

Catterline Coastal Erosion Study

2022 CBAG AGM

Wednesday 16th November 2022

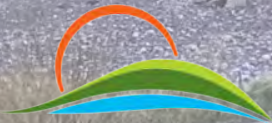
JBA
consulting

Demetra Cristaudo

Katie Corbett

Marine & Coastal Risk Management Team

JBA Consulting



CBAG

Catterline Braes Action Group

Outline

Study undertaken by JBA

- Coastal erosion assessment
- Economic evaluation
- Coastal protection measures
- Conclusions and recommendations

CoastSnap - Community Beach Monitoring

- What is CoastSnap?
- Catterline CoastSnap Station

Work Commissioned to JBA

Scope of the Project

Overall objective:

Provide evidence to support a future business case for future funding applications, needed to implement coastal erosion solutions to protect Catterline Bay, the infrastructure and the village

Scope:

1. Review of the historic changes & ongoing erosion
2. Assess future beach erosion and cliff retreat as a result of wave action and rising sea-levels (climate change)
3. Quantify the economic value of the Bay and access to the beach
4. Recommend a variety of options to increase resilience of the cliff to climate change

Coastal Erosion Assessment

A decorative graphic element on the right side of the slide, consisting of overlapping triangles and quadrilaterals filled with diagonal lines in shades of blue and green.

Coastal Erosion Assessment

The Coastal Erosion Assessment included:

- **Historic changes**
 - Ongoing erosion
- **Long-term prediction (Sea Level Rise)**
 - Cliff retreat due to sea level rise
- **Short-term prediction (Storm events)**
 - Bay vulnerability
 - Estimating beach response during storms

