Moray Coastal Change Adaptation Plan

Lossiemouth to Binn Hill Coast

Final Report

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www.jbaconsulting.com

JBA Project Manager

Doug Pender Meng PhD MCIWEM C.WEM
Unit 2.1 Quantum Court
Heriot Watt Research Park
Research Avenue South
Edinburgh
EH14 4AP

Revision History

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Contract

This report describes work commissioned by Will Burnish, on behalf of Moray Council, by a letter dated 9 August 2022. Moray Council's representative for the contract was Will Burnish. Jenny Shadrick, Doug Pender, and Angus Pettit of JBA Consulting carried out this work.

Prepared by ..... Jennifer Shadrick BSc MSc PhD

Coastal Analyst

Prepared by ..... Doug Pender MEng PhD MCIWEM C.WEM

Principal Engineer

Reviewed by ..... Angus Pettit BSc MSc CEnv CSci MCIWEM C.WEM

Technical Director

Purpose

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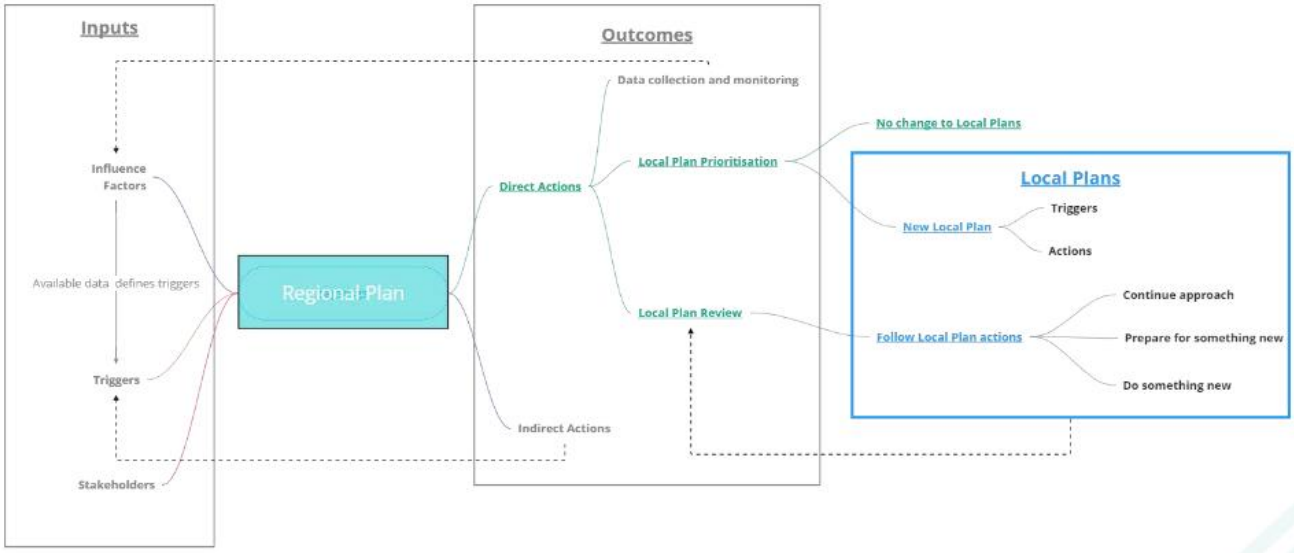
Executive summary

The report documents the Coastal Change Adaptation Plan (CCAP) for the Lossiemouth to Binn Hill Coast Community Area (CA) in Moray. It forms one of the eleven Local Plans, for the Moray Council region.

It aligns with the wider Regional Plan[1] and forms the highest level of detail of the overall Coastal Change Adaptation Planning process adopted by Moray Council.



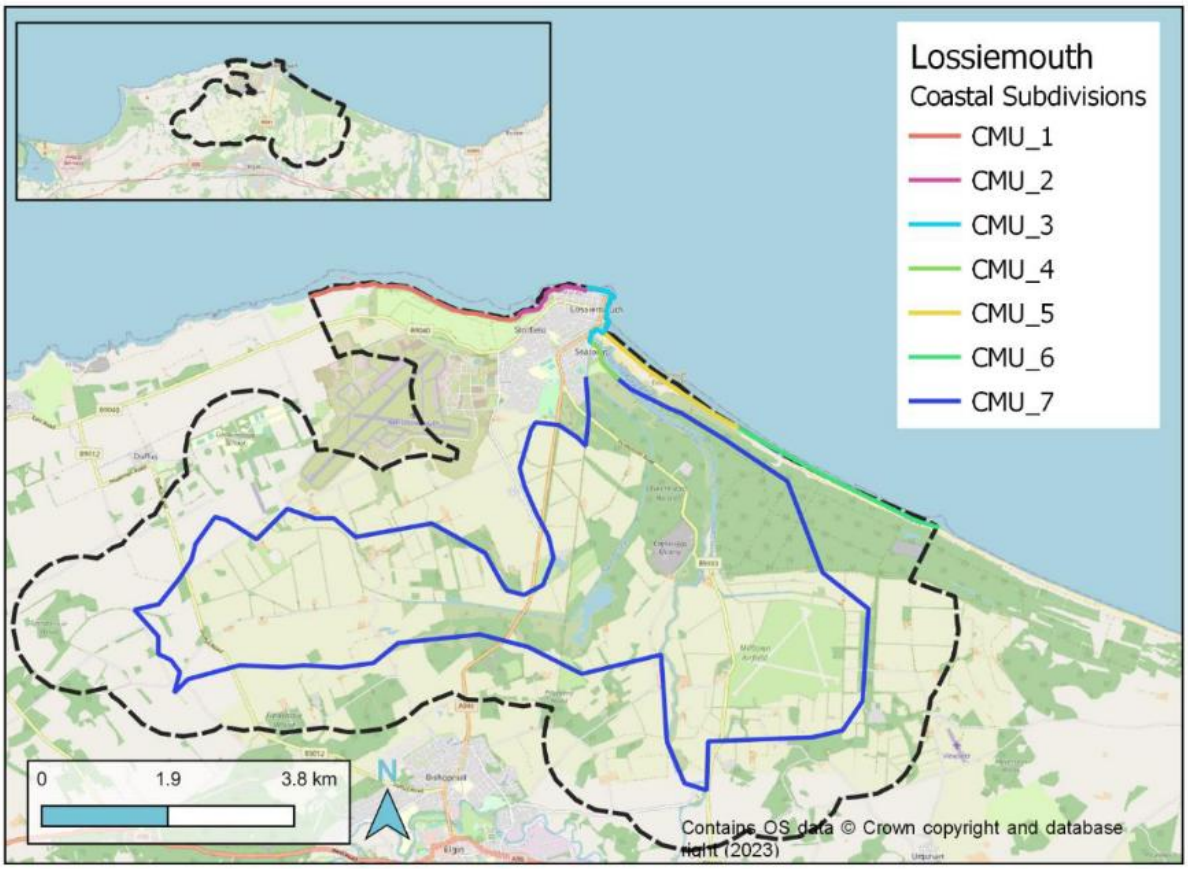
The CCAP provides an overview of the coastal flood and erosion risks to Lossiemouth to Binn Hill Coast, which are used to underpin development of possible Adaptation Pathways for this community. These are presented, along with a framework to support proactive coastal risk management, enable implementation of climate change adaptation actions and link with climate resilient development planning along Moray's coast.

The Plan has been developed using available datasets from Moray Council, SEPA and the Dynamic Coast Project. It aims to directly support statutory and non-statutory Moray Council policies, plans and strategies and aligns with key coastal climate change adaptation guidance and resources within and beyond Moray Council.

This Plan documents the Phase 0 starting point of adaptation, meaning that no definitive preferred Adaptation Pathway and associated Action Plan have been developed. Rather this Plan sets out a framework and process for Moray Council to implement to effectively plan and support sustainable adaptation.

To develop Adaptation Pathways, the coast of the CA was classified into Coastal Management Units (CMUs) defined by 1) Classification of coastal landform type, and 2) Risk associated with coastal flooding and erosion. A total of six CMUs were identified, and six associated Adaptation Pathways were developed for each CMU.

1 Moray Coastal Change Adaptation Plan: Regional Plan - IRR-JBAU-XX-XX-RP-MO-0001-S4-P03-Regional_Plan



The framework is to be delivered through the defined Implementation Plan by defining Triggers and setting associated Actions against these. A single Implementation Plan is applied to the entire CA, where the outcome of the process determines what direction will be followed within the Adaptation Pathway. The Implementation Plan has three key stages:

1) Monitoring and Triggers
2) Actions
3) Outcomes

Trigger points are identified and set following a risk-based approach and will be identified through repeat monitoring of available data that informs coastal flood and erosion risk.

Realisation of Triggers signal a need for review or change of the Adaptation Pathway. Actions bridge the gap between Triggers and Outcomes and define what processes need to be implemented before an appropriate Outcome is identified. Adaptation interventions are potential measures that can be applied. There are four possible categories:

1) No intervention
2) Enhance natural features
3) Protect
4) Create Space

A set of Phase 0 Actions have been identified, that require immediate attention because of Triggers being met in this iteration of the Lossiemouth to Binn Hill Coast CCAP. Furthermore, this initial stage of the adaptation planning process has identified several knowledge gaps and opportunities for activities to be undertaken upfront to support coastal change adaptation at Lossiemouth to Binn Hill Coast.

The current iteration of the Lossiemouth to Binn Hill Coast CA local plan is at Phase 0. Triggers met in Phase 0 of the Adaptation Pathway and associated Actions for each CMU are summarised in the table below. These will be delivered during the first cycle.

Full details of the Phase 0 Actions are included in Appendix C and documented in Section 4.4.

CMU	Trigger	Action
1	No current Triggers	No current Actions
2	Erosion buffer exceeded	Undertake assessment and plan for intervention
3	Flooding threshold exceeded	Undertake assessment and plan for intervention
4	Flooding threshold exceeded	Undertake assessment and plan for intervention
5	No current Triggers	No current Actions
6	No current Triggers	No current Actions
7	Flooding threshold exceeded	Undertake assessment and plan for intervention

As well as Triggers and Actions that correspond directly to the Adaptation Pathway and specified CMUs, Proactive Actions, that support the whole of the Lossiemouth to Binn Hill coast are summarised below:

1) Investigate opportunities for dune enhancement.
2) Develop modelling framework to support future assessments.
3) Investigate opportunities for habitat creation on the Spynie Canal.
4) Establish coordinated and consistent beach monitoring plan for Natural CMUs.
5) Adaptation and resilience workshop with local community and stakeholders.
6) Identify landownership and safeguarding.

Again, these will be delivered during the first cycle.

Contents

List of Figures

List of Tables

Abbreviations

CCAP	Coastal Change Adaptation plan
CA	Community Area
CMU	Coastal Management Unit
DC	Dynamic Coast
mAOD	meters Above Ordinance Datum
MHWS	Mean High Water Spring
NFRA	National Flood Risk Assessment
NRP	Non-residential Property

RCP	Representative Concentration Pathways
RP	Residential Property
SEPA	Scottish Environment Protection Agency
SLR	Sea Level Rise

Glossary

Accretion*	The build-up of sediment resulting in the seaward movement of the coast/ Mean High Water Springs.
Actions*	A plan or policy option that promotes an adaptive approach to coastal change that makes use of long term or resilient solutions such as preserving natural features.
Action Plan*	The proposed strategy or course of action to be taken depending on trigger point reached.
Adaptation*	The adjustment in economic, social or natural systems in response to actual or expected climate change, to limit harmful consequences and exploit beneficial opportunities.
Adaptation Pathways*	A flexible way of managing future uncertainty by planning for multiple scenarios without rigid timelines responding to the nature of future changes as they unfold.
Asset*	An item, such as a building, that is deemed to have an economic, social, or cultural value (or combination of).
Decision point*	A management action based on a trigger being reached.
Erosion*	The removal of sediment resulting in the landward movement of the coast (Mean High Water Springs)
Hard coast*	Coast that is comprised mainly of materials resistant to erosion such as hard rock types or artificial structures.
Implementation Plan	The framework developed in this first iteration, or Phase 0 of the Adaptation Pathway to support Moray Council in the development of Action Plans for each CMU.
Implementation Plan Actions	Actions that Moray Council will deliver in response to a Trigger being met and will determine the Outcome of the phase of the Adaptation pathway.
Outcomes	Outcomes of the Implementation Plan determines the current path of the Adaptation Pathway.
Soft coast*	A coast composed of unconsolidated sediments, which is not inherently resilient to erosion, but relies on the balance of natural processes to maintain its shape in response to storms and everyday processes.
Triggers*	Either a physical process or an enabler/inhibitor that when reached or a threshold crossed.

*Term definitions from Scottish Government Coastal Change Adaptation Plan Guidance[2]

2 https://www.dynamiccoast.com/files/ccapg_2023feb.pdf

1 Introduction

1.1 Coastal Change Adaptation Planning in Moray

Our climate is changing and throughout history, our coast has responded to changes in sea level, storms, and other climate parameters. This means that the current position of Moray's coast is not fixed but is dynamic and will continue to evolve as our climate changes.

We can no longer use traditional, engineered, coastal risk management approaches in isolation to manage and protect society against these risks. Instead, we must, as a society, become more resilient and adapt to our changing coast through combined coastal risk management with climate resilient development planning on land near the coast. To enable this, we must be proactive in making combined coastal risk and land management decisions which provide long-term space for the coast to naturally respond to coastal climate change risks.

Developing and implementing an Adaptive Framework now to address how society responds to the current and future risks can help to reduce costs and negative impacts such as assets eroding into the sea or suffering repeat, frequent flooding. More positively, a proactive approach to adaptation and climate resilient development planning now can generate wider benefits and opportunities for coastal communities and the ecosystems which sustain and support them.

The Coastal Change Adaptation Plans (CCAPs) provide a key first step in this process; they are a practical mechanism to enable proactive engagement with and involvement of communities to co-develop a shared vision for long-term societal resilience to coastal climate change risk and impacts.

To support this adaptation journey in Moray the coast has been subdivided into Community Areas (CAs) (Figure 1-1). Lossiemouth to Binn Hill Coast is one of the CAs with the highest priority for a local adaptation plan, due to the rapidly changing coast and risk of flooding, and as recognised in the Regional Coastal Change Adaptation Plan (CCAP).

The coast of the CA is a mixture of soft, natural coast, built coast with sea walls and rock armour structures and Lossiemouth harbour with extensive hard concrete structures.

The East Beach system, located at the mouth of River Lossie, is highly dynamic; Dynamic Coast has projected maximum rates of erosion of 4.5 m/yr by 2100.

This provides the justification for a more detailed, local, CCAP which is contained in this document.

The entire Coastal Change Adaptation Plan for Moray is contained within a series of documents, the following should be consulted alongside this CCAP to provide context on the overall process.

- IRR-JBAU-XX-XX-RP-MO-0001-S4-P03-Regional_Plan
    - Provides the region wide plan and process to deliver coastal adaptation across Moray.
- IRR-JBAU-XX-XX-RP-MO-0007-S4-P03-Coastal_Change_Adaptation
    - Provides information on the concept of coastal change adaptation and how this has been applied to the Moray Coastal Change Adaption Plan.

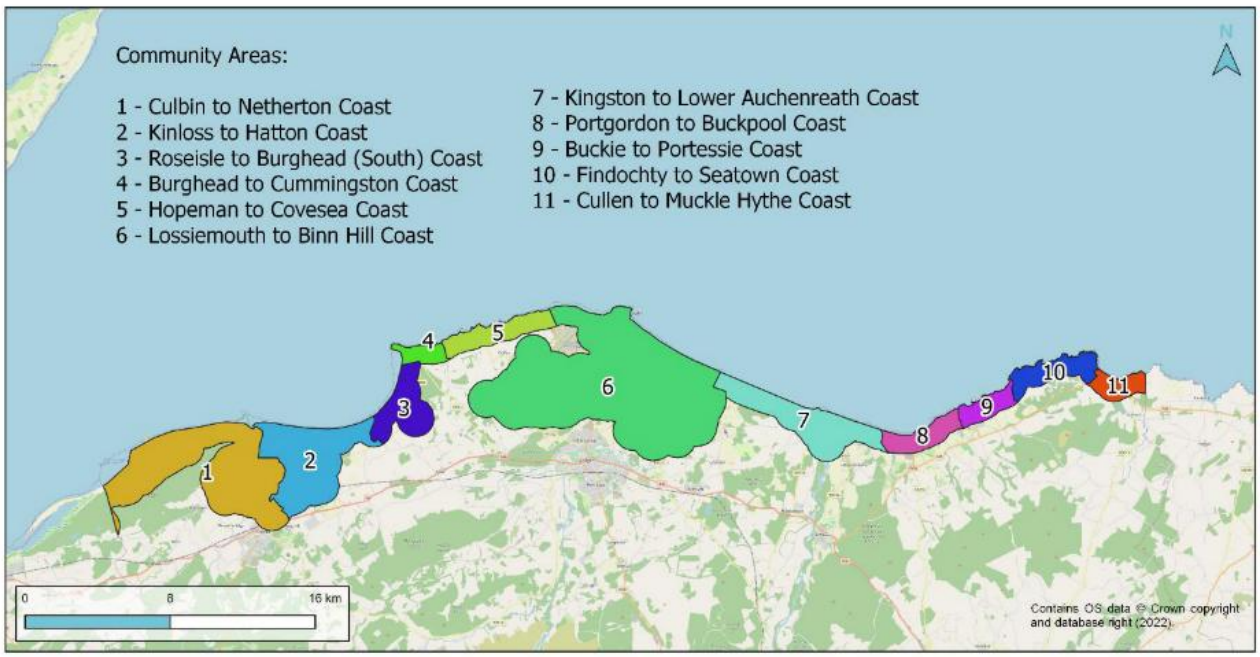


Figure 1-1: Extent and location of CAs within Moray.

1.2 What is a Local CCAP?

A Local CCAP follows the same principle as the Regional CCAP but is assessed and developed at a finer level of detail for a specified CA. A local CCAP is developed where a CA has been identified as a high priority, based on risk, development, management and socio-economic Influence Factors (see Regional Plan for more details). It divides the coast of the CA into individual Coastal Management Units (CMUs) and presents Adaptation Pathways for each. See section 2.2 for more details on CMUs and CMU classification.

1.3 What are adaptation pathways?

Adaptation Pathways are flexible tools that can be used by local authorities, politicians, local businesses and residents to make current and future decisions across all involved sectors to accommodate coastal change and associated uncertainty.

As well as the traditional management, they should identify opportunities to work with natural processes, enhance the environment and include necessary supportive steps to create space (e.g. accommodate erosion through land safeguarding) in preparation for inevitable future sea level rise and associated increases in erosion and flooding.

1.4 What do adaptation pathways do?

Adaptation Pathways aim to identify climate resilient risk management and development pathways for each or CMU; the phases in the pathways, provide flexibility for decisions at various points on the pathway to be modified dynamically through time.

Triggers are used in Adaptation Pathways to signal when the current management approach should be reviewed, and possibly changed, in response to updated information or change of circumstance i.e., risk has increased.

1.5 What is the focus of the Local CCAP?

Adapting to coastal and climate change requires two parallel streams:

1. Land-based initiatives to **prevent** new future risk.
2. Management initiatives to **reduce** current and future risk.

The Local CCAP presented here **focuses only the management initiatives** but, only by considering these in parallel with those land-based will result in a sustainable adaptation journey for Moray. This should identify both the need and practical steps required to safeguard land to support where areas of retreat may be considered in the future.

1.6 Where are we on the adaptation journey?

The aim of this first CCAP is to consolidate our understanding of the physical risks and how these interact with communities and their assets to identify the present day and future hazards of our changing coast for Lossiemouth to Binn Hill Coast. It then identifies and promotes a process that, when implemented by Moray Council, will support community adaptation to coastal change.

The adaptation journey is a multiphase, multiyear process and aims to transition communities into a more sustainable and resilient future. We are currently at **Phase 0**, meaning that no definitive preferred Adaptation Pathway and associated Action Plan have been developed.

1.7 What is the Phase 0 Adaptation Framework?

The overall aim of the Adaptation Framework set out in this Local CCAPs is to:

Guide Moray Council towards development of detailed Adaptation Pathways and associated Action Plans for the Lossiemouth to Binn Hill Coast CA.

To achieve this goal the following objectives have been set for Phase 0:

- Identify and characterise local CMUs within the CA suitable for development future Adaptation Pathways.
- Present coastal flood and erosion risk for each CMU.
- Develop an Implementation Plan to be used by Moray Council to support adaptive decision making, future action planning and evaluation of adaptation options.
- Identify CA and CMU specific Triggers that will influence adaptation decision making.
- Identify and set Proactive Actions that will support delivery of the CCAP in each CMU.
- Inform and support the Local Development Plan and Local Planning Policy. These should be implemented in parallel to avoid future risk by making space for change.

1.8 How has this framework been developed?

The approach to coastal change adaptation in Moray is presented in the Regional Plan which distils the Scottish Government guidance[3] into **four key pillars of adaptation** (Figure 1-2). Development and application of the CCAP Implementation Plan should align with these principles.

3 Scottish Government (2023) Coastal Change Adaptation Guidance – Interim https://www.dynamiccoast.com/files/ccapg_2023feb.pdf

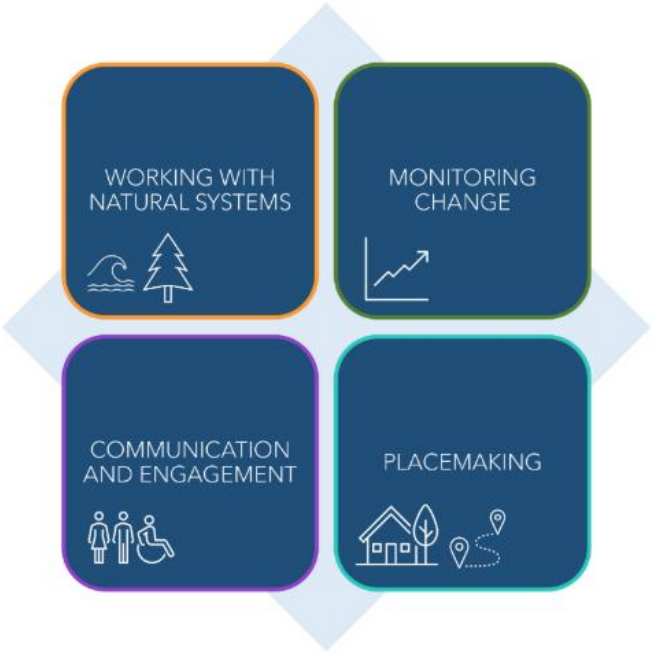


Figure 1-2: Four pillars of coastal adaptation for Moray.

1.9 How does the Local CCAP link to the Regional CCAP?

The Regional CCAP links to the Local CCAP in these key ways:

1. Defines the **prioritisation** of Local CCAP with risk, development, management, and socio-economic Influence Factors (see Regional Plan for more details).
2. Sets wide **Proactive Actions** that, when implemented, should be used to support Local CCAP Action Plans.
3. Provides the links between the **land-based** components of the Adaptation Planning process. This includes links with the LDP and delivery of necessary regional actions required to effectively support and plan for adaptation at a local level e.g. land safeguarding.

2 Plan Overview

2.1 Plan Area and Characteristics

The Lossiemouth to Binn Hill Coast community management area (CA) covers an area of ca.70 km^2 and is located between the Hopeman to Covesea Coast CA and Kingston to Lower Auchenreath Coast CA. The CA includes a range of coastal environments and land use areas (Figure 2-1).

