total length	**1117.1**	**100%**	**137.7**	**12%**	**356.3**	**32%**	**623.1**	**56%**

Max advance (m)	343	Craigens	169	319	343
Average change (m)	2.9		2.4	0.1	4.7
Max retreat (m)	-405	Arinagour	-146	-242	-405

1970-Modern	Cell 5		Sub-cell 5a		Sub-cell 5b		Sub-cell 5c	
	Length (km)	**Length (%)**	**(km)**	**(%)**	**(km)**	**(%)**	**(km)**	**(%)**
>30 m Advance	12.7	1%	1.7	0%	7.0	1%	4.0	0%
20-30 m Advance	8.0	1%	0.9	0%	2.8	0%	4.2	0%
10-20 m Advance	26.0	2%	3.8	0%	7.0	1%	15.2	1%
<10m Advance but >= 0.5 myr^{-1}	0.1	0%	0.0	0%	0.1	0%	0.0	0%
No Change	991.8	87%	123.7	11%	315.9	28%	552.3	48%
<10m Retreat but <= -0.5 myr^{-1}	0.0	0%	0.0	0%	0.0	0%	0.0	0%
10-20 m Retreat	52.7	5%	4.0	0%	19.2	2%	29.5	3%
20-30 m Retreat	21.0	2%	1.4	0%	6.3	1%	13.3	1%
>30 m Retreat	30.9	3%	1.5	0%	13.3	1%	16.1	1%
Total length	**1143.2**	**100%**	**136.8**	**12%**	**371.7**	**33%**	**634.6**	**56%**

Max advance (m)	144	Strathcarron	126	144	83
Average change (m)	-1.8		0.2	-2.3	-2.0
Max retreat (m)	-255	Morvich	-161	-255	-153

Asset Vulnerability Statistics for Cell 5

Table 5.4: 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 5.

Cell 5	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	6	8	3	3	11	17
Residential Property		-	-	16	16	4	-	16	20
Septic Water Tanks		-	-	9	9	1	2	7	10
Utilities		-	-	-	-	-	-	-	-
Rail	Length (km)	0.9	0.5	0.6	2.0	1.3	0.2	0.6	2.1
Roads (SEPA)		0.3	0.7	2.9	4.0	1.7	0.6	3.8	6.0
Roads (OS)		-	0.0	0.9	0.9	0.4	0.1	0.7	1.3
Clean Water Network		0.2	0.4	2.8	3.4	1.3	0.4	3.8	5.5
Total Anticipated Erosion	Area (hectares)	84.6	33.3	188.1	306.0	185.9	39.1	199.5	424.6
Runways		0.4	0.4	1.6	2.3	2.2	0.3	1.6	4.1
Cultural Heritage		0.1	0.1	0.7	0.8	0.1	0.1	0.8	1.0
Environment		63.7	18.4	93.6	175.7	129.8	21.3	88.7	239.8
Flooding (200 year envelope)		41.6	7.5	21.2	70.4	52.5	4.0	17.0	73.4
Flooding (1000 year envelope)		44.1	8.5	25.7	78.3	57.4	4.7	21.0	83.1
Erosion within PVAs		0.5	0.6	5.7	6.8	1.1	0.8	6.7	8.7
Erosion outwith of PVAs		84.1	32.8	182.4	299.3	184.7	38.3	192.8	415.9
Battlefields		-	-	-	-	-	-	-	-
Gardens and Designed Landscapes		0.1	0.1	0.7	0.9	0.1	0.1	0.8	1.0
Properties in Care		-	-	-	-	-	-	-	-
Scheduled Monuments		-	-	-	-	-	-	-	-
Nature Conservation Marine Protected Areas		-	-	-	-	-	-	-	-
National Nature Reserves (NNR)		-	-	-	-	-	-	-	-
Special Areas of Conservation (SAC)		12.5	4.2	24.9	41.6	26.9	9.9	21.4	58.1
Special Protection Areas (SPAs)		48.9	11.4	55.2	115.4	94.8	10.6	52.1	157.5
Sites of Special Scientific Interest (SSSI)		64.3	18.6	94.0	176.9	130.0	21.2	87.9	239.1

References

Crofts, R. and Mather, A.S. (1971) Beaches of Wester Ross. Department of Geography, University of Aberdeen, Countryside Commission for Scotland.

Ramsay, D.L. and Brampton, A.H. (2000) Coastal Cells in Scotland: Cell 5 - Cape Wrath to the Mull of Kintyre. Scottish Natural Heritage Research, Survey and Monitoring, Report No 147.

Ritchie, W. and Mather, A.S. (1969) Beaches of Sutherland. Department of Geography, University of Aberdeen, Countryside Commission for Scotland.

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