Site overview

Cliff

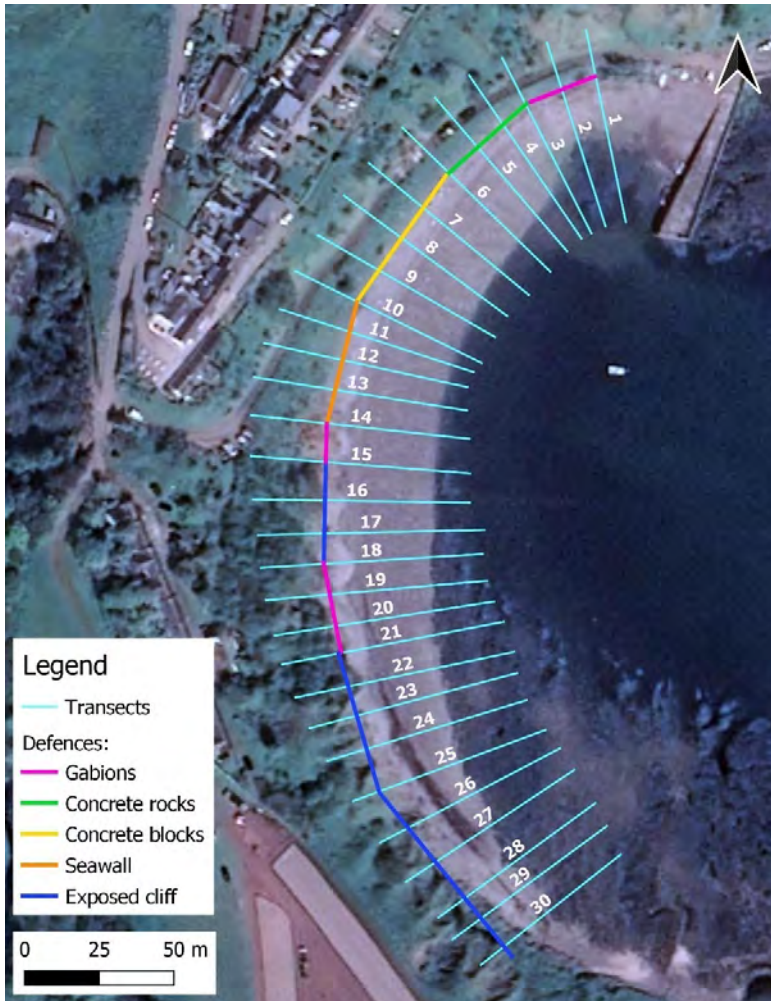
Shingle beach

Sandy bed

Coastal defences



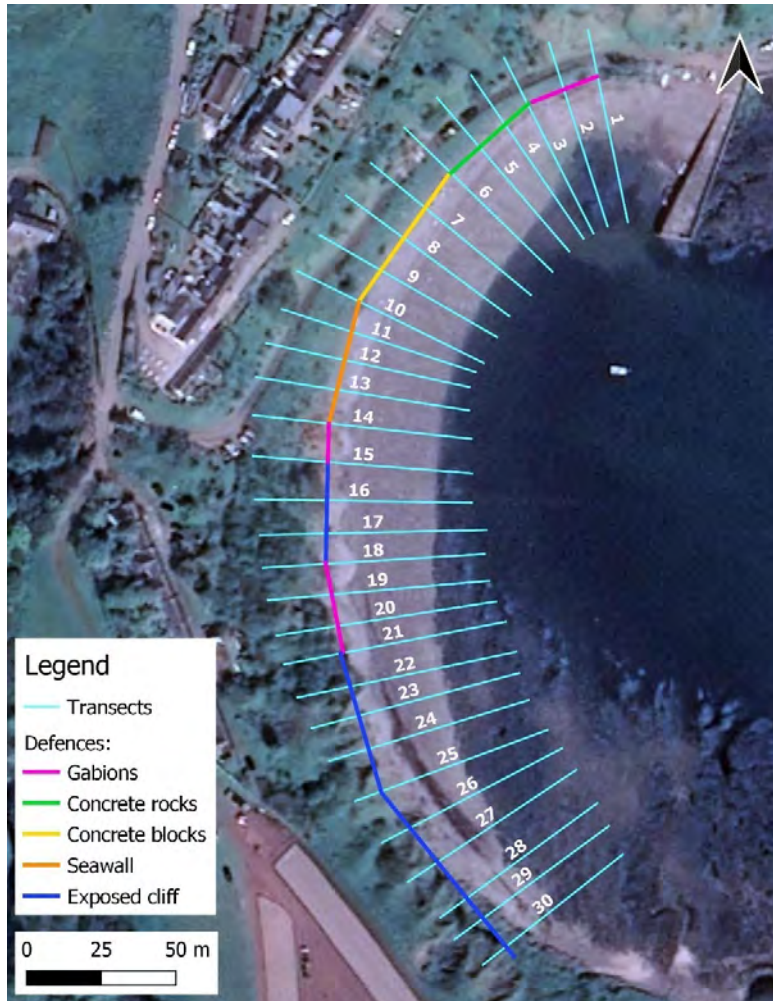
Site overview



Gabions



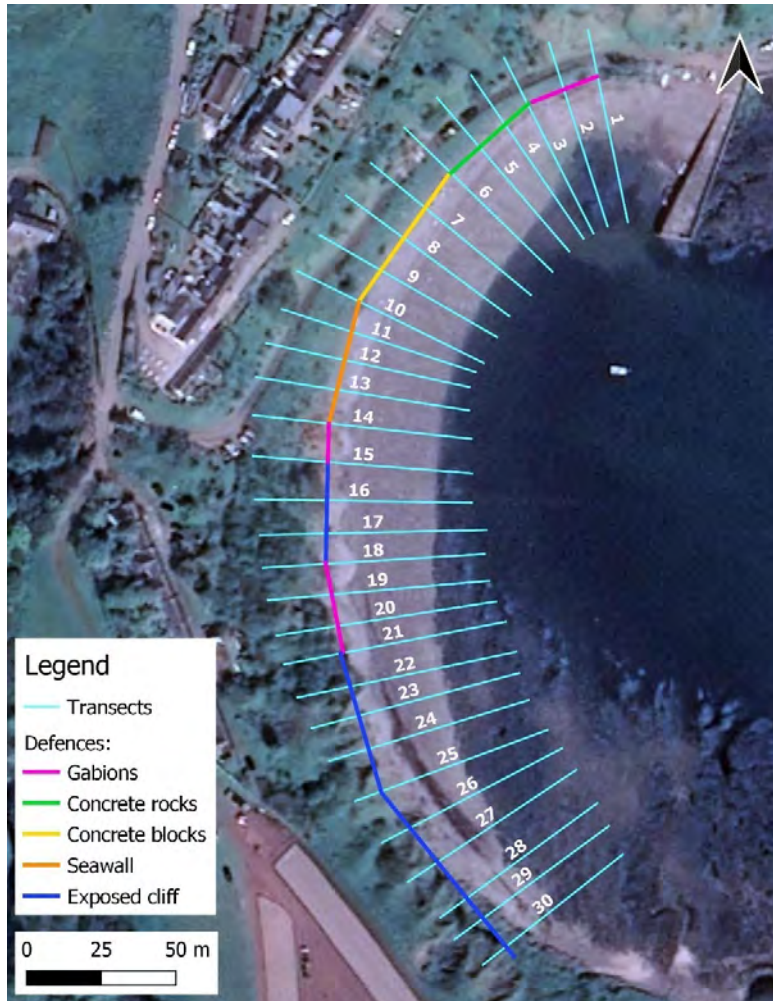
Site overview