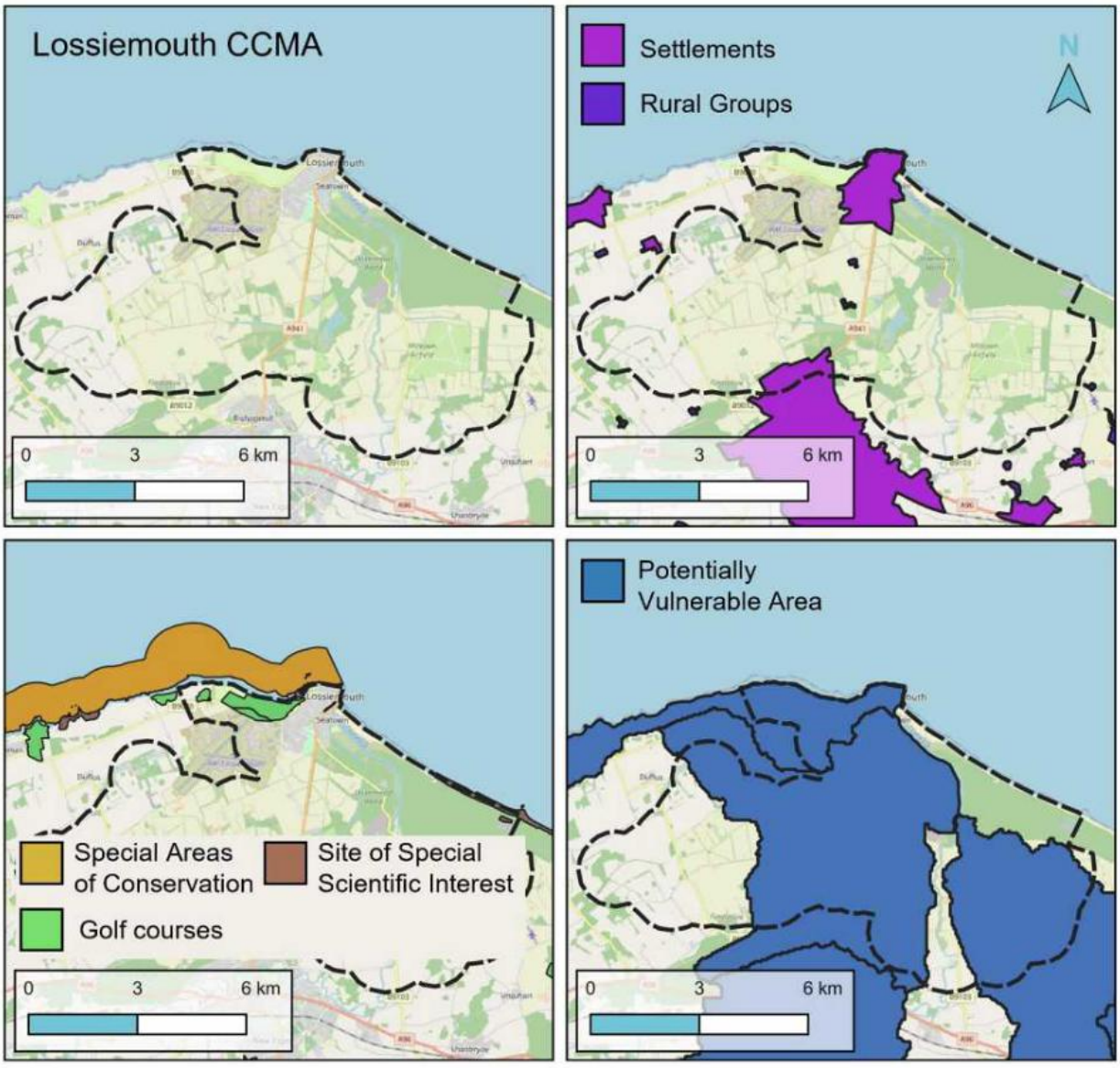


Figure 2-1: Lossiemouth to Binn Hill Coast CA, showing settlements, greenspace and environment and special consideration areas.

Settlements:

The Lossiemouth to Binn Hill Coast CA includes the settlements of Lossiemouth, the northern outskirts of Elgin and multiple rural groups. Lossiemouth has a population of 7,033 with 3,056 households[4]. The Moray Council LDP has identified designation areas for specific land use in settlement and rural groups.

Greenspace and Environment:

The entire coast of the Lossiemouth to Binn Hill Coast CMA is a NatureScot designated Site of Special Scientific Interest (SSSI) or Special Area of Conservation (SAC). The coastal waters offshore of the CA coast are a NatureScot designated Special Protection Area (SPA). Moray Golf Club is in the CA and provides valuable recreational and tourist amenity for the town and surrounding area. Royal Air Force Base Lossiemouth is also located in the CA.

Special consideration areas:

The Lossiemouth to Binn Hill Coast CA contains part of the Spynie Potentially Vulnerable Area (PVA) (Figure 2-1 (d)) as identified in the Nairn and Speyside Local Flood Risk Management Plan (LPD05)[5].

Habitats:

There are four key habitats along the coastal extent of Lossiemouth to Binn Hill Coast as identified by NatureScot (Figure 2-2). These habitats include unvegetated mobile shingle, unvegetated sand beach and shifting dunes.

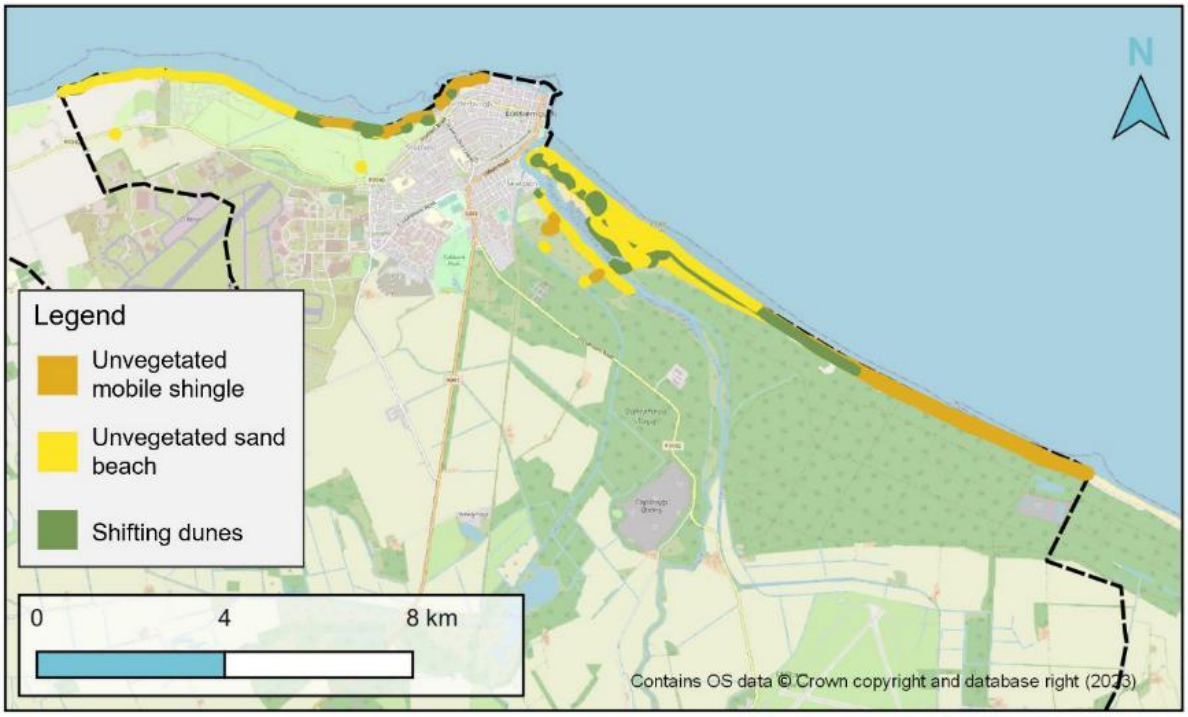


Figure 2-2: Coastal habitats at Lossiemouth as identified by NatureScot.

4 Moray Council. 2020. Moray Local Development Plan. http://www.moray.gov.uk/moray_standard/page_133431.html
5 Moray Council. 2016. Findhorn, Nairn and Speyside Local Flood Risk Management Plan. http://www.moray.gov.uk/downloads/file105636.pdf

2.2 Coastal Management Units

To facilitate the development of this Local CCAP, the coast of the CA is classified into Coastal Management Units (CMUs) defined by:

1. Classification of coast type.
    a. Natural – beaches, cliffs, dunes, saltmarshes, etc.
    b. Built structures – engineered and non-engineered artificial structures.
    c. Hybrid – combination of a and b
2. Risk associated with coastal flooding and erosion.
    a. Risk and Hazard
    Assets present in CMU, which are at risk of flooding/erosion hazard
    b. Risk and unknown Hazard
    Assets present in CMU, no data on flood/erosion risk available
    c. No Risk and Hazard
    No assets present in CMU, no flooding/erosion hazard
    d. No risk and no Hazard
    No assets present in CMU, no flooding/erosion hazard

Assets referred to in the risk classification include residential properties, key roads and infrastructure.

Following this, the Lossiemouth to Binn Hill Coast CA coast has been subdivided into seven CMUs (Figure 2-3). The seven CMUs are described below including a summary of the coastal change and flood risk. Full details of each CMU are provided in Appendix A.

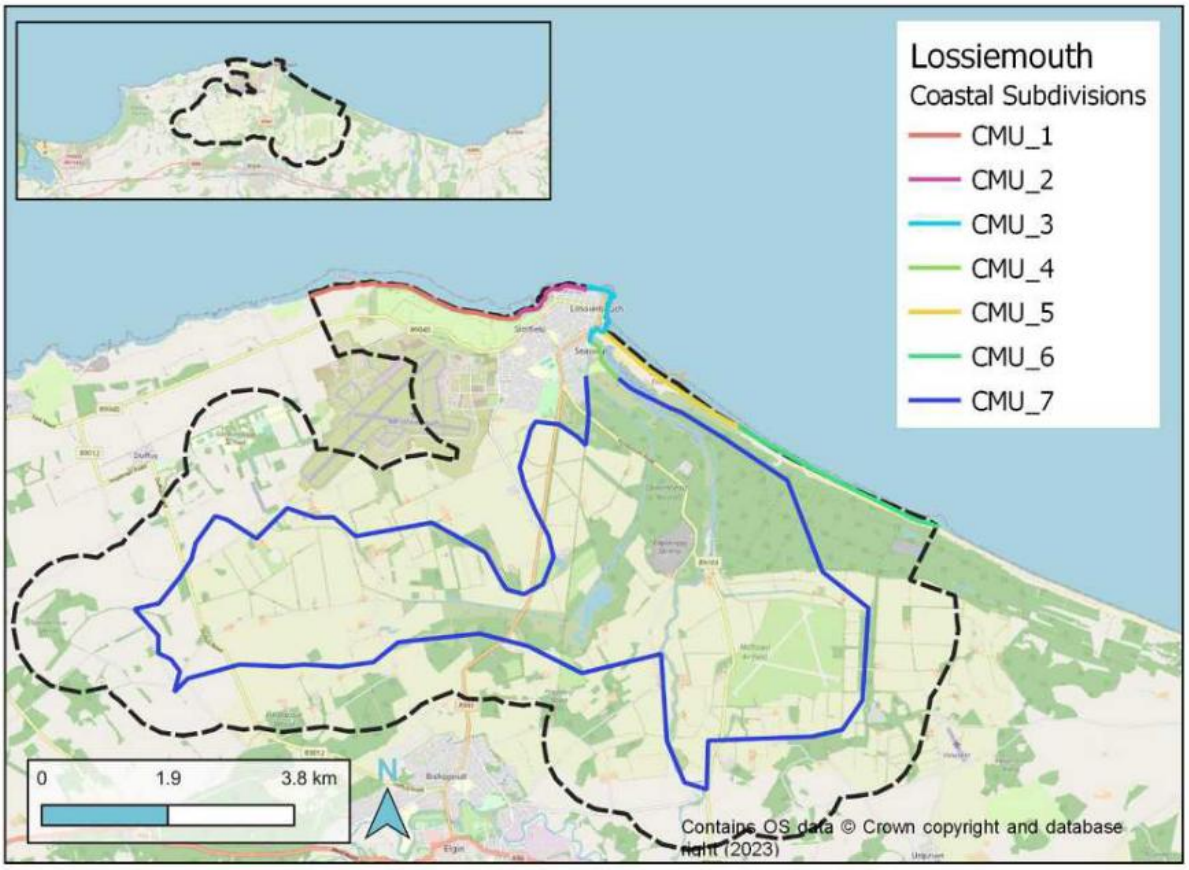


Figure 2-3: CMUs within the Lossiemouth CA.

2.2.1 CMU 1: Beach west - natural

CMU 1 is a natural section of the coast with no engineered coastal defences, to the west of Lossiemouth town. The coast is fronted primarily by unvegetated sand beaches, with some areas of mobile shingle beaches and coastal dunes systems. CMU 1 contains Moray Golf Club and Silver Sands Leisure Park. Available information show there is currently negligible risk predicted from coastal flooding in this unit to the land and to assets. Dynamic Coast data shows that historically (from ca. 2003 to 2011), this CMU has eroded at a maximum rate of 0.7 m/yr. Maximum future erosion rates are expected to increase to 2.1 m/yr by 2100. This may result in a maximum 122.1 m of land loss caused by shoreline retreat by 2100. There are only two assets(the lighthouse and adjoining cottage) within the Dynamic Coast erosion vicinity under the High Emission Scenario, both located at the Covesea Skerries Lighthouse.

2.2.2 CMU 2: Shingle west - hybrid

CMU 2 contains both natural sections of coast with shingle beaches present and defended sections of the coast, with rock armour and hard structures in place. Inland from the coast includes an area of Moray Golf Club and the Branderburgh area of Lossiemouth town. Available information show there is currently negligible risk predicted from coastal flooding in this unit to the land and to assets. Historical coastal erosion datasets in the modern period are limited in this area; this means that the data used in the Dynamic Coast assessment are fewer than for other areas of Moray. Here, the Dynamic Coast data shows that historically (from ca. 2003 to 2011), this section of coast eroded at a maximum rate of 0.7 m/yr. Maximum future erosion rates are expected to increase to 1.3 m/yr by 2100. This would result in a maximum 40.7 m of land loss caused by shoreline retreat by 2100. Assets within the Dynamic Coast erosion vicinity under the High Emission Scenario include 17 residential properties, 12 non-residential properties and ca. 240 m of minor roads.

2.2.3 CMU 3: Harbour Town central – built structures

CMU 3 includes Lossiemouth harbour and marina and the eastern edge of Lossiemouth town following Seatown Road, up to and including the Seatown bridge. CMU 3 is entirely defended with hard engineered structures at the harbour, a seawall and rock armour. There is no historic or recent data, nor any future predictions of erosion on coastal erosion from Dynamic Coast at this CMU because of the hard engineered structures in place.

The 1 in 200-year flooding extent includes areas adjacent to the harbour and marina, Station Park, and an area of Seatown, west of Spynie Canal. Under a 1 in 200-year plus climate change event, the flooding extends onto a main section of Seatown Road and a larger area of Seatown. Current assets at risk from a 1 in 200-year flooding event include six residential properties, five non-residential properties, two wastewater utility points, and c.370 m of roads.

2.2.4 CMU 4: Seatown central - hybrid

CMU 4 is a natural section of coast, which is protected from flooding and erosion from the natural sand spit at the mouth of River Lossie (CMU 5). CMU 4 contains Seatown and Lossiemouth Caravan Park and encompassed by two watercourses: the River Lossie to the north-east and Spynie Canal to the south-west. There are assets at risk from coastal erosion in CMU 4, but this is linked to the erosion of the sandspit that makes up CMU 5. As such. assets at risk from erosion in CMU 4 are included in the CMU 5 hazard assessment.

Under a 1 in 200-year flood event, a large area of Seatown (ca. 150 m inland from the bank of River Lossie) east of the bridge is at risk of flooding. The Lossiemouth Caravan Park is also at risk of flooding; the flooding extent reaches ca. 80 m inland at the caravan park. Assets at risk from a 1 in 200-year flooding event include 15 residential properties, five non-residential properties, one wastewater utility and ca. 70 m of roads and pathways.

2.2.5 CMU 5: Sand spit dunes central - natural

CMU 5 includes the dynamic natural features of the sand spit and dune system at the mouth of the River Lossie, to the east of Lossiemouth town (Lossiemouth East Beach). Currently, the natural features in CMU 5 protect the land and settlements from erosion and flooding in CMU 4. However, the beach and dune system at CMU 5 is vulnerable to erosion and subsequent changes will therefore potentially increase the flood risk at CMU 4. In CMU 5, the risk is linked to coastal erosion. Dynamic Coast data shows that historically (from ca. 1994 to 2017), this sand spit at Lossiemouth to Binn Hill Coast CA has retreated rapidly, at a maximum rate of 3.1 m/yr. Maximum future erosion rates are expected to increase to 4.5 m/yr by 2100. This would result in a maximum 318.0 m of shoreline retreat by 2100. The assets that are at risk from erosion of the sand spit at CMU 5 are in the area landward of the spit at CMU 4. Assets within the Dynamic Coast erosion vicinity under the High Emission Scenario include 25 residential properties and four non-residential properties.

2.2.6 CMU 6: Shingle beach east - natural

CMU 6 is a subsection comprised of natural coast fronted by a shingle beach. The area inland contains woodland and an active quarry. There is negligible risk from coastal flooding in this unit to the land and to assets. Dynamic Coast data shows that historically (from ca. 1967 to 2011), the coast at CMU eroded at a maximum rate of 0.5 m/yr. Maximum future erosion rates are expected to increase to 1.8 m/yr by 2100. This would result in a maximum 103.6 m of land loss caused by coastal retreat by 2100. Despite erosion of the land, there are no current assets at risk from erosion, now or in the future, in CMU 6.

2.2.7 CMU 7: Inland - natural

CMU 7 covers the inland area of the Lossiemouth to Binn Hill Coast CA, there is therefore no risk present or future of coastal erosion for this CMU. The boundary of CMU 7 is informed by the SEPA flood maps and so follows key water courses in the Lossiemouth to Binn Hill Coast CA: River Lossie, Spynie Canal, Loch Spynie and Innes Canal. CMU 7 also contains Milltown Airfield, Caysbriggs Quarry, Oakenhead Wood, a section of the A941, B9103 and B9012. The 1 in 200-year flooding extent follows River Lossie and Innes Canal, flooding parts of the B9103 road and ca. 1.6 km^2 of land surrounding the Milltown Airfield. The 1 in 200-year flooding extent also follows the Spynie Canal and linked water networks. A significant area, of 11.8 km^2, is at risk of flooding around the Spynie Canal. This includes section of the A941, B9012, other minor roads, properties, woodland, and agricultural land. Key assets at risk from a 1 in 200-year flooding event include 10 residential properties, 22 non-residential properties, ca. 2.6 km of key A and B roads.

2.3 CMU categorisation for local adaptation plan

Review of the characteristics and risk associated with each CMU led to the classifications summarised in Table 2-1. These were used to develop initial Adaptation Pathways, Triggers, and an associated Implementation Plan.

Table 2-1: Lossiemouth to Binn Hill Coast CMU categorisation.

CMU	Coastal Type Classification	Risk Classification
1	Natural	Risk and Hazard
2	Hybrid	Risk and Hazard
3	Built Structures	Risk and Hazard
4	Hybrid	Risk and Hazard
5	Natural	Risk and Hazard
6	Natural	No Risk and Hazard
7	Natural	Risk and Hazard

3 Adaptation Pathways

Development of Adaptation Pathways for each CMU are based on the classification presented in Table 2-1 and the approach outlined in Appendix B. This aims to provide a flexible approach to adaptation that works towards a defined and desirable end outcome for the CMU and CA.

Details of this outcome are however, not defined at this stage, and will ultimately be dependent on monitoring changes in the following factors at the coast and on land adjacent to the coast:

- **Natural systems**
  - Habitat.
  - Greenspace.
- **Climate**
  - Climate change guidance.
  - SEPA flood maps or risk assessments.
  - Coastal flood occurrence.
- **Risk exposure**
  - Change in defence condition.
  - Update to SEPA flood warning system.
  - Erosion risk buffer exceeded.
  - Flood risk threshold exceeded.
- **Socio-economics**
  - Changes of asset ownership.
  - Changes of land ownership.
  - Community pressures.

Adaptation Pathways for each CMU are presented in the following sections.

3.1 CMU 1, 5, 6 and 7 Adaptation Pathways

CMUs 1, 5, 6 and 7 are classified as natural coasts and have been assigned an adaptive pathway for natural coasts with both with risk and no risk of erosion and flooding (Figure 3-1):

- **CMU 1 = Natural with risk and hazard**
- **CMU 5 = Natural with risk and hazard**
- **CMU 6 = Natural with no risk and hazard**
- **CMU 7 = Natural with risk hazard**

Phase 0 of the adaptation pathway (1st column of potential actions) are the current actions undertaken by Moray Council in respect of these CMUs. Here this is **No Intervention**. This means that there will be no coastal and/or erosion risk management interventions during this phase.

For the adaptation pathway to move to Phase 1 (2nd column of potential actions) a pre-defined Trigger must be realised. Then, depending on the outcome of any Implementation Plan Actions, this may or may not result in a change to the management approach adopted for the CMU.

Consultation of the CCAP Implementation Plan (Section 4.6) will guide the process and ultimately the pathway to adaptation.

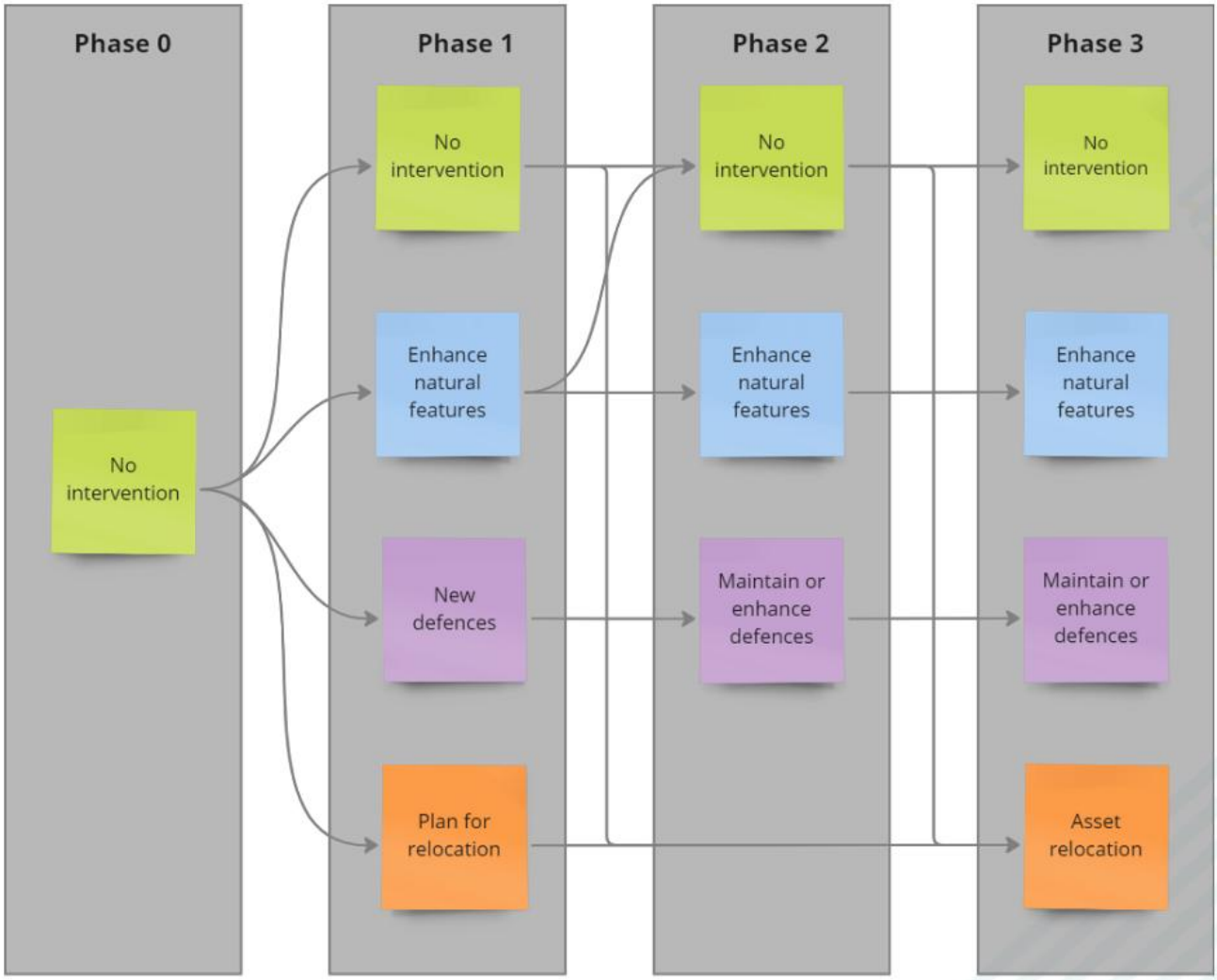


Figure 3-1: Adaptation Pathway for CMUs 1, 5, 6 and 7 (natural coast).Grey lines represent possible future pathways.

3.2 CMU 2 and 4 Adaptation Pathway

CMUs 2 and 4 are classified as hybrid coasts with risk of erosion (CMU 2) and flooding (CMU 4) (Figure 3-2). CMU 2 is predominantly a natural coast that has additional engineered reinforcement using rock armour to the north by the recycling centre and hard structures in place by the carpark by Moray Golf Club. CMU 4 is mostly natural coast, with some rock armour as an additional flood and erosion measure and is also protected by the natural sand dune system of CMU 5.

- **CMU 2 = Hybrid with risk and hazard**
- **CMU 4 = Hybrid with risk and hazard**

Phase 0 of the adaptation pathway (1st column) is the current actions undertaken by Moray Council in respect of these CMUs. Here this is **No Intervention** as Moray Council are not obligated to maintain the rock armour structure in the CMU. This means that there will be no coastal and/or erosion risk management interventions, nor maintenance of existing structures during this phase.

For the adaptation pathway to move to Phase 1 (2nd column containing potential actions) a pre-defined Trigger must be realised. Then, depending on the outcome of any Implementation

Plan Actions, this may or may not result in a change to the management approach adopted for the CMU.

Consultation of the CCAP Implementation Plan (Section 4.4) will guide the process and ultimately the pathway to adaptation.

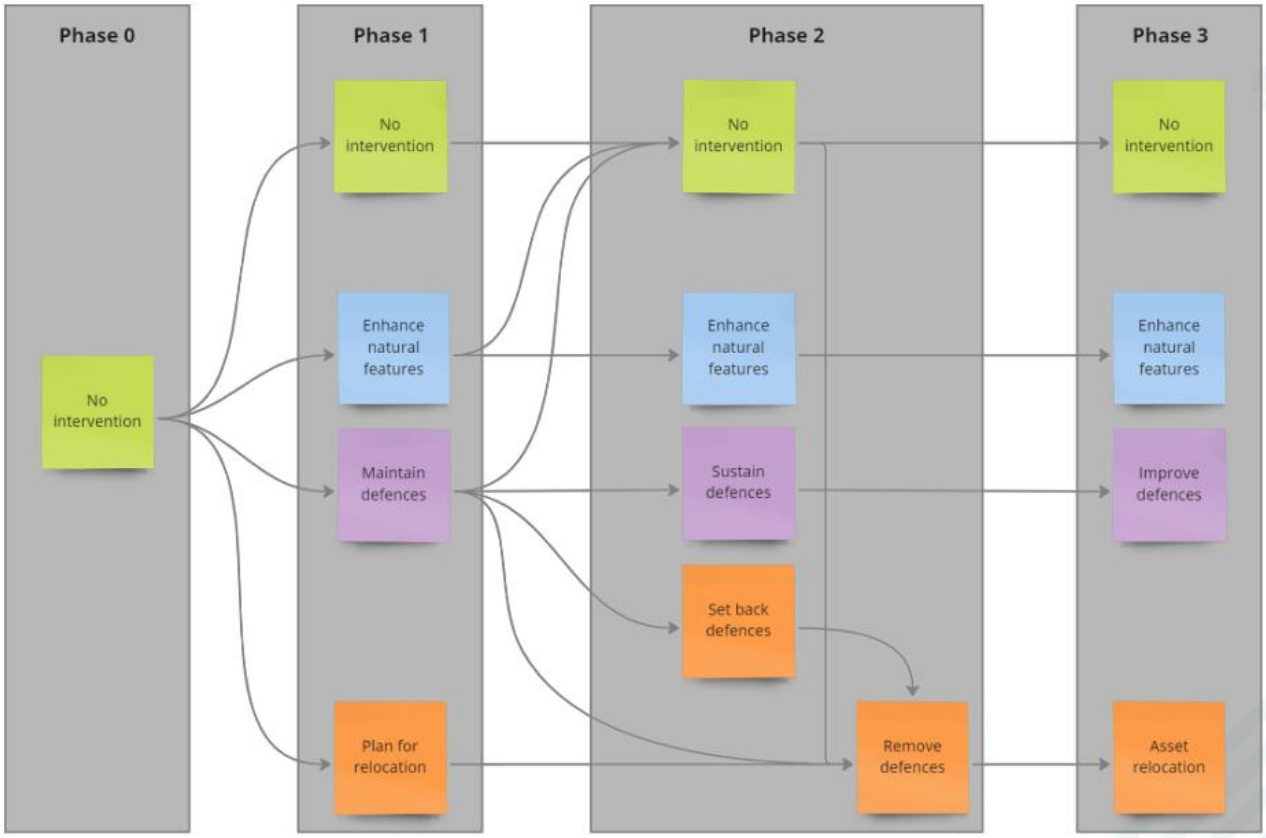


Figure 3-2: Adaptation Pathway for CMU 2 and 4 (hybrid coast). Grey lines represent possible future pathways.

3.3 CMU 3 Adaptation Pathway

CMU 3 includes Lossiemouth Marina, formed of concrete and stone walls and is classified as built structures with a risk of flooding (Figure 3-3). At CMU 3, there is no pathway to "enhance natural features" as natural features do not contribute or provide any control on the flood risk.

- **CMU 3 = Built Structures with risk and hazard**

Phase 0 of the adaptation pathway (1st column) is the current actions undertaken by Moray Council in respect to these CMUs. In CMU 4 this is **No Intervention** as Moray Council are not obligated to maintain the marina structures. This means that there will be no coastal and/or erosion risk management interventions, nor maintenance of existing structures during this phase. Responsibility of maintenance and repair of these assets lies Lossiemouth Marina and the operating company[6].

For the adaptation pathway to move to Phase 1 (2nd column containing potential actions) a pre-defined trigger must be realised. Then, depending on the outcome of any Implementation

6 https://www.lossiemouthmarina.com/

Plan Actions, this may or may not result in a change to the management approach adopted for the CMU.

Consultation of the CCAP Implementation Plan (Section 4.6) will guide the process and ultimately the pathway to adaptation.

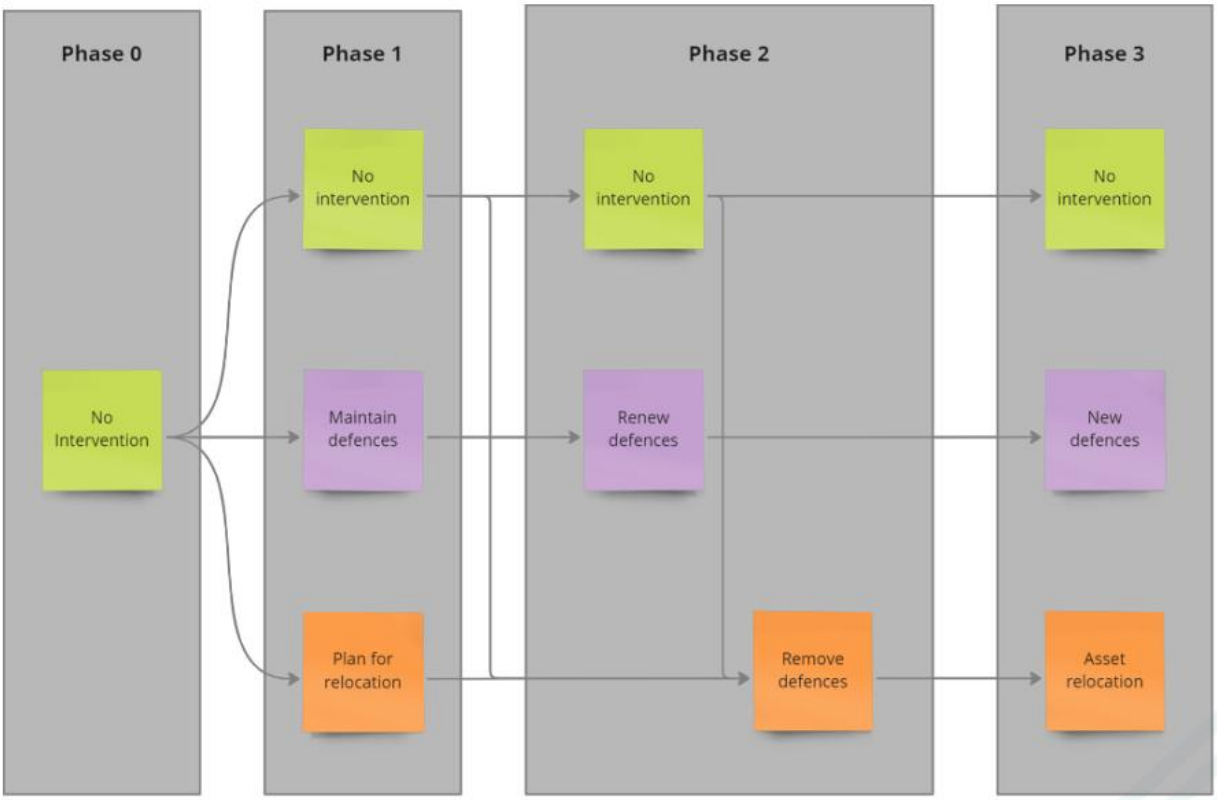


Figure 3-3: CMU 3 Adaptation Pathway (built structures). Grey lines represent possible future pathways.

4 Adaptation Process

4.1 Implementation Plan

To support the delivery of the Adaptation Framework, a single Implementation Plan is applied to the entire Lossiemouth to Binn Hill Coast CA with generic triggers and actions set that are relevant across the CA. Specific triggers and actions are then assigned to each CMU based on the Risk Assessment. Outcomes of the Implementation Plan link to the Adaptation Pathway specific to each CMU.

Delivery of the Implementation Plan has three stages (Figure 4-1):

1) Monitoring and Triggers (section 4.2)
2) Actions (section 4.3)
3) Outcomes (section 4.6)

The outcome of the Implementation Plan determines what direction will be followed within the Adaptation Pathway when moving to a new phase.

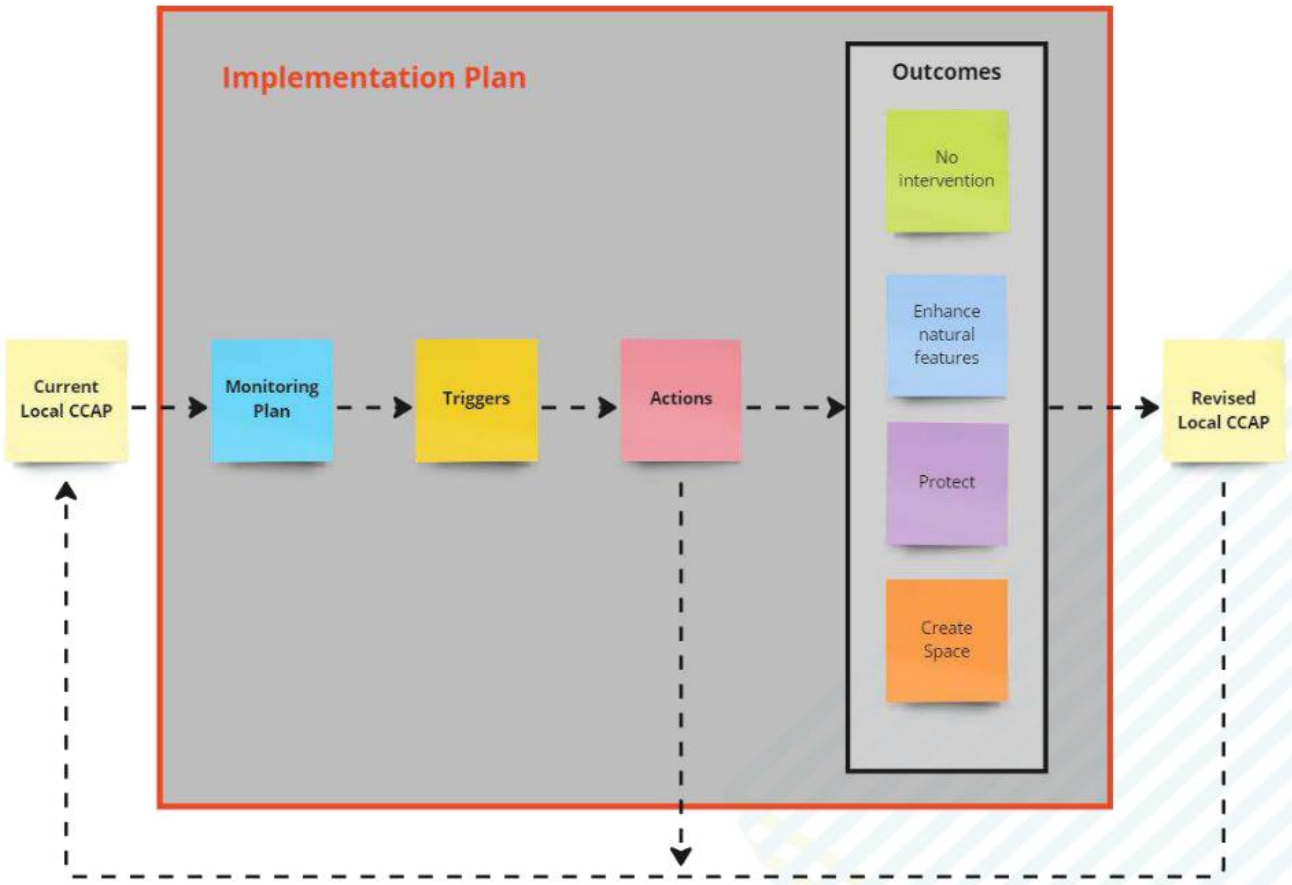


Figure 4-1: High-level Implementation Plan.

4.2 Monitoring and Triggers

4.2.1 Monitoring

Triggers are realised through monitoring of available data that informs risk of flooding and erosion. Triggers signal the requirement to deliver the Implementation Plan, which may lead to a review of the Risk Assessment and potentially change to the Adaptation Pathway. Triggers are categorised as:

- Natural systems triggers.
- Climate triggers.
- Risk exposure triggers.
- Socio-economic triggers.

These are subsequently grouped into categories with each requiring a plan for monitoring within the CA:

- Third party data and information
- Moray Council data and information
- Moray Council monitoring
- External pressure

4.2.2 Trigger Classification

Classification of the triggers falls into two parts.

1. Generic triggers applicable to the entire CA.
2. Bespoke triggers applicable to individual CMUs.

Climate, natural system, and socio-economic triggers are generic for the whole CA, but risk exposure triggers related to physical flooding, erosion and overtopping thresholds are specific to each CMU. For the Lossiemouth to Binn Hill Coast CA these are summarised in Table 4-5.

All trigger types considered for the Lossiemouth to Binn Hill Coast CA are summarised below:

1) Flooding triggers (section 4.2.3)
2) Overtopping triggers (section 4.2.4)
3) Erosion triggers (section 4.2.5)
4) Built structure condition triggers (section 4.2.6)
5) New information trigger (section 4.2.7)

Effective review of these requires development of a monitoring plan of risk at each CMU as follows:

- CMU 1: monitoring of erosion risk.
- CMU 2: monitoring of erosion risk and overtopping risk.
- CMU 3: monitoring of flood risk and overtopping risk.
- CMU 4: monitoring of flood risk.
- CMU 5: monitoring of erosion risk.
- CMU 6: monitoring of erosion risk.
- CMU 7: monitoring of flood risk.

4.2.3 CMU-specific flooding trigger

Based on SEPA's NFRA data, where there is risk of flooding, the elevation of assets at risk are compared to sea levels taken from the SEPA tide gauge at Buckie. Assets considered at risk from flooding include:

- Residential properties.
- Key roads.
- Coastal defences.

Where flood risk is present in a CMU, the lowest elevation of a residential property (minus 300mm freeboard) or key road is used to determine a frequency of exceedance using the tide gauge levels (Table 4-1).

At Lossiemouth to Binn Hill Coast, current SEPA maps indicate a flood risk at CMU 3, CMU 4 and CMU 7.

Exceedance Frequency is the number of events that exceed the asset (defined below) threshold in a 10-year period.

The CMU-specific flooding trigger is realised if the exceedance frequency increases beyond specified criteria. There are two levels to this Trigger realisation that require different actions. These also vary depending on the type of asset at risk of flooding:

- **Residential properties**
    1. Exceedance frequency of **two** or more in a **ten-year window**.
        - Increase monitoring and plan for assessment.
    2. Exceedance frequency of **five** or more in a **ten-year window**.
        - Undertake assessment and plan for intervention.
- **Key Roads**
    1. Exceedance frequency of **five** or more in a **ten-year window**.
        - Increase monitoring and plan for assessment.
    2. Exceedance frequency of **ten** or more in a **ten-year window**.
        - Undertake assessment and plan for intervention.
- **Coastal Defences (note no MC defences at Lossiemouth to Binn Hill Coast)**
    1. Exceedance frequency of **one** or more in a **ten-year window**.
        - Increase monitoring and plan for assessment.
    2. Exceedance frequency of **two** or more in a **ten-year window**.
        - Undertake assessment and plan for intervention.

Locations of the assets used to define the flooding triggers are shown in Figure 4-2. All property and road flooding triggers for CMU 3, CMU 4 and CMU 7 for the Lossiemouth to Binn Hill Coast CA (Table 4-1).

It is important to note that the elevation of the coastal defence asset (e.g. harbour wall, rock revetment, natural beach-dune system) compared to the tide level exceedance frequency is not a true representation of the actual risk of flooding. The risk of flooding is also associated with the elevation of the land surrounding the asset at risk; this is discussed further in Appendix A and highlights the requirement for a more detailed assessment to inform Phase 1 of the adaptation planning.

Table 4-1: CMU-specific flooding triggers for Lossiemouth to Binn Hill Coast properties and roads. Cells shaded red indicate that the flooding trigger has already been met.

CMU	Lowest level of Property (mOD)		Property – Freeboard (mOD)	Current 10-year frequency	Flooding trigger level 1 Exceedance Frequency:	Flooding trigger level 2 Exceedance Frequency:
3	Property	2.4	2.1	345.2	2.0	5.0
4	Property	1.8	1.5	1330.0	2.0	5.0
7	Property	1.7	1.4	1456.4	2.0	5.0
CMU	**Lowest level of Road (mOD)**			**Current 10-year frequency**	**Flooding trigger level 1 Exceedance Frequency:**	**Flooding trigger level 2 Exceedance Frequency:**
3	Gregory Place	2.0		481.8	5.0	10.0
7	A941	2.5		39.0	5.0	10.0

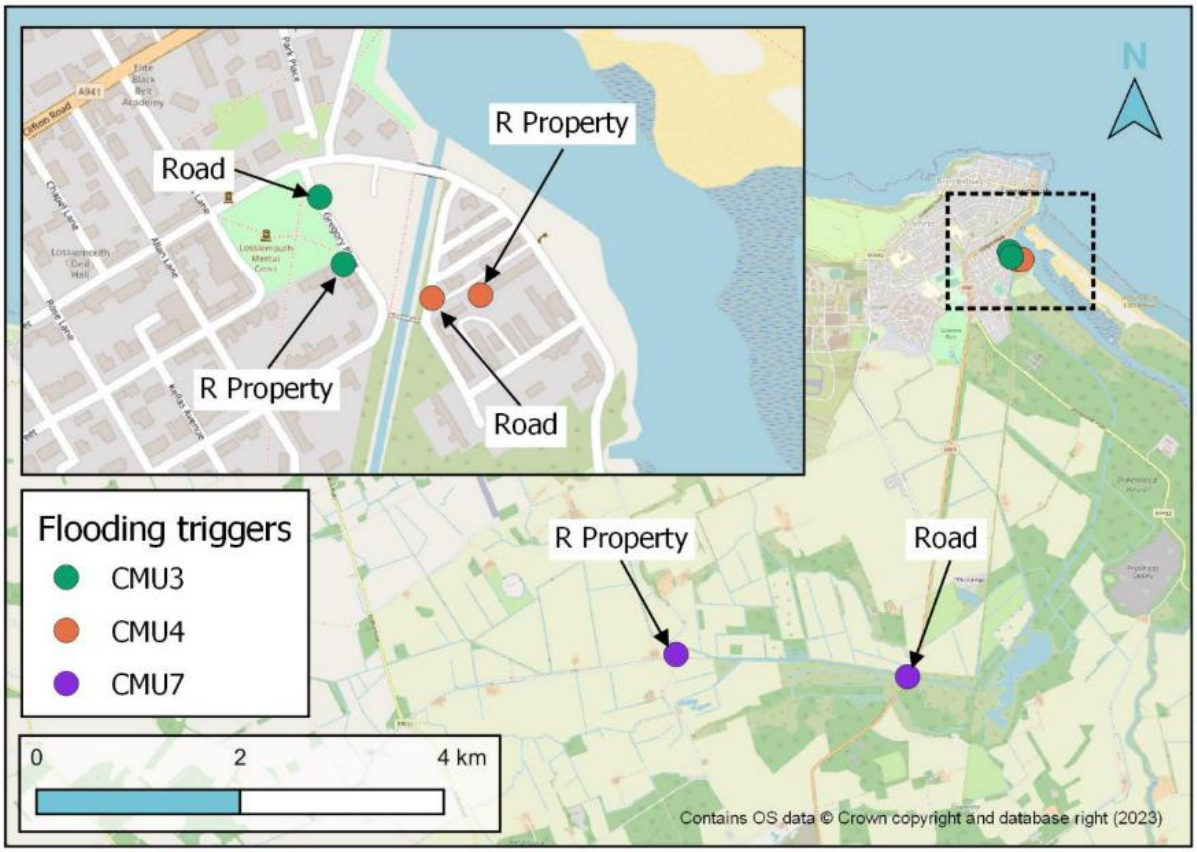


Figure 4-2: Lossiemouth to Binn Hill Coast flooding trigger locations for residential properties (R property) and Roads.

4.2.4 CMU-specific overtopping triggers

Where there is risk of flooding from wave overtopping (not currently accounted for in SEPA NFRA data or flood maps), an overtopping risk assessment has been undertaken. This has been used to develop threshold levels based on extreme return periods. To enable proactive planning, the overtopping risk assessment has been undertaken for four SLR scenarios:

- 0.0 m (present-day)
- +0.2 m
- +0.5 m
- +1.0 m

Overtopping rates have been estimated for each return period to produce and envelope of potential overtopping under each sea level scenario (Appendix A). This has been undertaken for two profiles, in two different CMUs:

1) The rock armour along the shore of in CMU 2, west of Lossiemouth harbour (Figure A-4).
2) The vertical sea wall next to the Station Park in CMU 3, south of Lossiemouth harbour (Figure A-4).