Concrete rocks and blocks



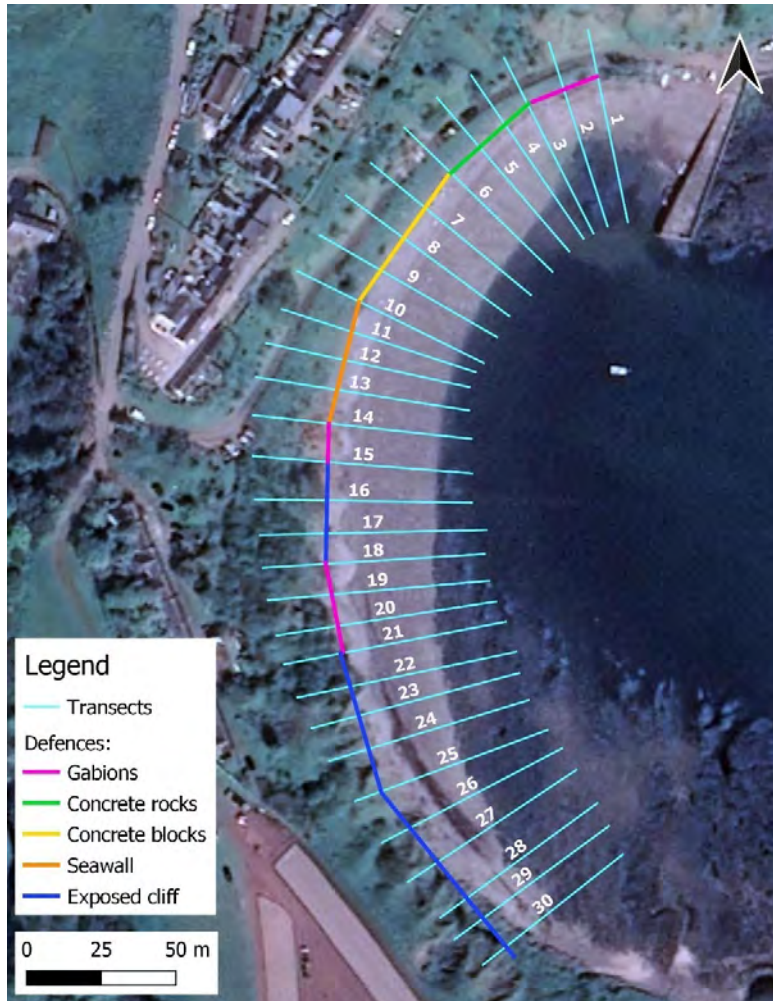
Site overview



Seawall



Site overview



Exposed cliff



Data

- 3D models of topographic surveys
- Historic record (2016, 2018-2022)
- Thanks to John Howell!



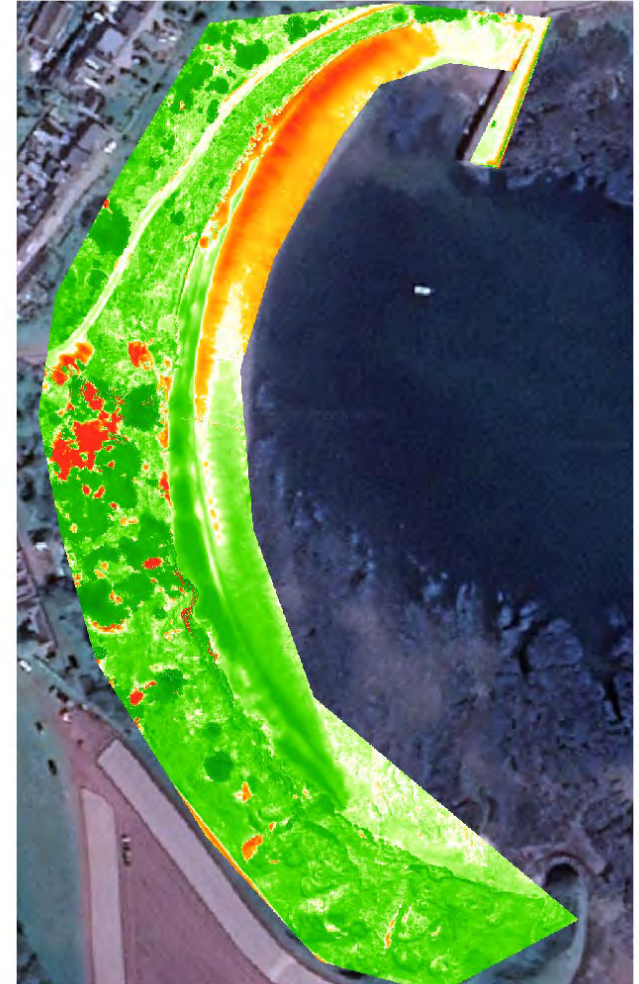
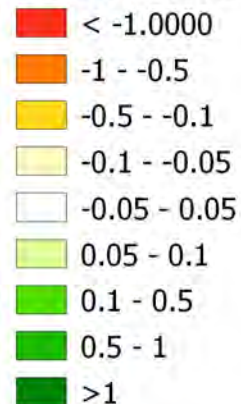
Surveys conducted and provided by the
University of Aberdeen

Historic changes

Overall changes

- Differences in elevation - 2016 to 2022
- Cliff
 - Vegetation included
- Shingle beach
 - North – Erosion
 - Centre – Stable
 - South – Accretion