An overtopping trigger is realised once overtopping volume during the 1 in 2-year and 1 in 30-year return period events exceed given threshold levels[7]. There are two levels to the trigger realisation that require different actions:

1. Level 1: overtopping volume exceeds 5 l/s/m during a 1 in 30-year event.
    - Increase monitoring and plan for assessment.
2. Level 2: overtopping volume exceeds 2 l/s/m during a 1 in 2-year event.
    - Undertake assessment and plan for intervention.

The overtopping rates itself does not require monitoring rather the updated overtopping calculations, should new data become available (e.g., extreme waves or sea levels, defence survey, beach levels etc). The Triggers are therefore an indication of the performance level of the structure.

In the event of an overtopping event being realised, Moray Council should consult with SEPA to understand where the realised rates fit on the overtopping volume estimates (section A.3.2 and A.4.2) to assess whether this represented an exceedance of these initial triggers. Depending on the outcome the value of overtopping triggers should be adjusted to reflect the outcome, if appropriate.

Overtopping results from the risk assessment (Table 4-2) show that triggers are not being met now (2023 present-day). At CMU 3, Level 1 and Level 2 overtopping triggers will be met after 0.2 m of sea level rise. At CMU 2, Level 1 and Level 2 overtopping triggers will be met after 1.0 m of sea level rise. Climate change data should be monitored to understand when action is required. Current projections estimate that, by 2100, sea levels on the Moray coast could rise up to 0.9m[8].

7 It should be noted that thresholds are based primarily on judgement, tolerable limits in guidance and associated consequence in the immediate vicinity of the beach crest. A more detailed assessment of when overtopping volume results in flooding or damage properties is recommended. Here there are several properties and buildings in close proximity to the coastline which may suffer damage and require additional consideration for emergency planning.
8 https://www.sepa.org.uk/media/594168/climate-change-guidance.pdf

Table 4-2: Overtopping triggers for the rock armour and sea wall in CMU 2 and CMU 3 respectively. Cells shaded red indicate that an overtopping trigger has been met. Where l/s/m = litres/second/minute

Sea level rise	CMU 2 Overtopping Trigger Level 1: 1 in 30-year overtopping rate (l/s/m)	CMU 2 Overtopping Trigger Level 2: 1 in 2-year overtopping rate (l/s/m)	CMU 3 Overtopping Trigger Level 1: 1 in 30-year overtopping rate (l/s/m)	CMU 3 Overtopping Trigger Level 2: 1 in 2-year overtopping rate (l/s/m)
0.0 m (present-day)	0.35	0.03	4.57	0.83
0.2 m	1.11	0.12	10.35	2.30
0.5 m	4.61	0.74	28.85	8.76
1.0 m	24.9	7.09	82.83	40.96

4.2.5 CMU-specific erosion trigger

Where there is risk of erosion, the distance from the at-risk assets on land to the coast is used to define the Trigger. For assets including properties, roads, utilities and other types, the coast is defined by the landward extent of the natural feature e.g. beach, barrier, spit or cliff. Assets considered at risk from erosion include:

- Residential properties.
- Key roads.
- Other features, such as carparks and golf courses.

To note, if two assets are in the same location (e.g. a road and property) only the most seaward asset is used to define the Trigger for that CMU.

As with the other CMU-specific triggers, a two-level approach is defined using buffers around the asset at risk. The associated action is, again, dependent on the consequence and asset at risk.

Erosion buffer distances (metres) for each level are defined as follows:

- **Residential properties**
    1. Maximum of historic erosion rate multiplied by 20 or 20m.
        - Increase monitoring and plan for assessment.
    2. Maximum of historic erosion rate multiplied by 10 or 10m.
        - Undertake assessment and plan for intervention.
- **Roads and other features**
    1. Maximum of historic erosion rate multiplied by 5 or 5m.
        - Increase monitoring and plan for assessment.
    2. Maximum of historic erosion rate multiplied by 2 or 2m.
        - Undertake assessment and plan for intervention.

The Level 1 erosion trigger has been met for the carpark and the Level 2 erosion trigger has already been met for one property, both in CMU 2 (Table 4-3). Location of all assets used for erosion triggers are shown in Figure 4-3 and Table 4-4.

Table 4-3: CMU-specific erosion triggers for Lossiemouth to Binn Hill Coast properties, roads and features. Cells shaded red indicate that the erosion trigger has been met.

CMU	Maximum historical change rate (m/year)	Present-day distance of Property to coast (m)		Erosion trigger level 1: Coast X m from property	Erosion trigger level 2: Coast X m from property
1	0.7	RP	80.0	20.0	10.0
2	0.7	RP	10.0	20.0	10.0
5	3.1	RP	166.0	62.0	31.0
CMU	**Maximum historical change rate (m/year)**	**Present-day distance of Road to coast (m)**		**Erosion trigger level 1: Coast X m from road**	**Erosion trigger level 2: Coast X m from road**
2	0.7	St Gerald. Rd	24.0	5.0	2.0
5	3.1	Church St	162.0	15.5	6.2
CMU	**Maximum historical change rate (m/year)**	**Present-day distance of feature to coast (m)**		**Erosion trigger level 1: Coast X m from feature**	**Erosion trigger level 2: Coast X m from feature**
1	0.7	Caravan Park	29.0	5.0	2.0
1	0.7	Golf Course	11.0	5.0	2.0
2	0.7	Carpark	4.0	5.0	2.0
5	3.1	Caravan Park	264.0	15.5	6.2
6	0.5	Quarry	271.0	5.0	2.0

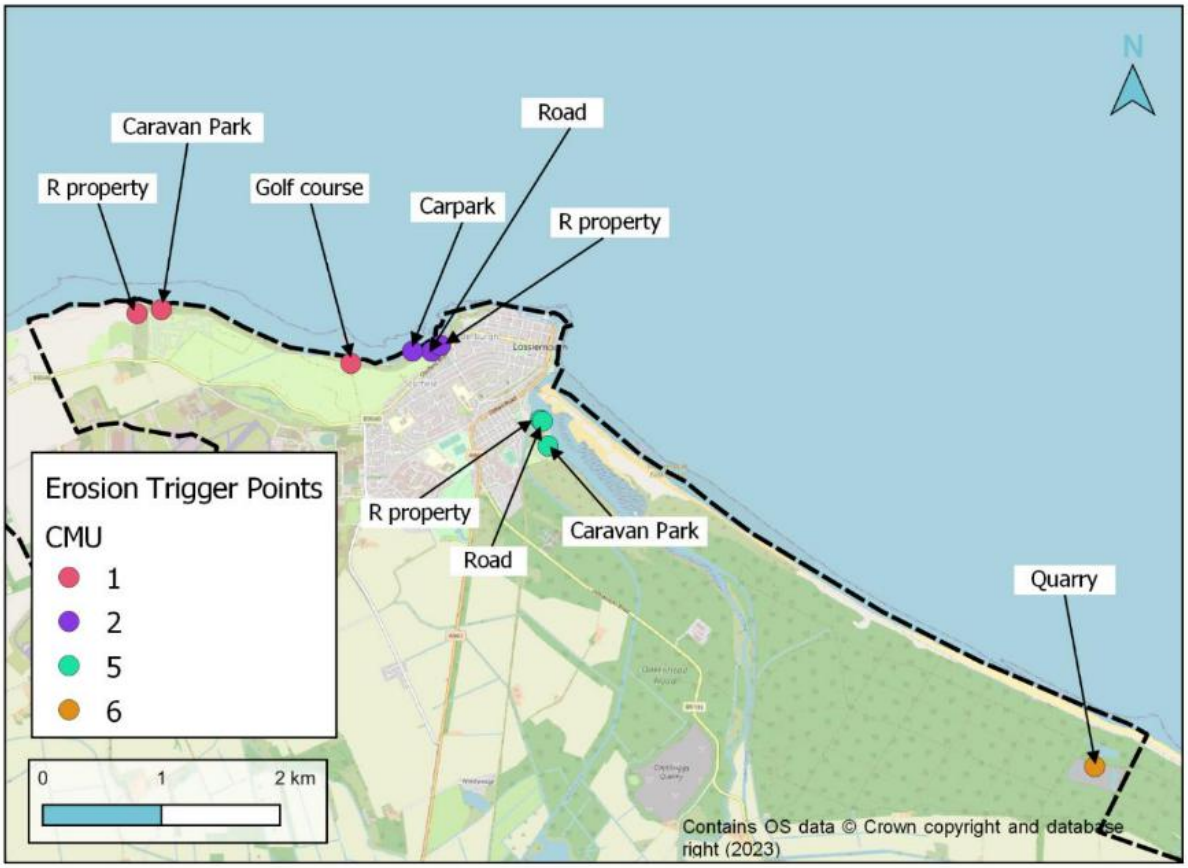
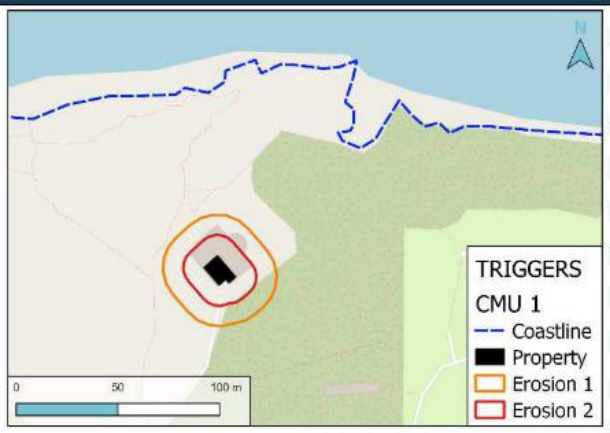
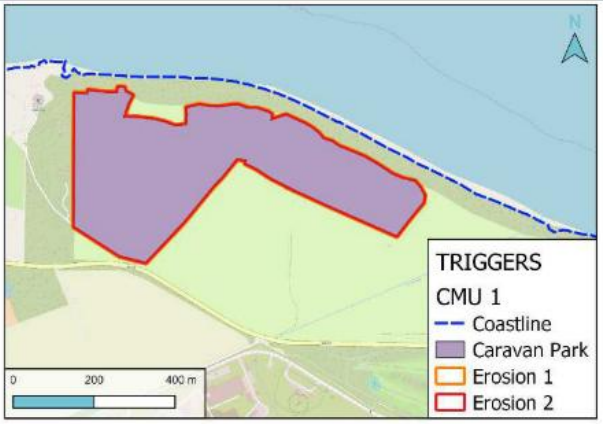
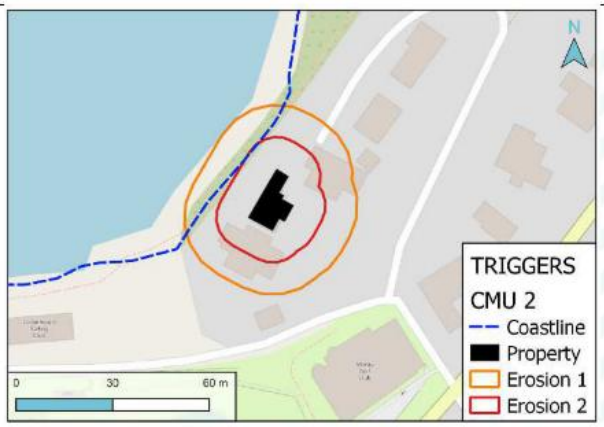
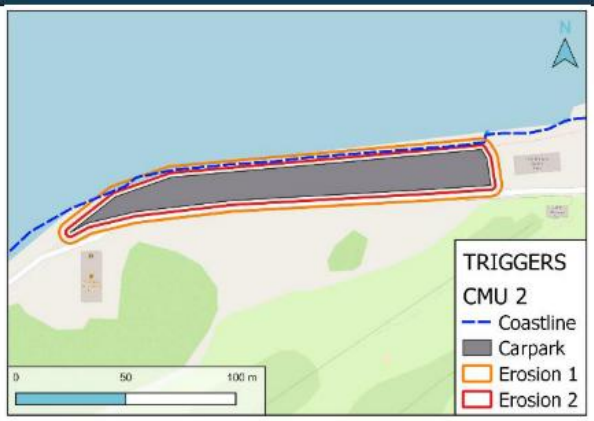
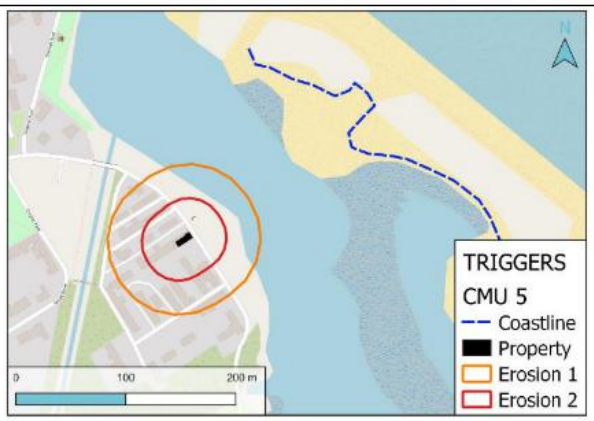
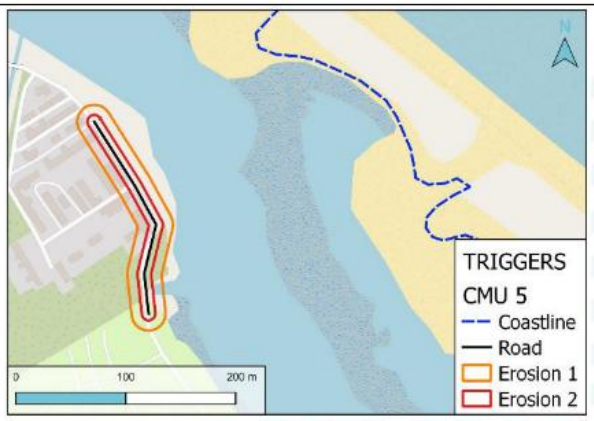
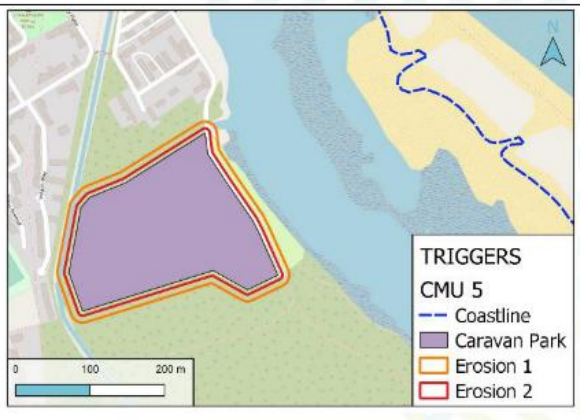


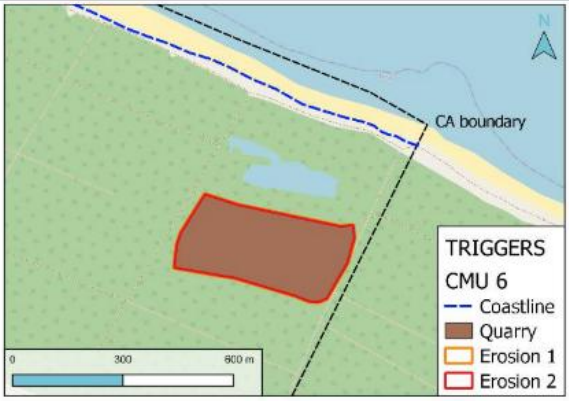
Figure 4-3: Lossiemouth to Binn Hill Coast erosion trigger locations.

Table 4-4: Lossiemouth to Binn Hill Coast erosion triggers.

CMU	Asset	Trigger Met	Erosion Trigger
1	RP	No	

CMU	Asset	Trigger Met	Erosion Trigger
1	Caravan Park	No	
1	Golf Course	No	
2	RP	Yes (level 2)	
2	Road	No	

CMU	Asset	Trigger Met	Erosion Trigger
2	Carpark	Yes (level 1)	
5	RP	No	
5	Road	No	
5	Caravan Park	No	

CMU	Asset	Trigger Met	Erosion Trigger
6	Quarry	No	

4.2.6 CMU-specific condition triggers

Where a built structure is present in a CMU, a CMU-specific trigger will be applied to the condition of the built structure. Currently, built structures are present in:

- CMU 2
- CMU 3
- CMU 4

As with the other CMU-specific triggers, a two-level condition trigger approach and associated action is defined using the Grades of structure condition according to the EA and Defra condition assessments[9]:

- **Condition trigger level 1:**
    1. Defence condition Grade 4
        - Increase monitoring and plan for assessment.
- **Condition trigger level 2:**
    1. Defence condition Grade 5:
        - Undertake assessment and plan for intervention.

These CMU-specific condition triggers assume built structures are currently Grade 3 but this should be reviewed upon completion of the Regional Proactive Actions for defence condition.

4.2.7 New information trigger

New information on hazards, vulnerability, built structure and infrastructure assets etc will become available all the time as the CCAP is implemented. The new information trigger acknowledges this and accounts for changes to properties, roads, key features, or assets available from Dynamic Coast or the NFRA.

This new information may be provided by a Council/ stakeholder member or local resident of the CA and would trigger a review of the relevant part of the CCAP.

- **New Information trigger:**
    1. New information received of asset at risk:
        - Understand risk and, if relevant, set adaptation triggers and actions.
        - Incorporate into monitoring plan.

9 Environment Agency (2013) Practical guidance on determining asset deterioration and the use of condition grade deterioration curves: Revision 1.

4.2.8 Moray Coastal Trail

Impact of flooding and erosion on the Moray Coastal Trail[10] (MCT) is yet to be quantified but it will likely become badly affected by coastal change and flooding in both the short and long-term.

As part of delivery of the Regional Plan a more detailed assessment will be undertaken to understand the impacts of climate change on the MCT (Regional Proactive Action 9). This will provide opportunities for investigation options to enhance and retain the amenity.

In this CA, it the MCT may be severely impacted by coastal erosion, particularly in CMU's 1, 2, 5 and 6. This includes potential disruption of access to East Beach over the new bridge.

4.3 Actions

Actions, like Triggers, can also be applied to the entire CA, or to specific CMUs where the risk of flooding and/or erosion is identified. Actions will be specific to CMUs where, for example, a coastal defence is present; a natural protective feature is present; the risk of flooding/erosion is localised; assets are at risk of flooding/erosion.

Actions applicable to all and specific CMUs in Lossiemouth to Binn Hill Coast CA have been identified in (Table 4-5). These are based on the Phase 0 Triggers only and it is possible that more will be required as a reactive response to change. Delivery of the Regional Plan[11] Proactive are also required to support. The types of Actions are summarised below:

Review risk assessment:

- Involves a review of available data and associated risk assessment. Increased monitoring, planning, and implementing an assessment, and planning for intervention because of the erosion and flooding triggers are included in the review risk assessment action.

Community engagement:

- **Places**: Involves local stakeholders, such as Councillors and affected community groups.
- **Practice**: Involves third party stakeholders, such as SEPA, Scottish Government, Nature Scot etc.
- **Asset**: Includes private defences harbours and utilities specific to built structures or hybrid CMUs.

Post flood data collection:

- Involves citizen science, surveys, photographs etc.

New risk assessment:

- Following a review of the current risk assessment and/or community engagement, a new risk assessment may be required. Should a new assessment be deemed necessary this should follow appropriate guidance[12] and include all necessary components to develop a preferred Adaptation Pathway and associated Action Plan for delivery. E.g. risk, economics, social, environment, engineering, land use planning etc.

Actions bridge the gap between Triggers and Outcomes and define what processes need to be implemented before the most appropriate Outcome is recognised and delivered for each CMU. Actions linked to specific triggers and relevant Lossiemouth to Binn Hill Coast CMU is included in Table 4-5. These highlight what may be delivered during the Phase 0 cycle and are dependent on the associated Trigger being realised.

10 https://www.morayways.org.uk/routes/the-moray-coast-trail/
11 Moray Coastal Change Adaptation Plan: Regional Plan - IRR-JBAU-XX-XX-RP-MO-0001-S4-P03-Regional_Plan
12 Scottish Government. 2016. Flood protection appraisals: guidance for SEPA and responsible authorities https://www.gov.scot/publications/guidance-support-sepa-responsible-authorities/pages/2/

Table 4-5: Triggers, trigger categories and associated actions for each Lossiemouth to Binn Hill Coast CMU.

Category	Trigger	Action	CMU
Natural Systems	Changes to habitat	Community engagement (places)	All
	Changes to greenspace	Community engagement (places)	All
Climate	Update to climate guidance	Review risk assessment Community engagement (practice)	All
	Update to SEPA flood maps	Review risk assessment Community engagement (practice)	All
	Coastal flood occurrence	Review risk assessment Community engagement (places, asset) Post flood survey	All
Risk exposure	Defence condition	Community engagement (asset)	CMU 2 CMU 3 CMU 4
	Update to SEPA flood warning	Review risk assessment Community engagement (places, practice)	All
	Erosion buffer exceeded	Review risk assessment Community engagement (places)	CMU 1 CMU 2 CMU 5 CMU 6
	Flood risk threshold exceeded	Review risk assessment Community engagement (places)	CMU 3 CMU 4 CMU 7
	Overtopping risk threshold exceeded	Review risk assessment Community engagement (places)	CMU 2 CMU 3
	Update to Dynamic Coast	Review risk assessment Community engagement (practice)	All
Socio-economic	Changes of asset use	Community engagement (asset)	All
	Changes of asset owner	Community engagement (asset)	All
	Community pressure	Review risk assessment Community engagement (places)	All

4.4 Phase 0 Actions

Phase 0 Actions require immediate attention and have been identified by associated triggers realised through the development process of this initial CCAP for Lossiemouth to Binn Hill Coast. These are outlined below:

- CMU 2:
    - Trigger: Erosion risk threshold exceeded (level 2)
        - **Action 2**: Undertake assessment and plan for intervention.
- CMU 3:
    - Trigger: Flooding risk threshold exceeded (level 2)
        - **Action 2**: Undertake assessment and plan for intervention.
- CMU 4:
    - Trigger: Flooding risk threshold exceeded (level 2)
        - **Action 2**: Undertake assessment and plan for intervention.
- CMU 7:
    - Trigger: Flooding risk threshold exceeded (level 2)
        - **Action 2**: Undertake assessment and plan for intervention.

An overall summary of all CMUs, Triggers, buffers and Phase 0 Actions is provided as a standalone record in Appendix C for clarity.

4.5 Supporting Steps and Proactive Actions

The nature of adaptation means that future decisions and directions are unknown and will be affected by external changes not necessarily under Moray Council's influence. It is critical that proactive supporting steps and Proactive Actions are undertaken to enable effective decision making in the future.

Proactive Actions are defined as those whereby there should only be benefit. Undertaking these can therefore only have a positive impact on supporting adaptation or increasing resilience.

At this stage in the adaptation planning process six such actions have been identified. These have been developed focusing on the key pillar identified previously and through review and understanding of key knowledge gaps. They therefore aim to close these knowledge gaps at this stage and support alignment with wider aspects of the adaptation plan for the region.

A summary of these actions is provided in Table 4-6 with further details on each included in Appendix B. These are designed to complement the wider Proactive Actions identified in the Regional CCAP.

Table 4-6: Local Proactive Actions

Action	Details	Pillars
1	Investigate opportunities for dune enhancement	Working with Natural Processes 
2	Develop modelling framework to support future assessments to support potential adaptation actions	Working with Natural Processes 

Action	Details	Pillars
3	Investigate opportunities for habitat creation on River Lossie and Spynie Canal	Working with Natural Processes 
4	Establish coordinated and consistent beach monitoring plan for Natural CMUs	Monitoring Change 
5	Adaptation and resilience workshop with local community and stakeholders	Community and Engagement 
6	Identify landownership and safeguarding	Place Making 

4.6 Outcomes

Outcomes are the potential intervention measures that will be implemented after a trigger is realised and the associated actions, defined in the Implementation Plan, have been undertaken. There are four possible outcome categories:

1) No intervention.
2) Enhance natural features.
3) Protect.
4) Create Space.

These Categories however are general, and nuances and variations may result upon completion of any more detailed study.

As the Implementation Plan is applied at CMU level, the ultimate outcome is dependent on the CMU and the associated Adaptation Pathway. Table 4-5 summarises the general and specific CMU outcomes for the Lossiemouth to Binn Hill Coast CA.

Table 4-7: Lossiemouth to Binn Hill Coast CA possible outcomes.

Category	Outcome	CMU
No intervention	No intervention	All
Enhance natural features	Enhance natural features	CMU 1 CMU 2 CMU 3 CMU 5

		CMU 6 CMU 7
Protect	Maintain defences	CMU 2 CMU 3 CMU 4
	Sustain defences	CMU 2 CMU 3 CMU 4
	Improve defences	All
	Property resilience measures	CMU 3 CMU 4 CMU 7
Create space	Remove defences	CMU 2 CMU 3 CMU 4
	Set back defences	CMU 2 CMU 3 CMU 4
	Relocate assets	All
***standard of performance is sustained into the future in response to climate change** ****standard of performance is improved beyond the current and then maintained in response to climate change**		

The complete Implementation Plan for Lossiemouth to Binn Hill Coast is shown in (Figure 4-4); structured using the three stages: 1) Monitoring and Triggers, 2) Actions, and 3) Outcomes.

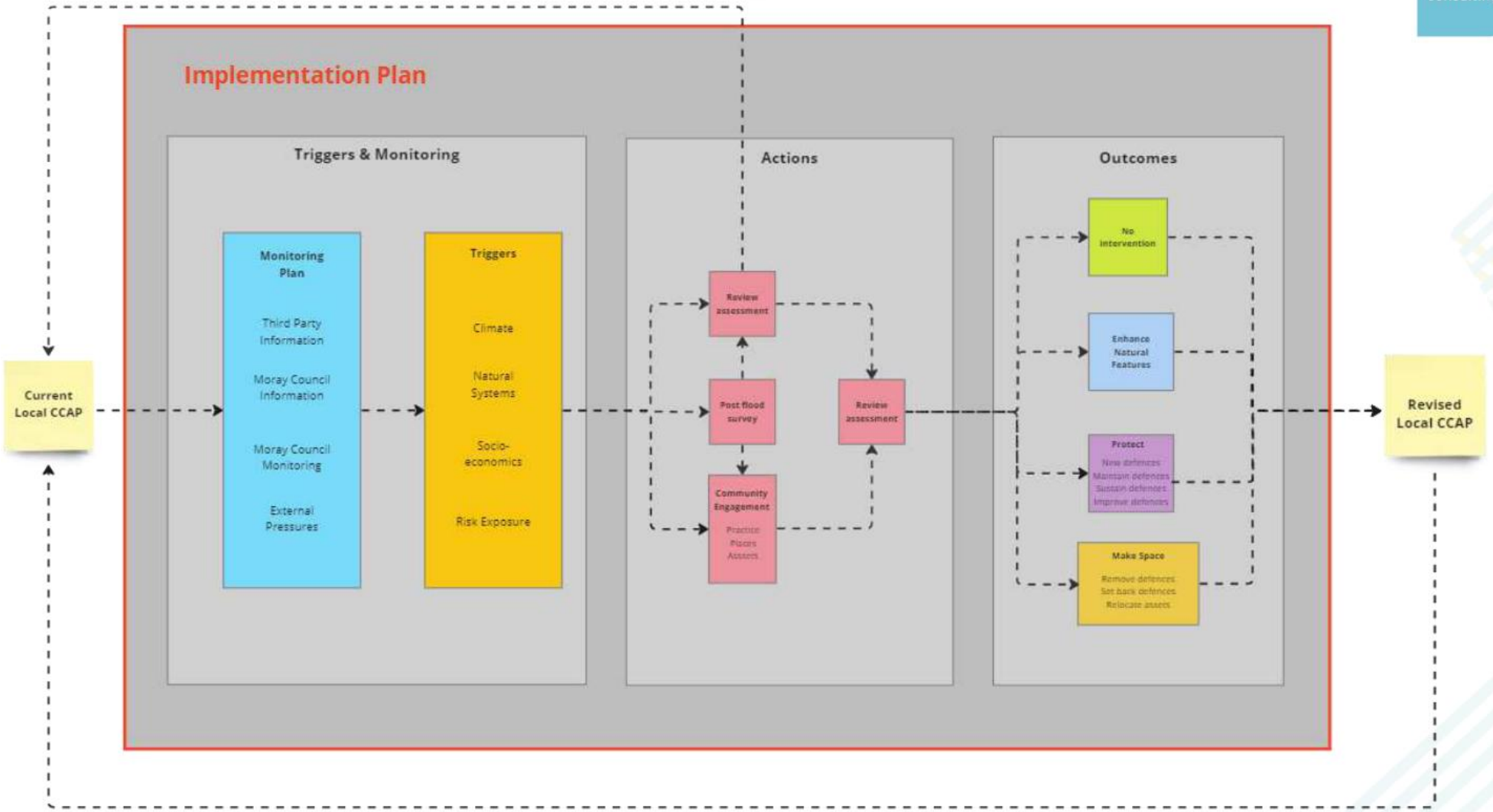


Figure 4-4: Complete Implementation Plan for Lossiemouth to Binn Hill Coast CA.

4.7 Example application

Figure 4-5 provides a schematic describing an example application of the Implementation Plan and how it fits in with the wider Adaptation Framework for Lossiemouth to Binn Hill Coast. The red box highlights the processes described in this iteration of the CCAP.

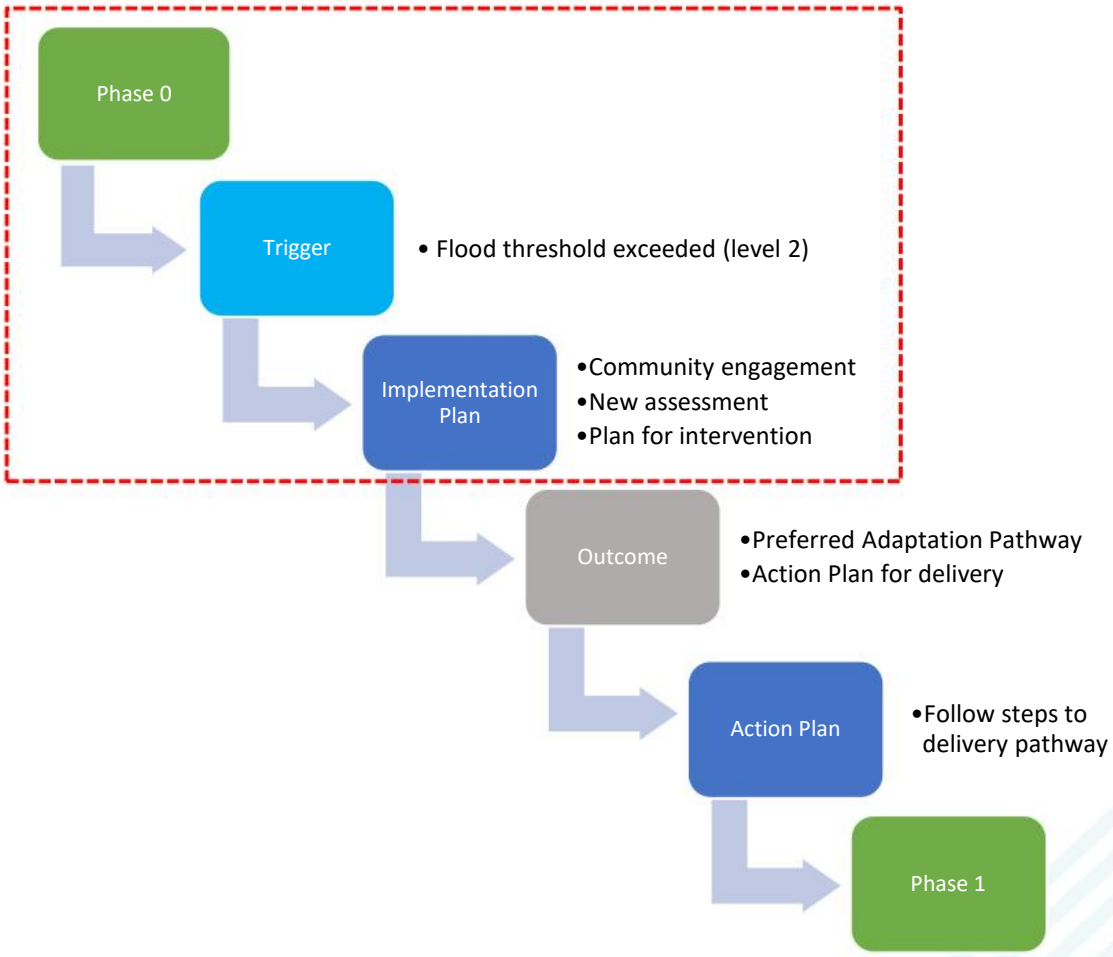


Figure 4-5: Example application of Phase 0 to Phase 1 of the adaptation process and how the Implementation Plan works with Adaptation Pathways and Action Plans.

5 Summary and Next Steps

5.1 Approach

This document presents the local CCAP for the Lossiemouth to Binn Hill Coast CA. It is the first iteration and will be subject to ongoing review and update to effectively guide the adaptation process. The approach for developing the Plan makes use of available, national information on coastal flood and erosion risk and combines these with relevant local datasets.

Adaptation in Moray has been has steered by relevant published documentation and the Scottish Governments interim guidance on CCAPs. These have been used to develop a Regional CCAP. This has been simplified into four key pillars of adaptation:

1) **Working with Natural Processes**
2) **Monitoring Change**
3) **Community and Engagement**
4) **Climate Resilient Placemaking**

This local Plan builds on the Regional Plan by focusing on these pillars to develop an Adaptation Framework that can effectively support Lossiemouth to Binn Hill Coast preparing for the impact that climate change will have on the coast. This will be delivered by following the Implementation Plan, presented here, that outlines triggers and associated actions to develop Adaptation Pathways and an Action Plan for the Lossiemouth to Binn Hill Coast CA. This will happen when the process moves into Phase 1.

The following sections provide summaries of the key findings of this initial stage of the adaptation planning process.

5.2 Coastal Management Units and Risks

The Lossiemouth to Binn Hill Coast CA was subdivided into seven CMUs. For each of these a refined assessment was undertaken to determine coastal type and associated current and future flood and erosion risk. These are summarised as:

- CMU 1 – Natural with Risk and Hazard
- CMU 2 – Hybrid with Risk and Hazard
- CMU 3 – Built Structures with Risk and Hazard
- CMU 4 – Hybrid with Risk and Hazard
- CMU 5 – Natural with Risk and Hazard
- CMU 6 – Natural with No Risk and Hazard
- CMU 7 – Natural with Risk and Hazard

These were then taken forward to develop Adaptation Pathways and an Implementation Plan with Triggers and Actions associated with each CMU.

5.3 Adaptation Pathways

To enable effective implementation of this CCAP across the Lossiemouth to Binn Hill Coast CA, each CMU has been assigned a generic Adaptation Pathway. This is specific to the CMU classification.

The adaptation journey is a multiphase, multiyear process and aims to transition communities into a more sustainable and resilient future. We are currently at **Phase 0**, meaning that no definitive preferred Adaptation Pathway and associated Action Plan have been developed.

To move to Phase 1 of the Adaptation Pathway, a trigger must be realised that results in New Assessment, which is the case for CMUs 2, 3, 4 and 7. During Phase 1 a a preferred pathway and associated Action Plan will be identified at these CMUs:

1. **Phase 0**:
    - Development of the Implementation Plan
    - Delivery of Phase 0 Actions (Appendix C)
    - Delivery of Phase 0 Proactive Actions (Appendix B)
2. **Phase 1**:
    - Implementation Plan outcomes:
        - Preferred Adaptation Pathway
        - Action Plan for delivery
    - Delivery of Phase 1 Proactive Actions
3. **Phase 2+**:
    - Implementation Plan outcomes:
        - Preferred Adaptation Pathway (Continue or revise Phase 1)
        - Action Plan for delivery (Continue or revise Phase 1)
    - Delivery of Phase 2 Proactive Actions

While ultimately the Adaptation Pathways have a desired outcome, what that looks like and how it will be reached cannot be defined at this stage. Effective monitoring against the set triggers will enable the CCAP to evolve through Phases and support Moray Council decision making to aim to achieve this end-outcome.

5.4 Implementation Plan

The Implementation Plan was developed by defining Triggers and setting Actions against these. Implementation of the Plan will result in end outcomes that will ultimately influence the direction of the Adaptation Pathways in the Lossiemouth to Binn Hill Coast CA.

At this stage the pathways do not result in definitive end points. Triggers, while tangible, provide markers whereby Moray Council will undertake actions, guided by the Implementation Plan. The Outcomes of these however, are unknown and the direction of the pathway in the future therefore cannot be defined.

Triggers focus on the updates to the data and documentation that has underpinned the development of the plan, and bespoke flooding or erosion thresholds being exceeded, through monitoring of physical processes.

As well as Actions that rely on Triggers being realised. This initial stage of the adaptation planning process has identified several knowledge gaps and opportunities for activities to be undertaken upfront. These are defined as Proactive, whereby undertaking these will only benefit and support Moray's adaptation to coastal change.

In total, six Proactive Actions have been set.

5.5 Next Steps

Adaptation to coastal change will be a continual journey and it is therefore important that the process is ongoing. Here, the following key steps require implementing by Moray Council to support this journey and follow CCAP:

- Implement internal governance processes to review and monitor Triggers.
- Deliver local Phase 0 Actions.
- Deliver local Proactive Actions.

Appendices

A CMU Risk Assessment

A.1 Data and Overview

Coastal parameters and associated datasets for Lossiemouth to Binn Hill Coast are summarised in Table A-1.

Table A-1: Coastal dataset summary for Lossiemouth to Binn Hill Coast CA.

Coastal Data		Details	Data source
Hindcast wave height	0.62 m	50th percentile	CMEMS
	0.96 m	75th percentile	
	2.69 m	99th percentile	
Tide levels	HAT	2.5	TotalTide
	MHWS	2.0	
	MHWN	1.1	
	MSL	-	
	MLWN	-0.5	
	MLWS	-1.6	
	LAT	-2.0	
Extreme Sea Levels	2.04 m	MHWS	CFB (3064)
	2.75 m	2-year	
	3.04 m	50-year	
	3.10 m	100-year	
	3.17 m	200-year	
	3.32 m	1000-year	
Sea level rise projections	0.15 m	2050 70th percentile	UKCP18
	0.20 m	2050 95th percentile	
	0.59 m	2100 70th percentile	
	0.84 m	2100 95th percentile	

An overview of coastal flood and erosion hazards is provided for Lossiemouth to Binn Hill Coast CA (Figure A-1). This has been produced using SEPA flood mapping for 1 in 200-year and 1 in 200-year plus climate change flood events as well as Dynamic Coast erosion projections for 2020 to 2100. The data has been analysed for each CMU individually and has been used to identify receptors at risk.

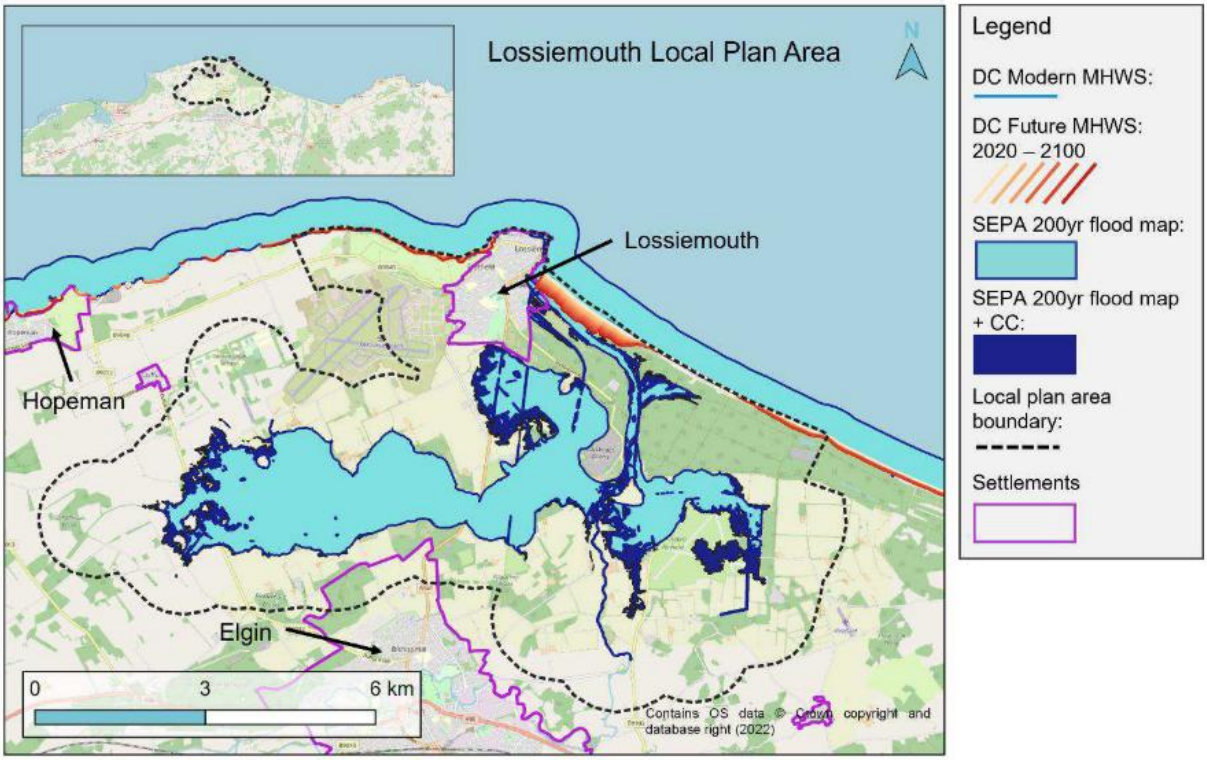


Figure A-1: Lossiemouth to Binn Hill Coast CA coastal flood and erosion hazard overview.

A.2 CMU 1: Beach west natural

CMU 1 is a natural section of the coast to the west of Lossiemouth, with no formal engineered coastal defences. The coast is fronted primarily by unvegetated sand beaches, with some areas of mobile shingle and coastal dunes systems. CMU 1 contains Moray Golf Club Course and Silver Sands Leisure Park, which are situated within the coastal dunes. Covesea Skerries Lighthouse is also located within CMU 1, to the west of the holiday park. SEPA flood maps and NFRA datasets show negligible risk from coastal flooding in this unit to the land and to assets.

Dynamic Coast data shows that historically (from ca. 2003 to 2011),, this area of Lossiemouth to Binn Hill Coast CA eroded at a maximum rate of 0.7 m/yr. Yet, the median historical rate is accretion of 0.2 m/yr. Maximum future erosion rates are expected to increase to 1.2 m/yr by 2050 and to 2.1 m/yr by 2100. This would result in a maximum 122.1 m of land loss caused by shoreline retreat by 2100. Table A-2 summarises Dynamic coast data for CMU 1. There are only two assets within the Dynamic Coast erosion vicinity under the High Emission Scenario, both located at the Covesea Skerries Lighthouse:

- One NRPs at risk from erosion: 68 m from present-day shoreline
- One RPs at risk from erosion: 80 m from present-day shoreline

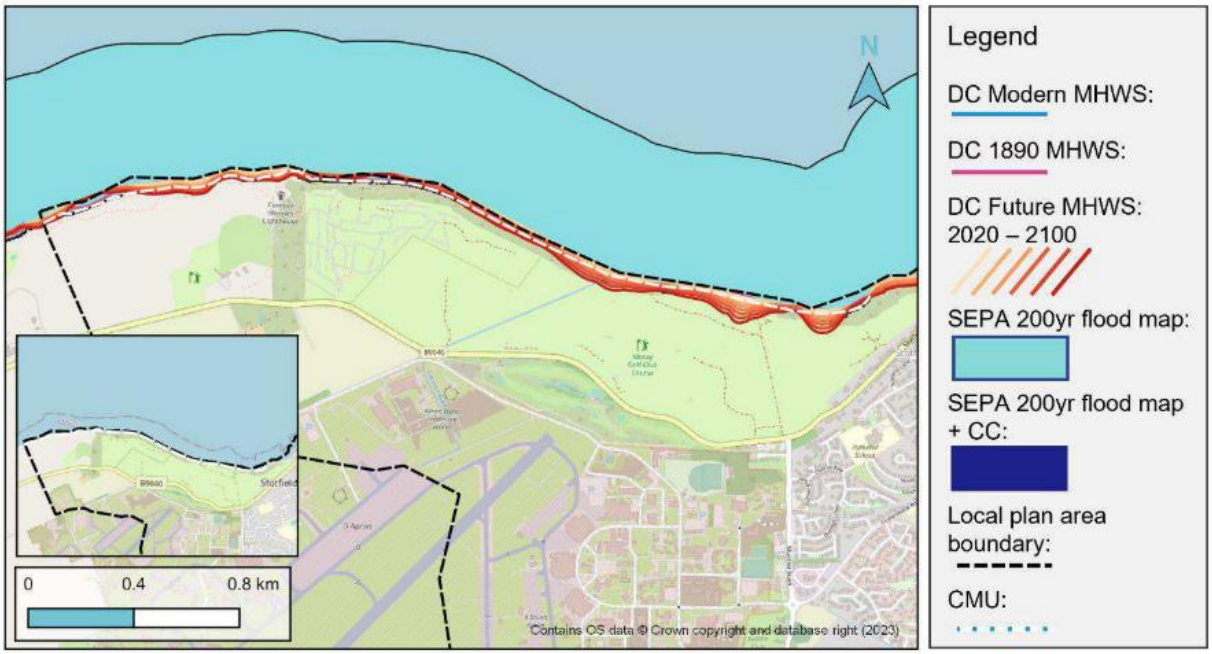


Figure A-2: CMU 1: Beach west natural coastal hazards map showing SEPA flooding extents and Dynamic Coast (DC) past and future erosion. Inset shows CMU without coastal hazards.

Table A-2: CMU 1 Dynamic Coast erosion summary.

Dynamic Coast calculation	Results	
Historical rate	0.7 m/yr	Maximum
	+0.2 m/yr (accretion)	Median
2050 rate	1.2 m/yr	Maximum
	0.3 m/yr	Median
2050 distance	31.0 m	Maximum
	4.5 m	Median
2100 rate	2.1 m/yr	Maximum
	0.9 m/yr	Median
2100 distance	122.1 m	Maximum
	40.5 m	Median

A.3 CMU 2: Shingle west hybrid

A.3.1 Dynamic Coast and SEPA

CMU 2 contains both natural sections of coast with shingle beaches and defended sections of the coast with rock armour and hard structures in place. Inland from the coast includes an area of the Moray Golf Club Course and the Branderburgh area of Lossiemouth town, with properties, a carpark and greenspace. SEPA flood maps and NFRA datasets show no risk from coastal flooding in this unit to assets.