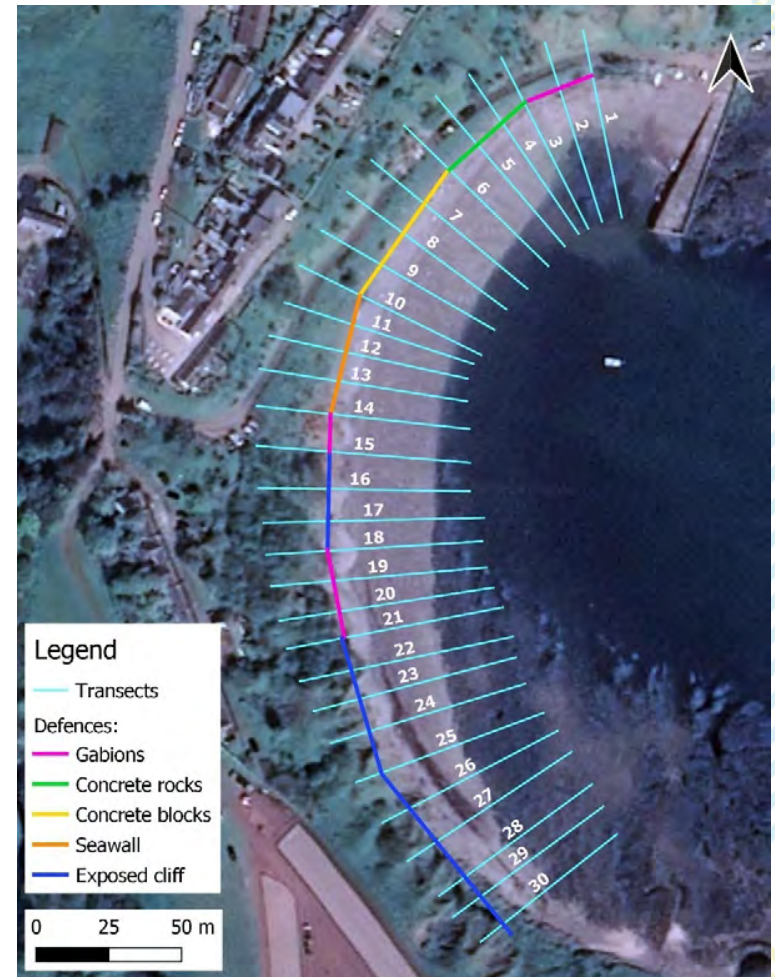
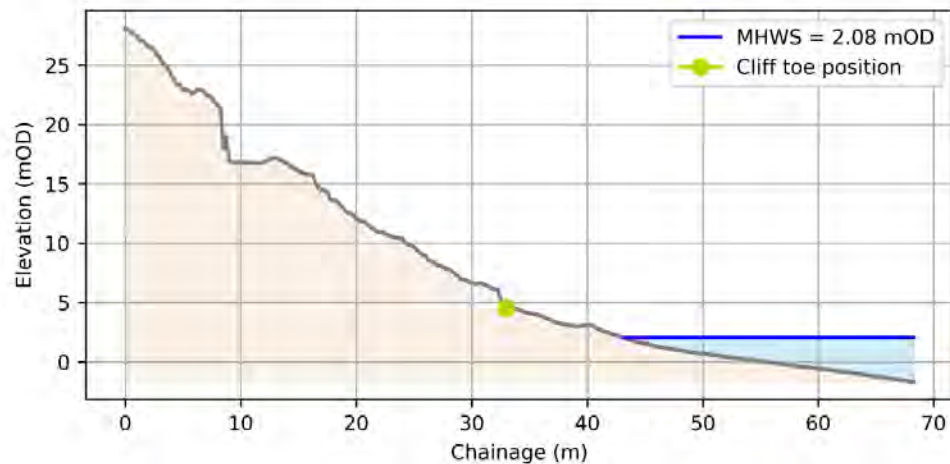
Erosion (-) / Accretion (+) m



Historic changes

Cliff toe change

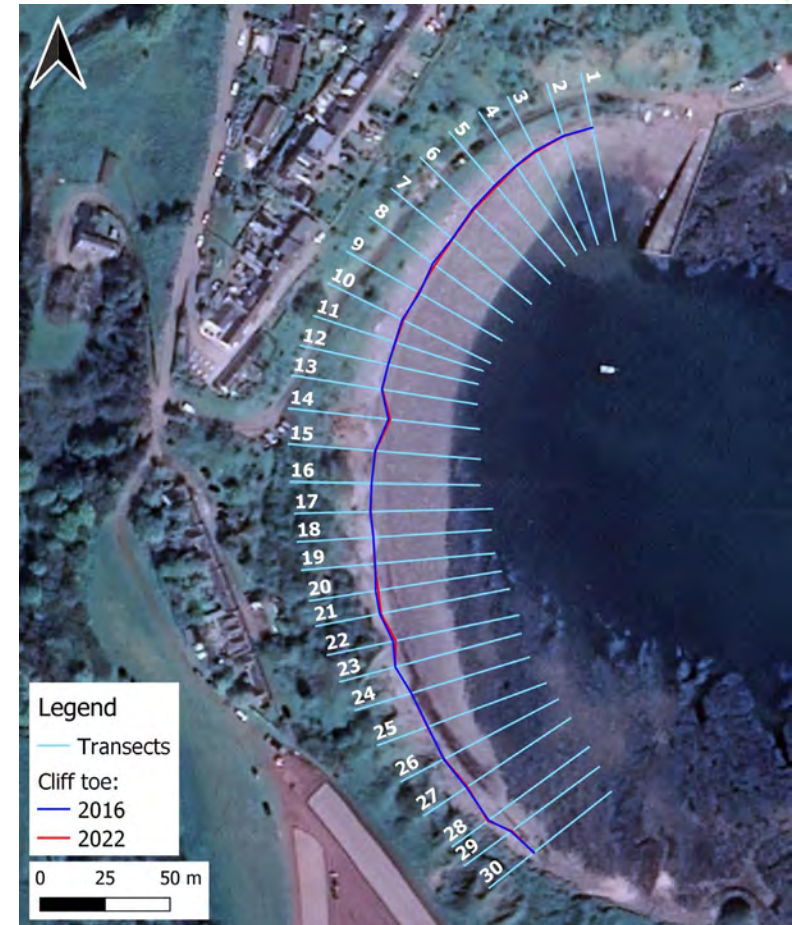
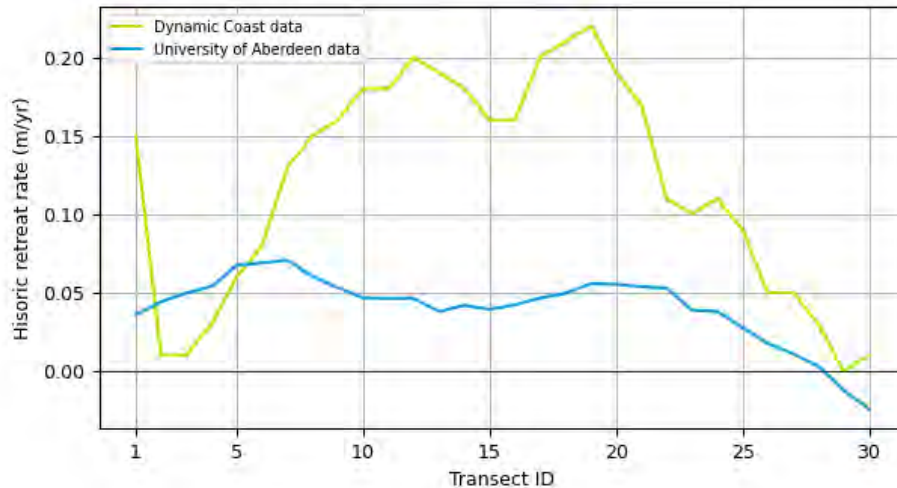
- Cross-shore transects
- Cliff toe identification for 30 transects



Historic changes

Cliff toe change

- Differences in elevation between 2016 and 2022
- Historic retreat rate - accreting