Dynamic Coast data is only available for the west section of CMU 2 and shows that historically (from ca. 2003 to 2011), this section of coast eroded at a maximum rate of 0.7 m/yr. Yet, the median historical rate is accretion of 0.1 m/yr. Maximum future erosion rates are expected to increase to 1.1 m/yr by 2050 and to 1.3 m/yr by 2100. This would result in a maximum 40.7 m of land loss caused by shoreline retreat by 2100. Table A-3 summarises Dynamic coast data for CMU 2. Assets within the Dynamic Coast erosion vicinity under the High Emission Scenario are summarised below:

- 12 NRPs at risk from erosion: minimum 9 m from present-day shoreline
- 17 RPs at risk from erosion: minimum 10 m from present-day shoreline
- Minor road (~240 m)

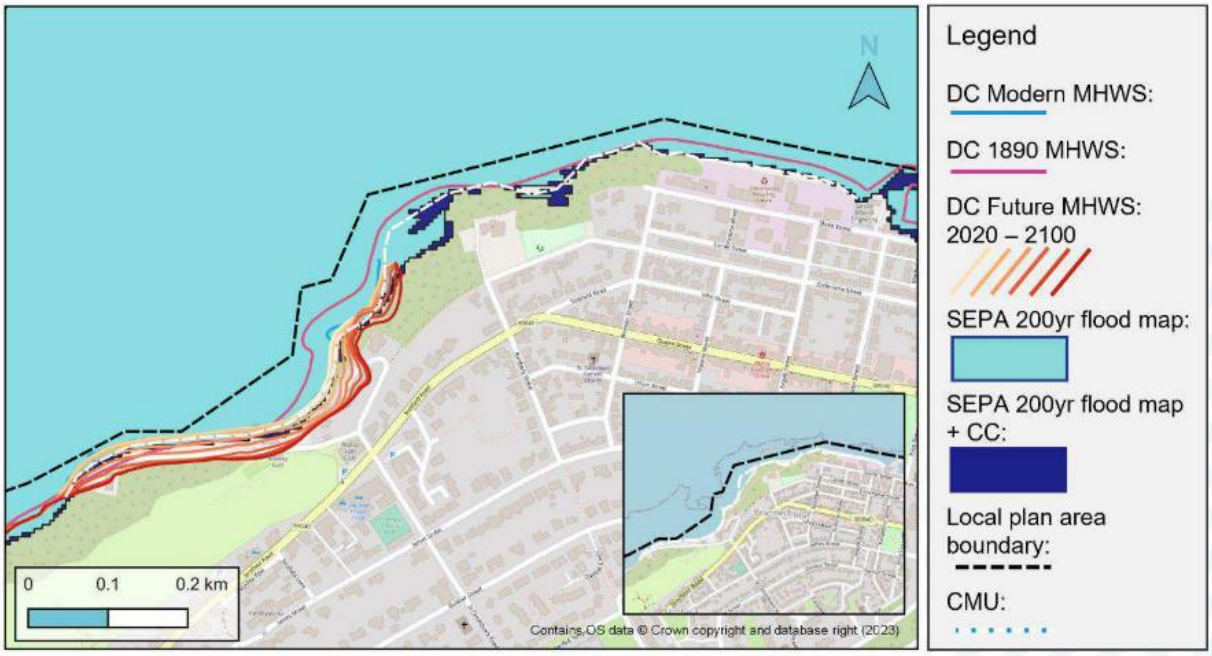


Figure A-3: CMU 2: Shingle west hybrid coastal hazards map showing SEPA flooding extents and Dynamic Coast (DC) past and future erosion. Inset shows CMU without coastal hazards.

Table A-3: CMU 2 Dynamic Coast erosion summary.

Dynamic Coast calculation	Results	
Historical rate	0.7 m/yr	Maximum
	+0.1 m/yr (accretion)	Median
2050 rate	1.1 m/yr	Maximum
	0.5 m/yr	Median
2050 distance	29.1 m	Maximum
	9.1 m	Median
2100 rate	1.3 m/yr	Maximum
	0.0 m/yr	Median
2100 distance	61.6 m	Maximum
	40.7 m	Median

A.3.2 Overtopping assessment

The overtopping assessment has been undertaken for the rock armour section in CMU 2, west of Lossiemouth harbour. At this location, overtopping volumes have been calculated based on the following profile schematisation:

- Cross-sectional profile of rock armour in CMU 2 (Figure A-4) from 2017 SEPA Mapping study (6 mAOD crest level, 0.5 mAOD toe level)

Results from the overtopping assessment for all four sea level rise scenarios are shown in Figure A-5 to Figure A-8 and correspond to Table 4-2 in the main text.

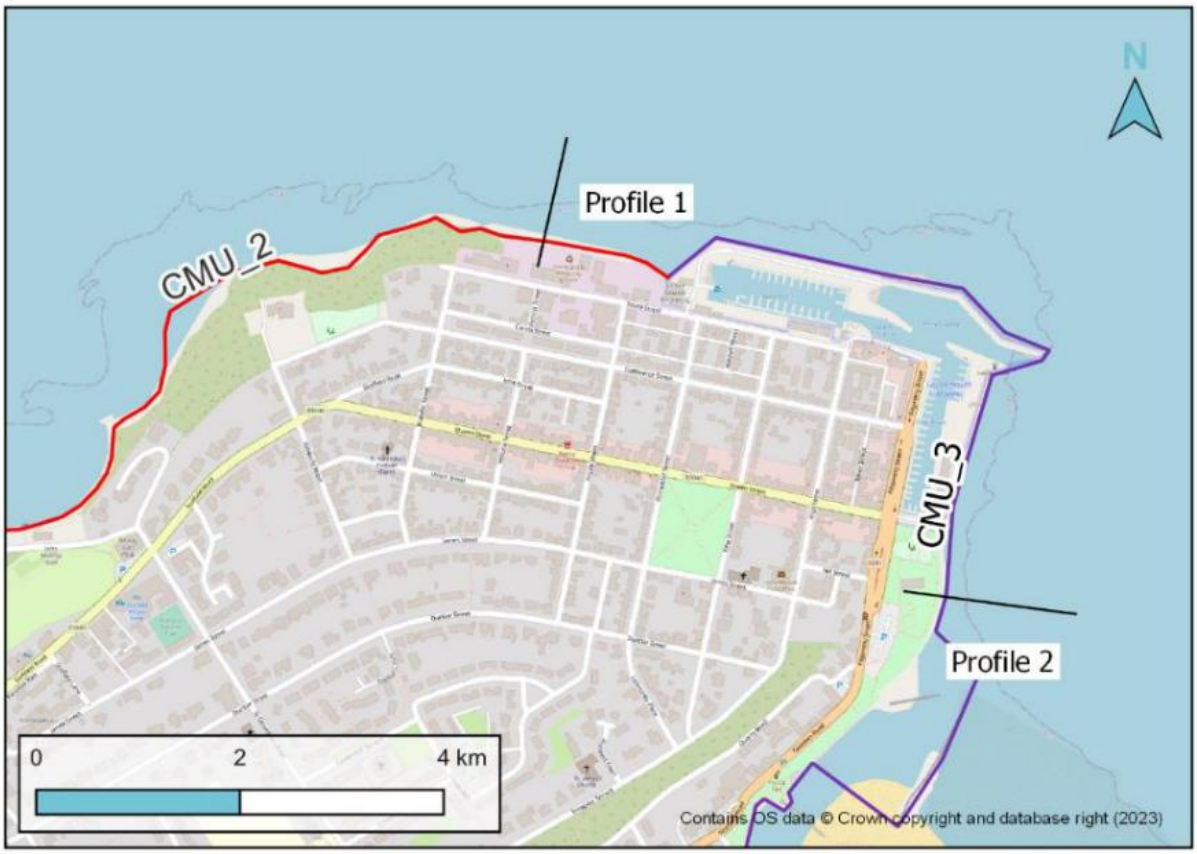


Figure A-4: Lossiemouth overtopping profile locations.

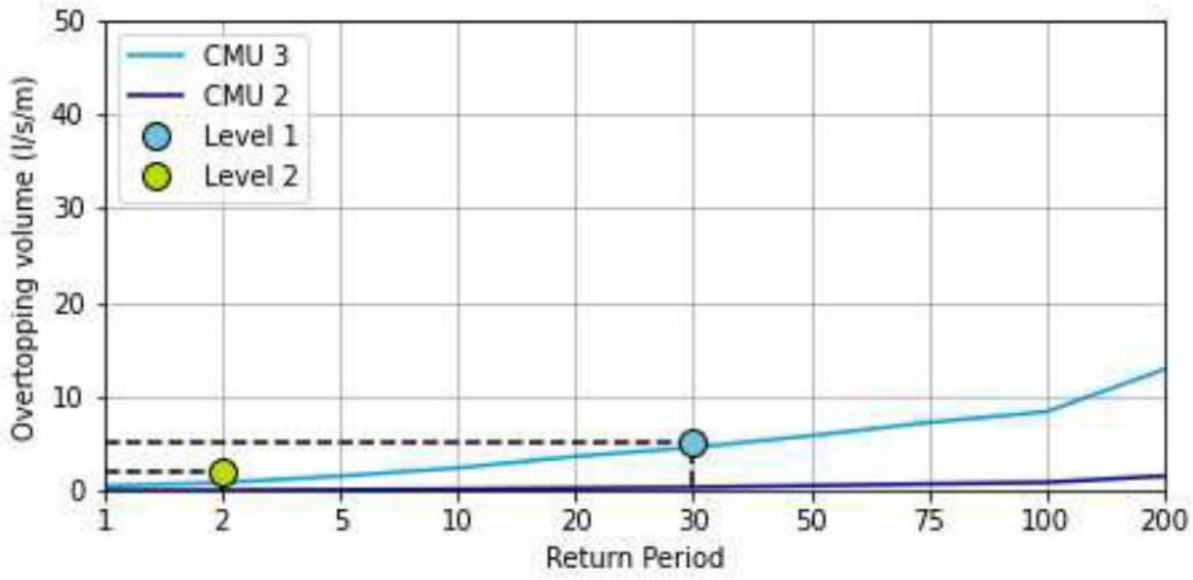


Figure A-5: Overtopping volume estimates for the rock armour in CMU 2 and sea wall in CMU 3 at present day (i.e. a 0.0 m sea level rise projection). Overtopping triggers plotted for 1 in 30-year and 1 in 2-year return period events.

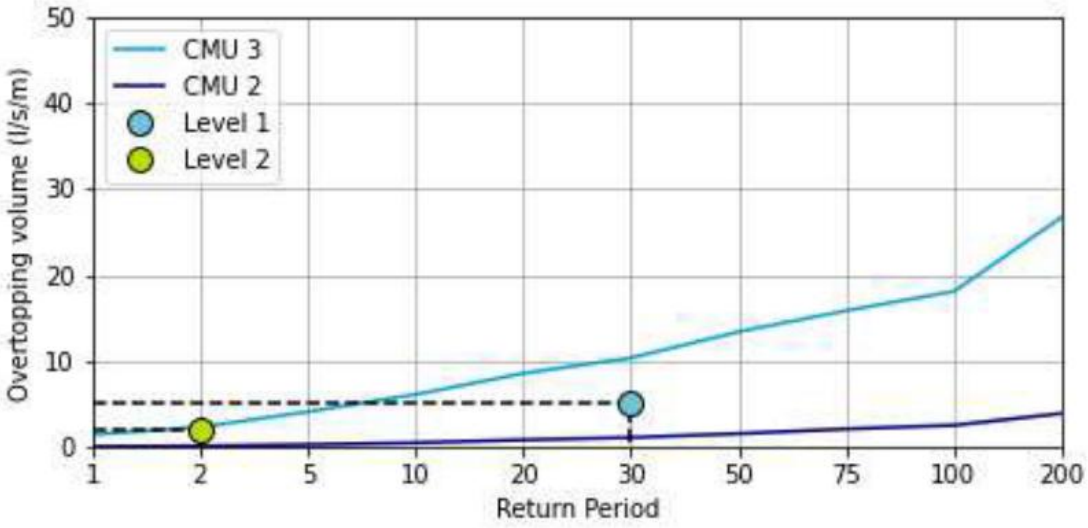


Figure A-6: Overtopping volume estimates for the rock armour in CMU 2 and sea wall in CMU 3 at present day with a 0.2 m sea level rise projection. Overtopping triggers plotted for 1 in 30-year and 1 in 2-year return period events.

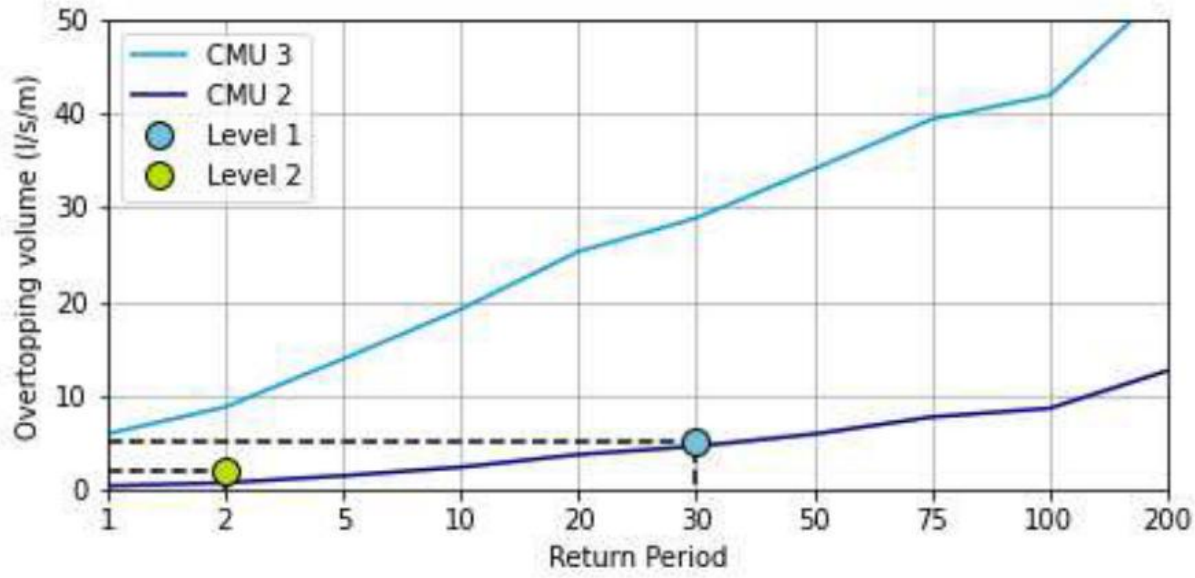


Figure A-7: Overtopping volume estimates for the rock armour in CMU 2 and sea wall in CMU 3 at present day with a 0.5 m sea level rise projection. Overtopping triggers plotted for 1 in 30-year and 1 in 2-year return period events.

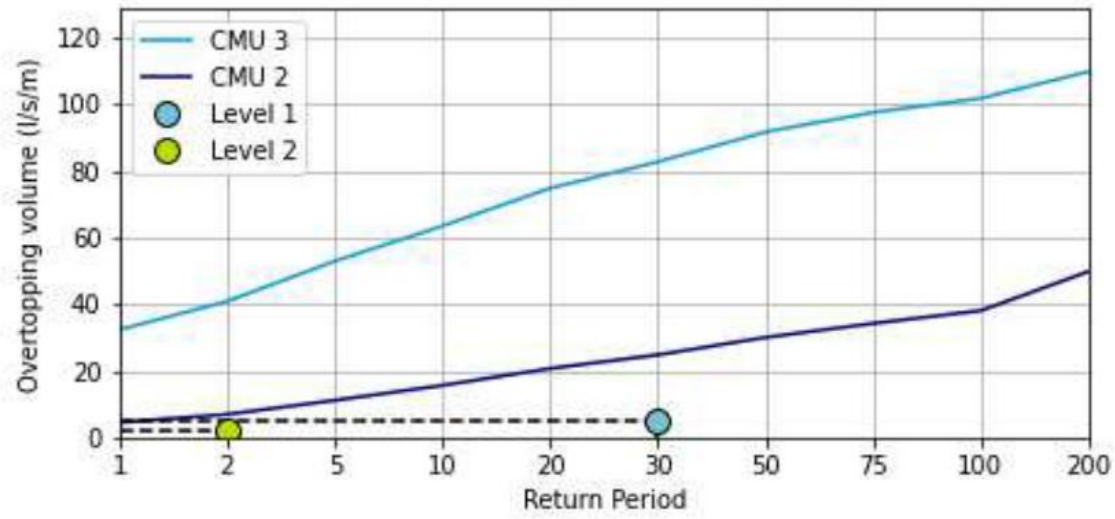


Figure A-8: Overtopping volume estimates for the rock armour in CMU 2 and sea wall in CMU 3 at present day with a 1 m sea level rise projection. Overtopping triggers plotted for 1 in 30-year and 1 in 2-year return period events.

A.4 CMU 3: Harbour town central defended

A.4.1 Dynamic Coast and SEPA

CMU 3 includes Lossiemouth harbour and marina and the eastern edge of Lossiemouth town following Seatown Road, up to and including the Seatown bridge. CMU 3 is entirely defended with hard engineered structures at the harbour, a sea wall and rock armour which currently reduces coastal flood and erosion risks. There is no data on coastal erosion from Dynamic Coast at this CMU, and because of the hard engineered structures in place, it is assumed there is no current risk from erosion at CMU 3. This, however, is dependent on the condition and any future failure of the structure.

The current risk to assets is exclusively from flooding. The 1 in 200-year flooding extent includes areas adjacent to the harbour and marina, including Station Park, and an area of Seatown, west of Spynie Canal, including the road and some properties at Park place, Gregory Place and Seatown Road. Under a 1 in 200-year flood plus climate change event, the flooding extends onto a main section of Seatown Road a larger area of Seatown.

Assets at risk from a 1 in 200-year flooding event are summarised below:

- Six RPs
- Five NRPs
- Pitgaveny Street (ca. 70 m)
- Seatown Road (ca. 90 m)
- Park Place (ca. 66 m)
- Gregory Place (ca. 150 m)
- Two wastewater and water treatment utility points

Assets at risk from a 1 in 200-year flooding plus climate change event include assets at risk from a 1 in 200-year flooding event (shown above) plus assets summarised below:

- Nine RPs
- Two NRPs
- Pitgaveny Street (ca. 30 m)
- Seatown Road (ca. 120 m)

Figure A-9: CMU 3: Harbour town central defended coastal hazards map showing SEPA flooding and Dynamic Coast (DC) past and future erosion. Inset shows CMU without coastal hazards.

A.4.2 CMU 3 overtopping assessment

The overtopping assessment has been undertaken for the vertical sea wall next to the Station Park in CMU 3, south of Lossiemouth harbour. At this location, overtopping volumes have been calculated based on the following profile schematisation:

- Cross-sectional profile of vertical sea wall in CMU 3 (Figure A-4) from 2017 SEPA Mapping study (6 mAOD crest level, 0.5 mAOD toe level, 3.2 mAOD berm level)

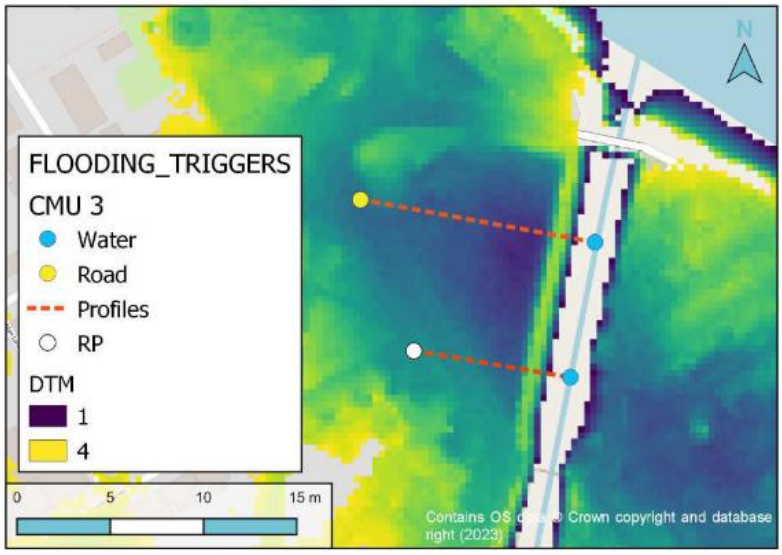
Results from the overtopping assessment for all 4 sea level rise scenarios are shown in Figure A-5 to Figure A-8 and correspond to Table 4-2 in the main text.

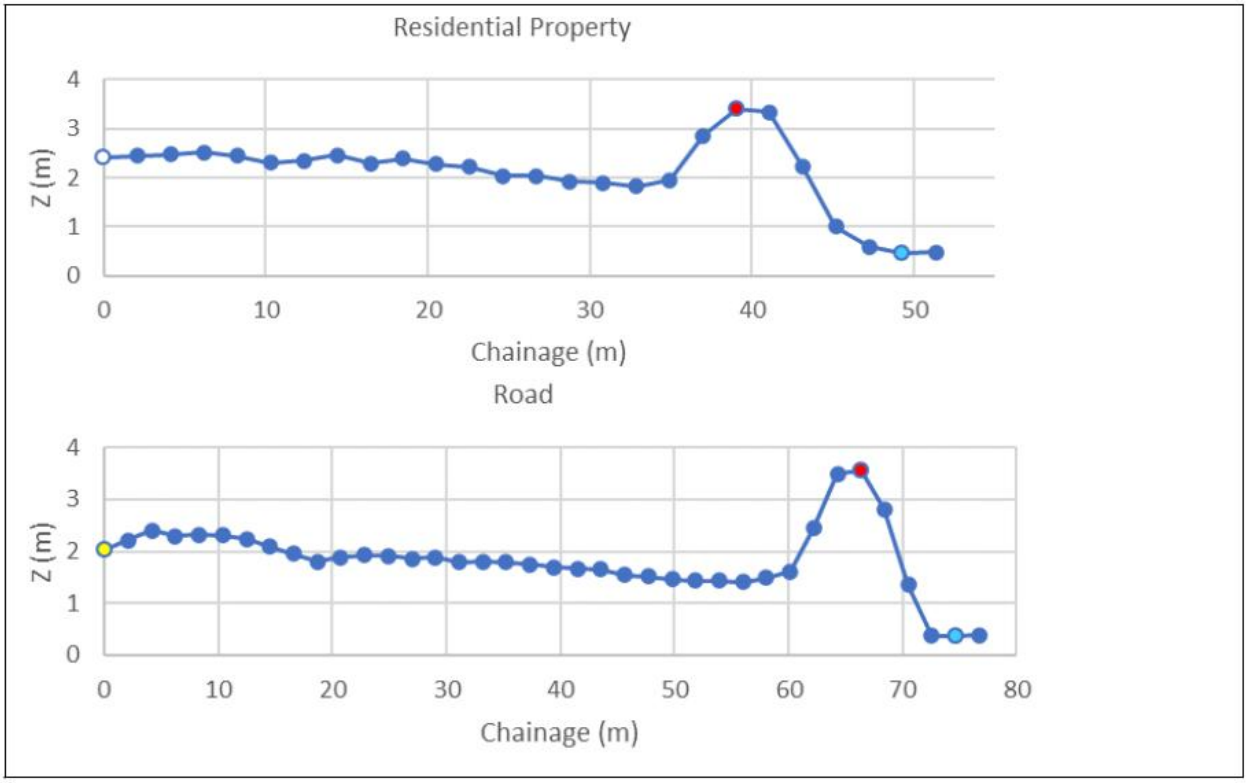
A.4.3 CMU 3 flooding triggers

It is important to note that the elevation of the asset compared to the sea level exceedance frequency is not a true representation of the actual risk of flooding. The risk of flooding is also associated with the elevation of the land surrounding the asset at risk.

As a preliminary investigation, the elevation of assets has been compared to the surrounding topography and likely pathways for flood water. These findings, supported with LiDAR data are summarised below (Table A-4):

Table A-4: CMU 3 property and road flooding trigger summary and comparison to LiDAR.

	Property	Road
Elevation of Asset (m)	2.4	2.0
Max. elevation of (Spynie Canal) bank at profile location (m)	3.4	3.5
LiDAR (2007 Scottish Government)		
		
Elevation profiles		



The pathway for flood water in CMU 3 is likely to follow Spynie Canal and will require breaching (or overtopping) of the canal banks for flooding to occur. The elevation of the banks is at lowest 3.4 mAOD in this area, therefore water levels will need to exceed this level for the property and road to be flooded. This is 1 m higher than the property elevation and 1.4 mAOD higher than the road elevation used for the CMU specific flooding trigger. The risk of flooding to these assets should be investigated further within the flooding trigger level 1 action.

A.5 CMU 4: Seatown central hybrid

CMU 4 is a natural section of coast, where flood and erosion risks are currently alleviated by a natural feature: the sand spit at the mouth of River Lossie in CMU 5. CMU 4, is therefore classified as a hybrid coast. CMU 4 contains Seatown and Lossiemouth Caravan Park and encompassed by two water bodies: the River Lossie to the north-east and Spynie Canal to the south-west. There are assets at risk from coastal erosion in CMU 4, but this is linked to the erosion of the sand spit in CMU 5 and so assets at risk from erosion in CMU 4 will be included in the CMU 5 hazard assessment.

Under a 1 in 200-year flood event, SEPA flood maps show that a large area Seatown (ca. 150 m inland from the bank of the River Lossie) east of the bridge is at risk of flooding. The Lossiemouth Caravan Park is also at risk of flooding; the flooding extent reaches ca. 80 inland at the caravan park. Under a 1 in 200-year flood plus climate change event, the flooding at Lossiemouth Caravan Park extends a further ca. 160 m inland.

Assets at risk from a 1 in 200-year flooding event are summarised below:

- 15 RPs
- Five NRPs
- Multiple roads in Seatown (ca. 400 m)
- Multiple roads/paths at Lossiemouth Caravan Park, including Church Road (ca. 570 m)
- One wastewater and water treatment utility point

Assets at risk from a 1 in 200-year flooding plus climate change event include assets at risk from a 1 in 200-year flooding event (shown above) plus assets summarised below:

- Four RPs
- Three NRPs
- Church Road (ca. 90 m)
- Road/paths at Lossiemouth Caravan Park (ca. 400 m)

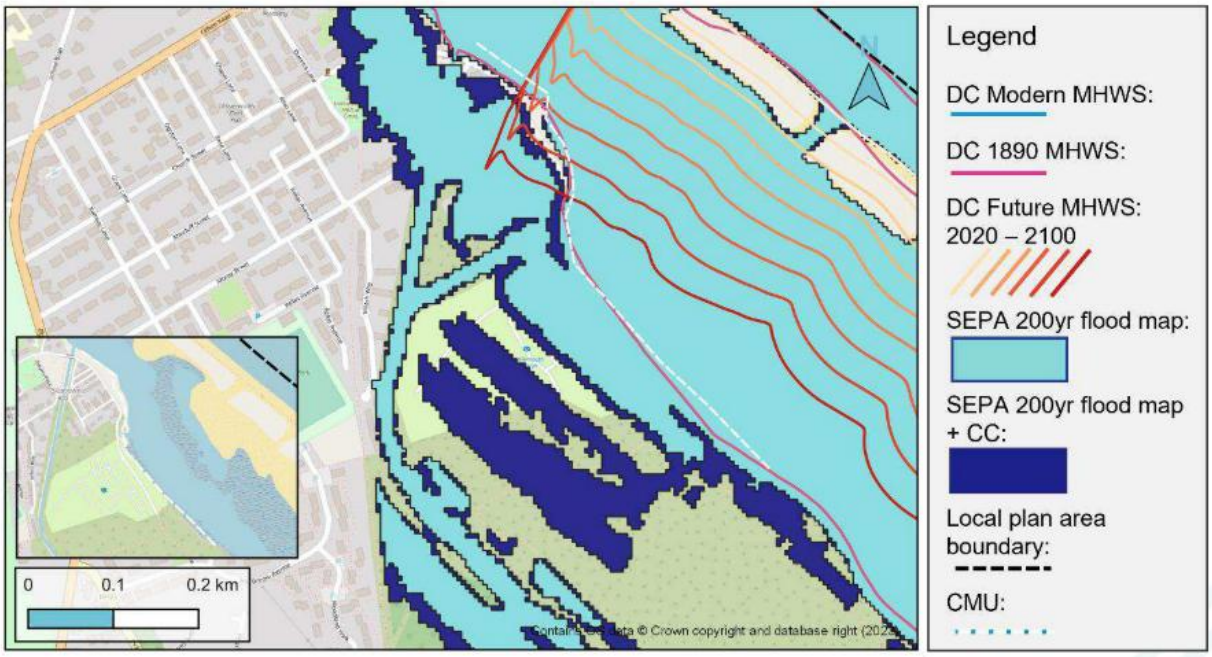


Figure A-10: CMU 4: Seatown central hybrid coastal hazards map showing SEPA flooding extents and Dynamic (DC) past and future erosion. Inset shows CMU without coastal hazards.

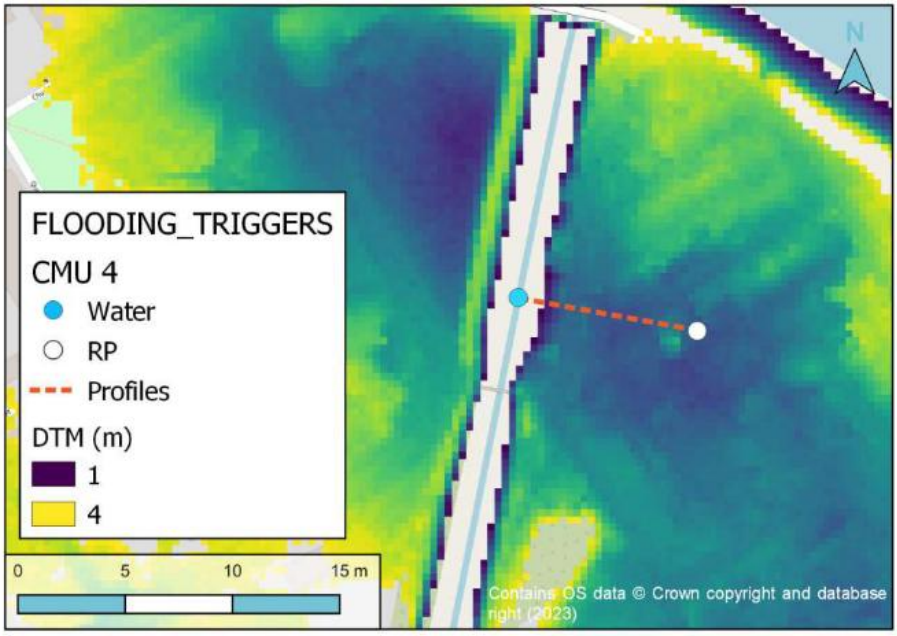
A.5.1 CMU 4 Flooding triggers

It is important to note that the elevation of the asset compared to the tide level exceedance frequency is not a true representation of the actual risk of flooding. The risk of flooding is also associated with the elevation of the land surrounding the asset at risk.

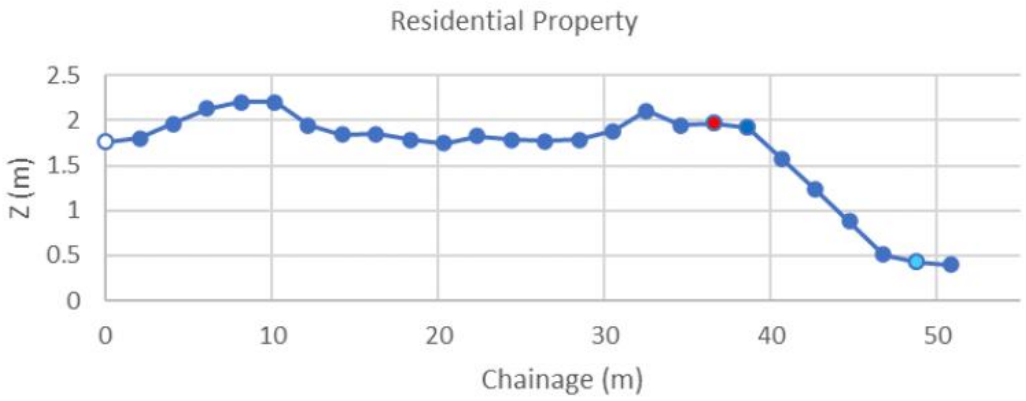
As a preliminary investigation, the elevation of assets has been compared to the surrounding topography and likely pathways for flood water. These findings, supported with LiDAR data, are summarised below (Table A-5):

Table A-5: CMU 4 property flooding trigger summary and comparison to LiDAR.

	Property
Elevation of Asset (m)	1.8
Elevation of (Spynie Canal) bank at profile location (m)	2.0
LiDAR (2007 Scottish Government)	



Elevation profiles



The pathway for flood water in CMU 4 is likely to follow Spynie Canal and will require breaching of the canal banks for flooding to occur. The elevation of the banks is, at lowest, 2.0 mAOD in this area, therefore water levels will need to exceed this level for the property and road to be flooded. This is 0.2 m higher than the property elevation used for the CMU specific flooding

trigger. The risk of flooding to these assets should be investigated further within the flooding trigger Level 1 action.

There is no road flooding trigger for CMU 4 as the lowest road elevations are close to the property flooding trigger and the road is not critical for access. A key road for access in CMU 4 is the road connecting the Lossiemouth Caravan Park in CMU 4 to the main town. This road is at minimum elevation of 3.0 mAOD and therefore, not at immediate risk from flooding.

A.6 CMU 5: Sand spit dunes central natural

A.6.1 Dynamic Coast and SEPA

CMU 5 includes the dynamic natural features of the sand spit and dune system at the mouth of the River Lossie, to the east of Lossiemouth town. The natural features in CMU 5 protect the land and settlements from erosion and flooding in CMU 4. The primary risk at CMU 5 is linked to coastal erosion.

Dynamic Coast data shows that historically (from ca. 1994 to 2017), this sand spit at Lossiemouth to Binn Hill Coast CA eroded rapidly, at a maximum rate of 3.1 m/yr. Maximum future erosion rates are expected to increase even more: to 3.7 m/yr by 2050 and to 4.5 m/yr by 2100. This would result in a maximum 318.0 m of land loss caused by shoreline retreat by 2100.

Table A-6 summarises Dynamic coast data for CMU 5. The assets that are at risk from erosion of the sand spit at CMU 5 are in the area landward of the spit at CMU 4. Assets within the Dynamic Coast erosion vicinity under the High Emission Scenario are summarised below:

- Four NRPs at risk from erosion: minimum 175 m from present-day shoreline
- 25 RPs at risk from erosion: minimum 166 m from present-day shoreline

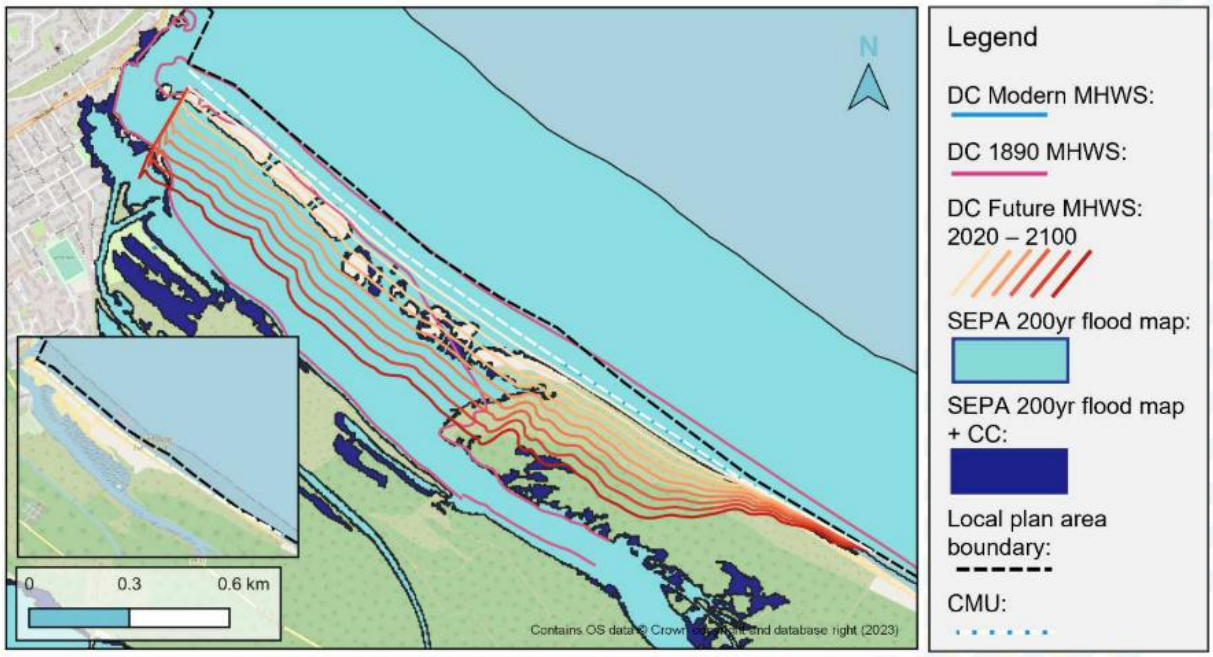


Figure A-11: CMU 5: Sand spit dunes central natural coastal hazards map showing SEPA flooding extents and Dynamic Coast past and future erosion. Inset shows CMU without coastal hazards.

Table A-6: CMU 5 Dynamic Coast erosion summary.

Dynamic Coast calculation	Results	
Historical rate	3.1 m/yr	Maximum
	2.6 m/yr	Median
2050 rate	3.7 m/yr	Maximum
	3.0 m/yr	Median
2050 distance	106.7 m	Maximum
	85.8 m	Median
2100 rate	4.5 m/yr	Maximum
	3.8 m/yr	Median
2100 distance	318.0 m	Maximum
	262.8	Median

A.6.1 Lossiemouth spit dunes topographic survey

In 2022, Moray Council collected topographic survey data on the dune system on the spit located in CMU 5. The dune system in CMU 5 is fronting Seatown in Lossiemouth, located in CMU 4. A 2007 LiDAR survey from the Scottish Government is also considered here[13]. Analysis of this data was used to assess risk and define specific triggers and actions for Lossiemouth to Binn Hill Coast in CMU 5.

A difference plot of the 2007 and 2022 surveys (Figure A-12) shows variable changes in the seaward-facing dune fronts, with some evidence of landward retreat close to Seatown. However, this observed coastal change is informed with only 2 datasets, it is therefore unclear whether observed retreat is a trend or a single post-storm erosion event. More survey is needed to identify longer-term trends.

Dune crest heights were calculated across 69 cross-sections along the dune spit system corresponding to the 2022 topographic survey (Figure A-13). Maximum crest heights of >11 mAOD are located at profiles 22-24 and 14-15. Minimum crest heights of <4 mAOD are located in between the maximum height dunes at profiles 6 and 18.

For profiles 4, 13, 24, 32 and 50 in Figure A-13, cross shore profiles are shown for the years 2007 and 2022 in Figure A-14. The crest location for the profiles 4, 13 and 24 has moved landwards by approximately 9-16 m respectively between 2007 and 2022; this corresponds to an average retreat rate of -1.8–3.2 m/yr for this section of dunes. Profiles 32 and 50 show the accretion in dune sediment occurring in the south-east (Figure A-14).

Dynamic Coast data says that historic rates of shoreline retreat between 1973 and 2015 were median 2.6 m/yr and maximum 3.1 m/yr at the Lossiemouth dunes in CMU 5. The 2022 topographic survey suggest that recent retreat of the dunes is comparable to the historical erosion rates provided by Dynamic Coast.

13 © Crown copyright Scottish Government SEPA, and Scottish Water (2007)

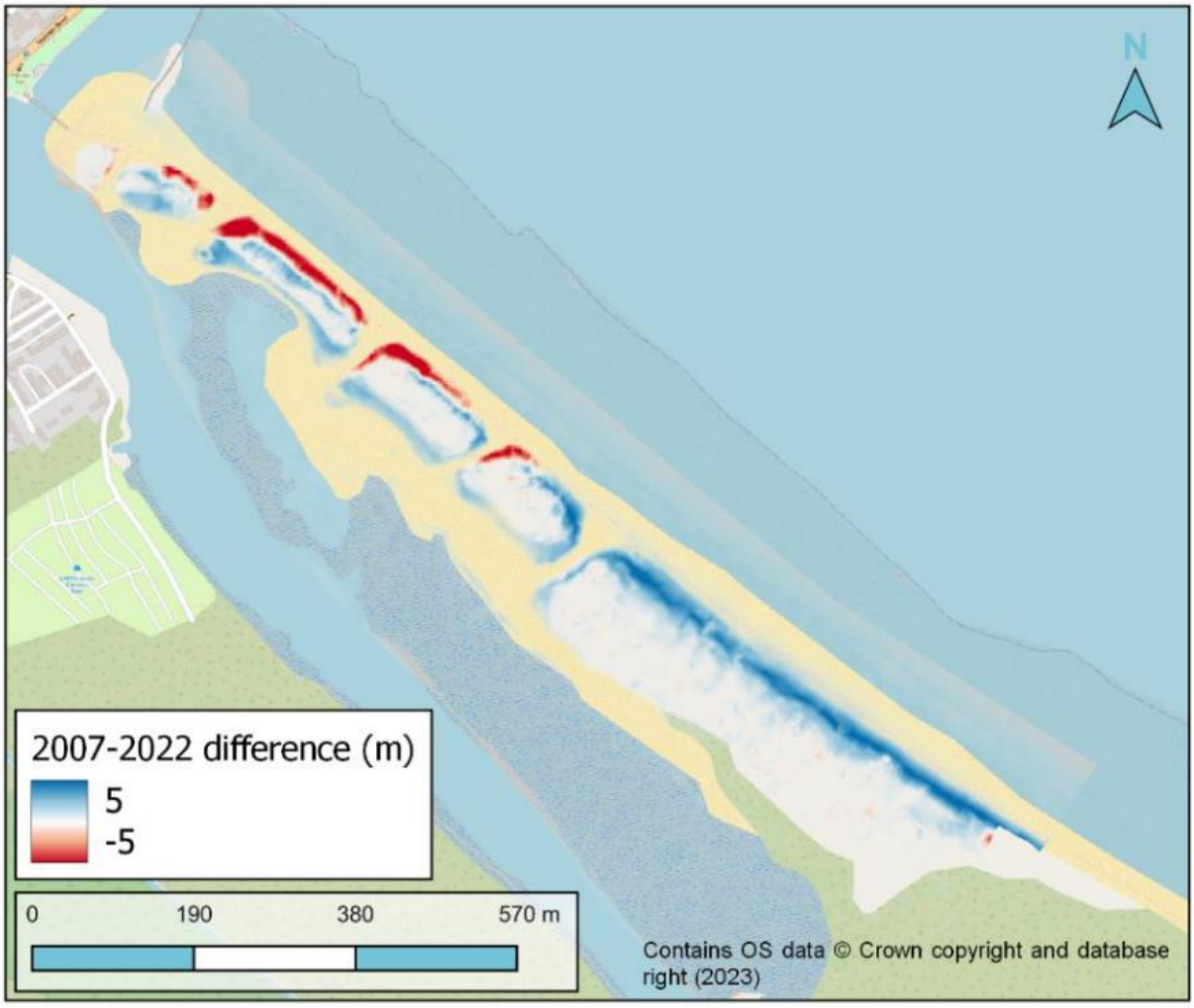


Figure A-12: Lossiemouth dunes difference plot (m) from 2007 to 2022 using Moray Council topographic survey data and LiDAR from SEPA. Red areas indicate negative change and blue areas indicate positive change.

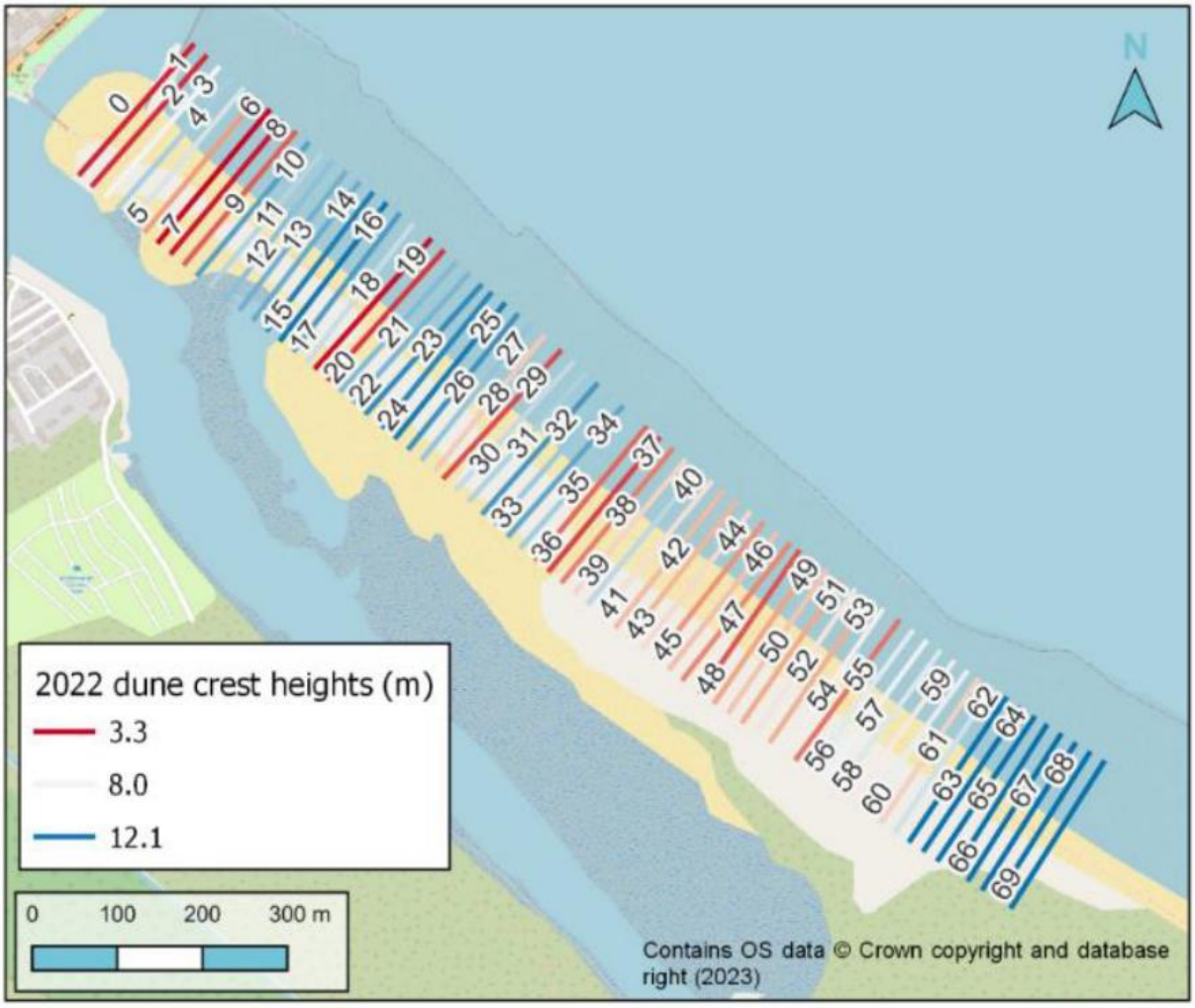


Figure A-13: Cross section profiles (numbers correspond to profile ID) and colour-coded crest heights in 2022. Red profiles indicate lower crest heights (and possibly areas of the dunes that are vulnerable to erosion), blue profiles indicate higher crest heights.