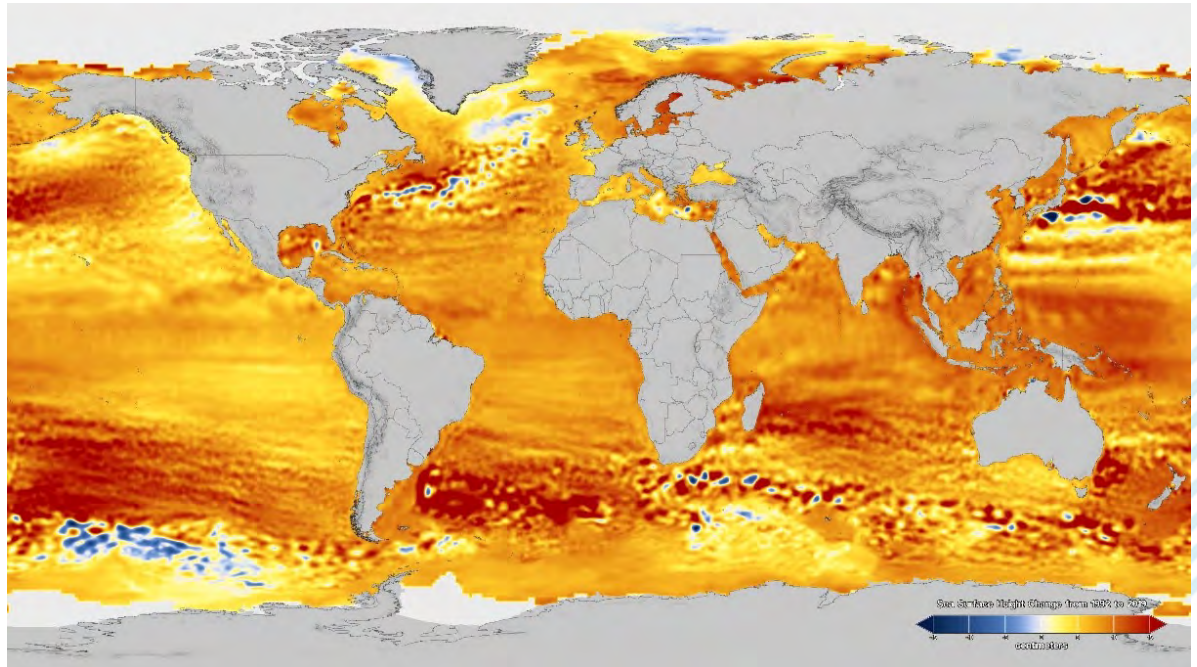
Long-term prediction

Sea Level Rise

Changes to the level of the sea surface due to:

- Addition of water from melting ice and glaciers
- Ocean expansion as water temperature increase
- Changes to land water storage
- Local changes, site specific

Flood and erosion risk
is expected to increase

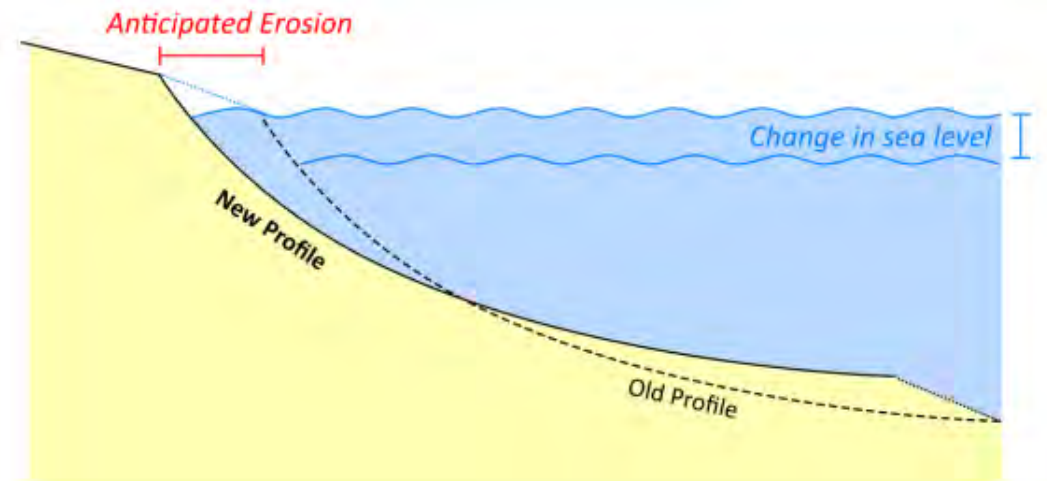


Regional sea level change between 1992 and 2019 based on satellite altimeter measurements. Blue areas indicate sea level fall, and orange/red areas indicate sea level rise. Credit: NASA