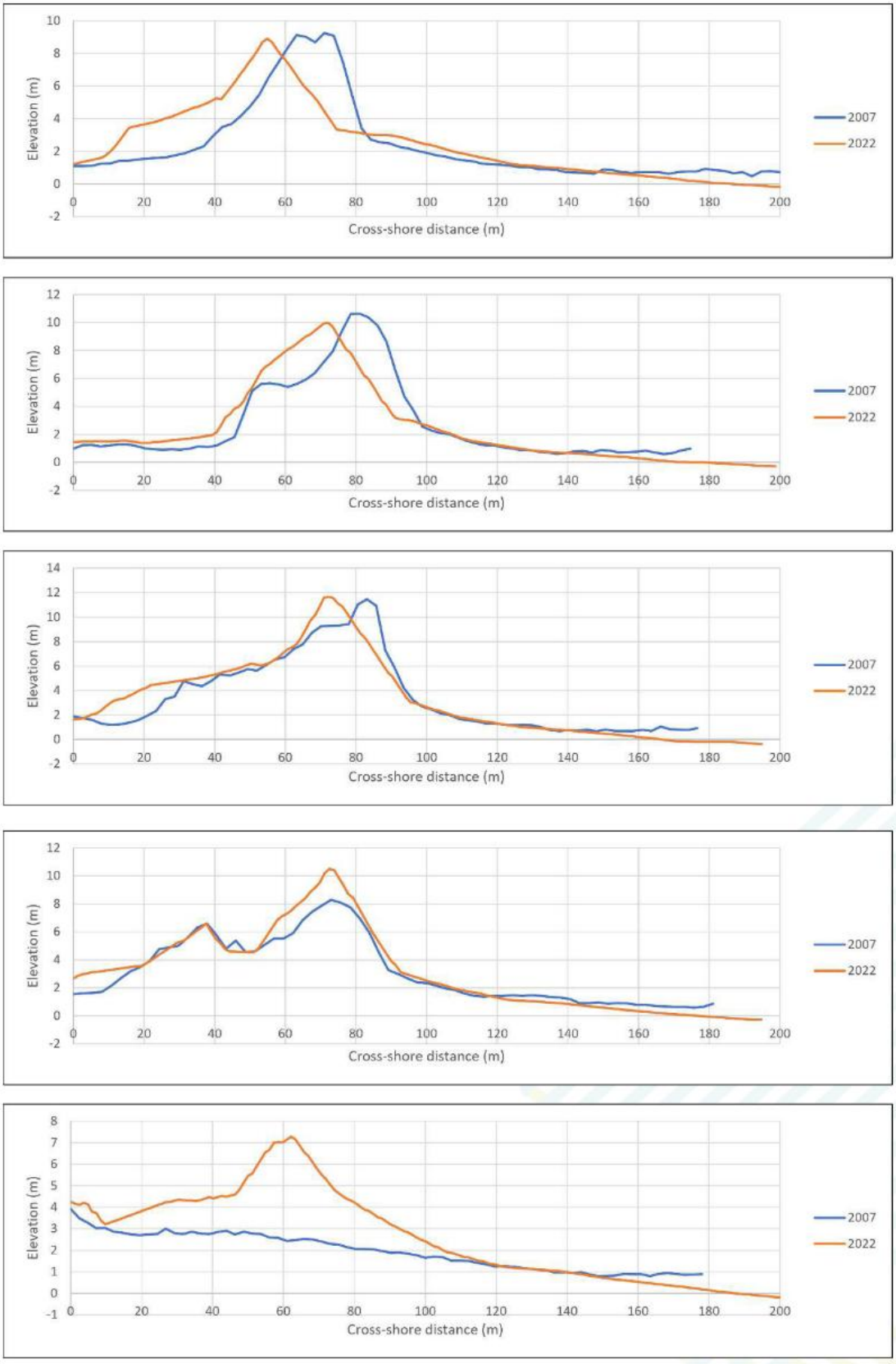


Figure A-14: Cross sections for profiles 4, 13, 24, 32 and 50 as shown in Figure A-9 for years 2007 (LiDAR) and 2022 (Moray Council topographic survey).

A.7 CMU 6: Shingle beach east natural

CMU 6 is a subsection of natural coast to the east of the dunes at the mouth of the River Lossie and is fronted by a shingle beach. The area inland contains woodland and a quarry. SEPA flood maps and NFRA datasets show negligible risk from coastal flooding in this unit to the land and to assets.

Dynamic Coastdata shows that historically (from ca. 1967 to 2011), the coast at CMU eroded at a maximum rate of 0.5 m/yr. Yet, the median historical rate is accretion of 0.3 m/yr. Maximum future erosion rates are expected to increase to 1.1 m/yr by 2050 and to 1.8 m/yr by 2100. This would result in a maximum 103.6 m of land loss caused by coastal retreat by 2100.

Table A-7 summarises Dynamic Coast data for CMU 6. Despite erosion of the land, there are no assets at risk from erosion in CMU 6. The Quarry at CMU 6 is currently 271 m from the present-day shoreline.

Figure A-15: CMU 6: Shingle beach east natural coastal hazards map showing SEPA flooding extents and Dynamic Coast (DC) past and future erosion. Inset shows CMU without coastal hazards.

Table A-7: CMU 6 Dynamic Coast erosion summary.

Dynamic Coast calculation	Results	
Historical rate	0.5 m/yr	Maximum
	+0.3 m/yr (accretion)	Median
2050 rate	1.1 m/yr	Maximum
	0.3 m/yr	Median
2050 distance	26.5 m	Maximum

Dynamic Coast calculation	Results	
	2.9 m	Median
2100 rate	1.8 m/yr	Maximum
	1.0 m/yr	Median
2100 distance	103.6 m	Maximum
	41.8 m	Median

A.8 CMU 7: Inland natural

CMU 7 covers the inland area of the Lossiemouth to Binn Hill Coast CA, there is therefore no direct risk of coastal erosion for this CMU. The boundary of CMU 7 is informed with the SEPA flood maps and so follows key water courses in the Lossiemouth to Binn Hill Coast CA: River Lossie, Spynie Canal, Loch Spynie and Innes Canal. CMU 7 also contains Milltown Airfield, Caysbriggs Quarry, Oakenhead Wood, a section of the A941, B9103 and B9012.

The 1 in 200-year flooding extent follows River Lossie and Innes Canal, flooding parts of the B9103 road and ca. 1.6 km^2 of land surrounding the Milltown Airfield. The 1 in 200-year flooding extent also follows the Spynie Canal and linked water networks. A significant area, of ca. 11.8 km^2, is at risk of flooding. This includes section of the A941, B9012, other minor roads, properties, woodland, and agricultural land. Under a 1 in 200-year flood plus climate change event, the flooding perimeter is extended, by at most ca. 800 m at the Milltown Airfield.

Key assets at risk from a 1 in 200-year flooding event are summarised below:

- Ten RPs
- 22 NRPs
- A941 (ca. 430 m)
- B9103 (ca. 1.2 km)
- B9012 (ca. 1 km)

Key assets at risk from a 1 in 200-year flooding plus climate change event include assets at risk from a 1 in 200-year flooding event (shown above) plus assets summarised below:

- Three RPs
- 11 NRPs
- A941 (~950 m)

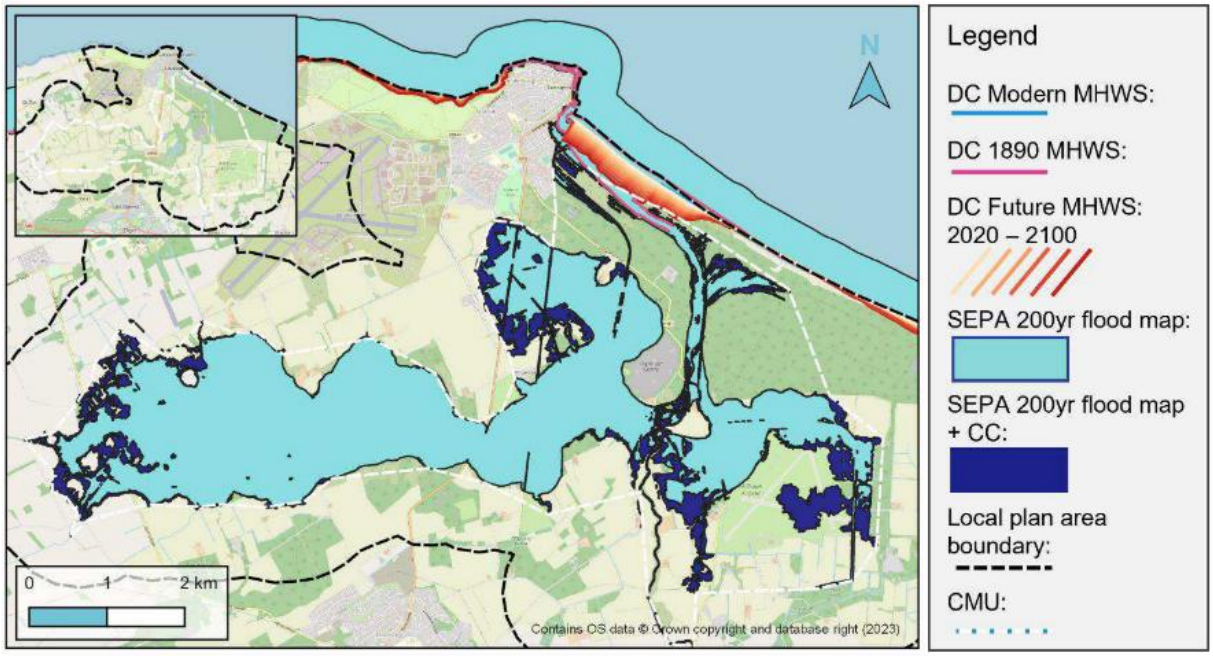


Figure A-16: CMU 7: Inland natural coastal hazards map showing SEPA flooding extents and Dynamic Coast (DC) past and future erosion. Inset shows unit without coastal hazards.

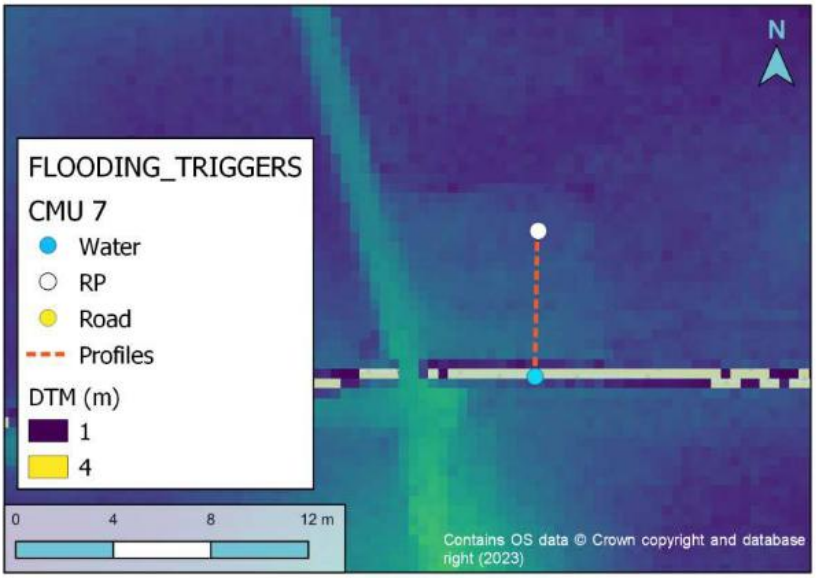
A.8.1 CMU 7 flooding triggers

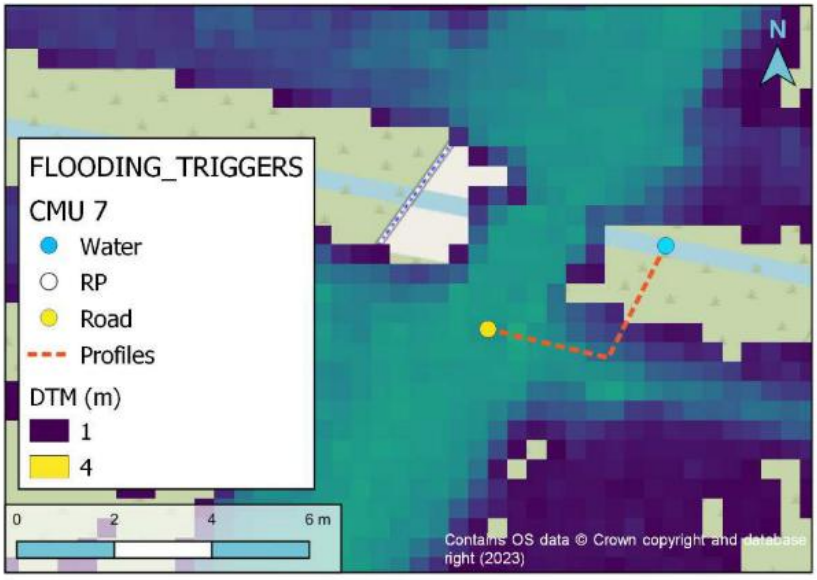
It is important to note that the elevation of the asset compared to the tide level exceedance frequency is not a true representation of the actual risk of flooding. The risk of flooding is also associated with the elevation of the land surrounding the asset at risk.

As a preliminary investigation, the elevation of assets has been compared to the surrounding topography and likely pathways for flood water. These findings, supported with LiDAR data are summarised below (Table A-8):

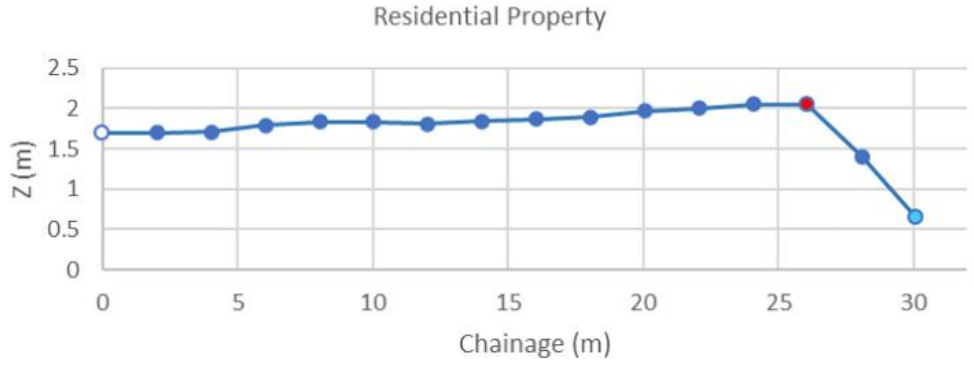
Table A-8: CMU 7 property and road flooding trigger summary and comparison to LiDAR.

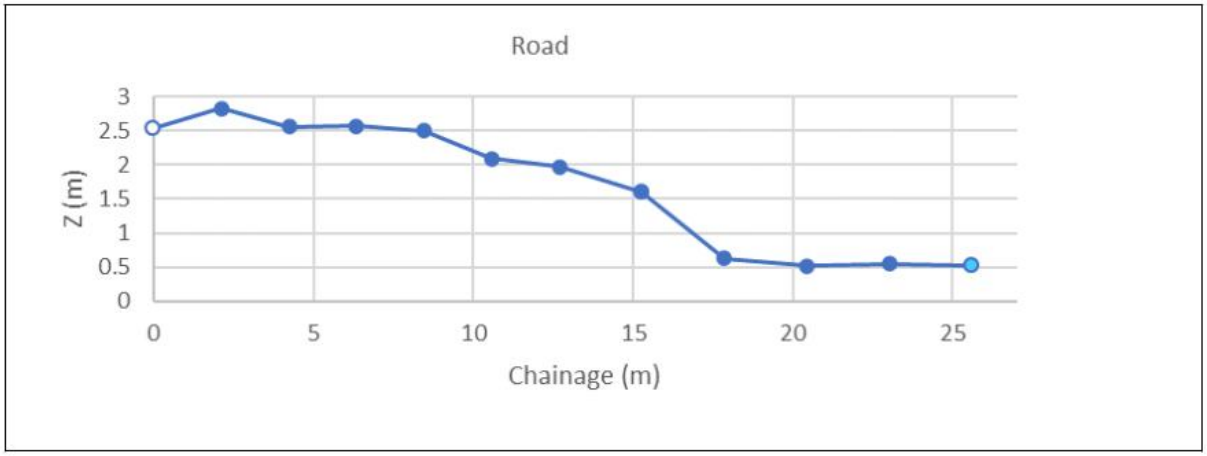
	Property	Road
Elevation of Asset (m)	1.7	2.5
Elevation of (Spynie Canal) bank at profile location (m)	2.0	2.5
LiDAR (2007 Scottish Government)		





Elevation profiles





The pathway for flood water in CMU 7 is likely to follow Spynie Canal and will require breaching or overtopping of the canal banks for flooding to occur. The elevation of the banks is, at lowest, 2.0 mAOD in the area closest to the residential property at risk, therefore water levels will need to exceed this level for the property to be flooded. This is 0.3 m higher than the property used for the CMU specific flooding trigger.

For the road flooding trigger in CMU 7, a section of the A941 is used, with an elevation of 2.5 mAOD. There is no topographic barrier with a higher elevation between the canal and road in this location to mediate flood risk.

B Proactive Actions

Action 1 – Investigate opportunities for dune enhancement.

The dune system in CMU5 provides one of the major defences against coastal flooding and erosion to Lossiemouth to Binn Hill Coast. Analysis of the data has shown this to be extremely dynamic, variable and, based on Dynamic Coast data, retreating rapidly. The variability in profile shape and geometry means that areas are potentially vulnerable to overwash and will reduce the protection offered to Seatown.

While some retreat of the system is likely inevitable under rising sea levels, to delay this from being realised, and increase the resilience, opportunities for enhancement should be explored.

This should primarily involve aspects around re-profiling, planting and vegetation enhancement, and public access to the beach. Opportunities for biodiversity and environmental enhancement should be identified within a wider programme with opportunities for delivery through community initiatives explored. This will not only support engagement but may reduce ongoing maintenance burden on Moray Council.

Action 2 – Develop modelling framework to support future assessments

Implementation of effective future risk assessments will require investment in numerical (or similar) modelling tools that can effectively and efficiently quantify flood and erosion risk. A modelling framework should be developed that includes:

- Statistical extremes
- Wave transformation
- Morphodynamics and erosion
- Flood inundation

Action 3 – Investigate opportunities for habitat creation on the Spynie Canal

Assessment of the flood risk and topography along the Spynie Canal have identified embankments that are preventing sea water inundation of the adjacent land. Future flood extents from SEPA show that these areas are below future extreme sea levels and will likely become inundated from coastal flooding.

The current condition and ownership of these embankments are unclear. The available information is indicating an opportunity to understand the potential for habitat creation through change of management practices of these embankments. This should be explored (in conjunction with Action 2) to understand the potentially to improve the sustainability in the coastal reach of the Spynie Canal.

Action 4 – Establish coordinated and consistent beach monitoring plan for Natural CMUs.

The requirements for monitoring the beach systems in the CA should be reviewed in the context of a wider Regional monitoring plan. Information should be collected through monitoring that is specific to support future risk assessments and compared to CMU specific erosion triggers. It should focus across the entire CA but increase in frequency and detail for CMU 2 where predicted risk associated with erosion and coastal change is greatest.

Action 5 – Adaptation and resilience workshop with local community and stakeholders

Adaptation to coastal change is not solely about physical interventions in coastal communities. Community and individual responsibility to increase resilience and adapt to coastal hazards is of paramount importance.

The outcomes of this initial phase of the CCAP should be presented to the community and stakeholders alongside consideration for wider support and education around climate awareness and flood resilience.

Action 6 – Identify landownership and safeguarding

To work with natural processes and make space for coastal change it is inevitable that existing land will be lost. To adapt effectively it is therefore important that land and asset ownership within the CA is fully understood to enable safeguarding of areas. This should feed into revisions of the wider Moray Council Local Development Plan.

C Trigger and Action Database

Table C- 1: Phase 0 Trigger and Action database for Lossiemouth to Binn Hill coast.

Community Area (CA)	CMU	Coast Type	Trigger Type	Asset Affected	Asset Description	Trigger Level	Trigger Exceeded?	Trigger Buffer Flooding (Freq/10 yr)	Trigger Buffer Overtopping (SLR m)	Trigger Buffer Erosion (m)	Action	Owner	Delivery Partners	Timescale	Cost
Lossiemouth To Binn Hill Coast	1	Natural	Erosion	Property		1	N			60	None	NA	NA	NA	NA
						2	N			70	None	NA	NA	NA	NA
				Other	Caravan Park	1	N			24	None	NA	NA	NA	NA
						2	N			27	None	NA	NA	NA	NA
				Other	Golf Course	1	N			6	None	NA	NA	NA	NA
						2	N			9	None	NA	NA	NA	NA
	2	Hybrid	Erosion	Property		1	Y			-10	Increase monitoring and plan for assessment.	Moray Council	None	Short	Low
						2	Y			0	Undertake assessment and plan for intervention.	Moray Council	Scot. Gov.	Medium	Medium
				Road		1	N			19	None	NA	NA	NA	NA
						2	N			22	None	NA	NA	NA	NA
				Other	Carpark	1	Y			-1	Increase monitoring and plan for assessment.	Moray Council	None	Short	Low
						2	N			2	None	NA	NA	NA	NA
			Overtopping	Defence	Rock armour	1	N		1		None	NA	NA	NA	NA
						2	N		1		None	NA	NA	NA	NA
			Condition	Defence	Mixed	1	N				None	NA	NA	NA	NA
						2	N				None	NA	NA	NA	NA
	3	Built Structures	Flood	Property		1	Y	-343			Increase monitoring and plan for assessment.	Moray Council	None	Short	Low
						2	Y	-340			Undertake assessment and plan for intervention.	Moray Council	Scot. Gov.	Medium	Medium
				Road		1	Y	-477			Increase monitoring and plan for assessment.	Moray Council	None	Short	Low
						2	Y	-472			Undertake assessment and plan for intervention.	Moray Council	Scot. Gov.	Medium	Medium
			Overtopping	Defence	Sea wall	1	N		0.2		None	NA	NA	NA	NA
						2	N		0.2		None	NA	NA	NA	NA
			Condition	Defence	Harbour	1	N				None	NA	NA	NA	NA
						2	N				None	NA	NA	NA	NA
	4	Hybrid	Flood	Property		1	Y	-1328			Increase monitoring and plan for assessment.	Moray Council	None	Short	Low
						2	Y	-1325			Undertake assessment and plan for intervention.	Moray Council	Scot. Gov.	Medium	Medium
	5	Natural	Erosion	Property		1	N			104	None	NA	NA	NA	NA
						2	N			135	None	NA	NA	NA	NA
				Road		1	N			147	None	NA	NA	NA	NA
						2	N			156	None	NA	NA	NA	NA
				Other	Caravan Park	1	N			249	None	NA	NA	NA	NA
						2	N			258	None	NA	NA	NA	NA
	6	Natural	Erosion	Other	Quarry	1	N			266	None	NA	NA	NA	NA
						2	N			269	None	NA	NA	NA	NA
	7	Natural	Flood	Property		1	Y	-1454			Increase monitoring and plan for assessment.	Moray Council	None	Short	Low
						2	Y	-1451			Undertake assessment and plan for intervention.	Moray Council	Scot. Gov.	Medium	Medium
				Road		1	Y	-34			Increase monitoring and plan for assessment.	Moray Council	None	Short	Low
						2	Y	-29			Undertake assessment and plan for intervention.	Moray Council	Scot. Gov.	Medium	Medium

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BD23 3FD
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+44(0)1756 799919
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