Long-term prediction

Bruun rule

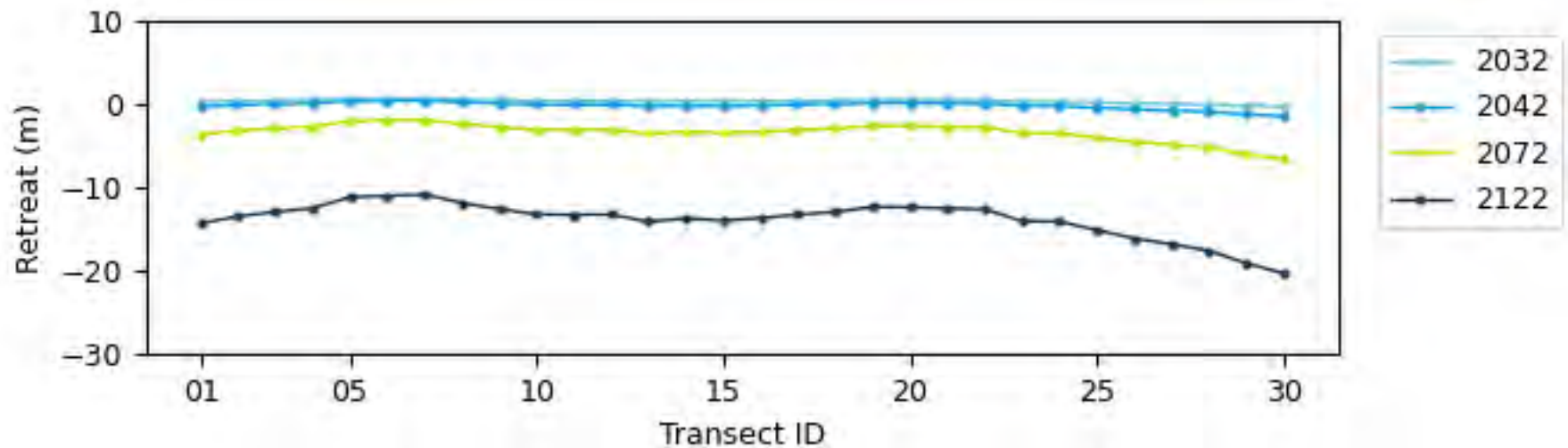
- Equilibrium profile and volume conservation
- Only including the change in sea level



Epoch	Sea Level Rise (m)
2032	0.04
2042	0.10
2072	0.32
2122	0.81

Long-term prediction

Results: retreat distances



Long-term prediction

2032 & 2042

Minimal changes

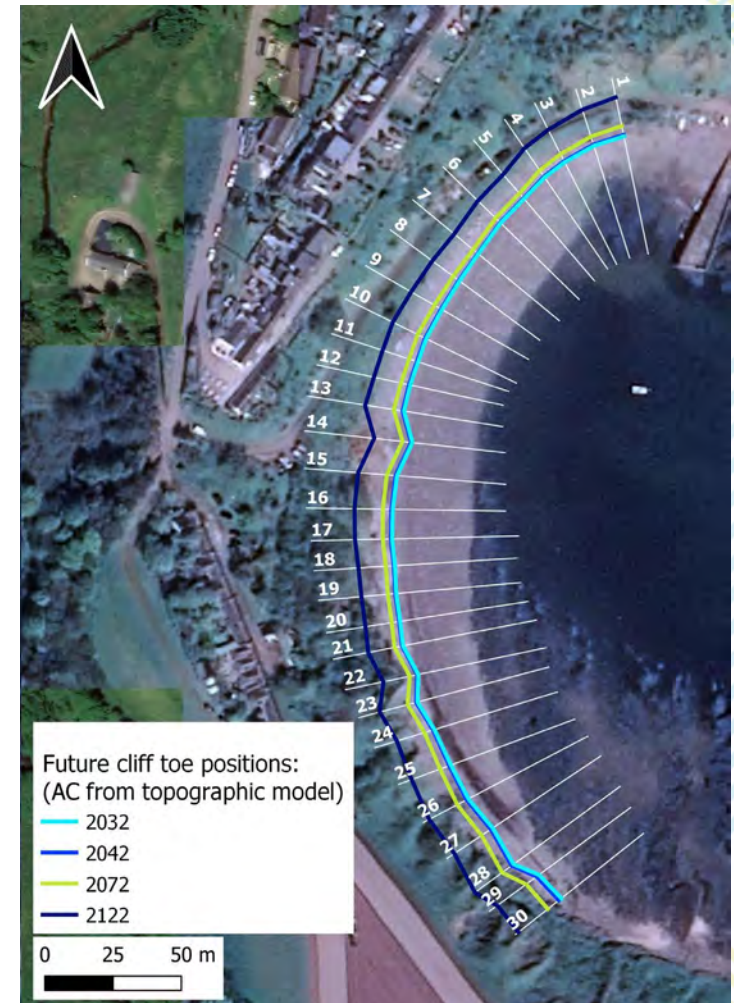
2072

Maximum retreat distance (from baseline)
of 6 m

2122

Maximum retreat up to 20 m

- Future projections based on the cliff toe
- Cliff top and cliff face recession is unknown at this stage
- Geological constraints not taken into account



Storm Event – December 2012



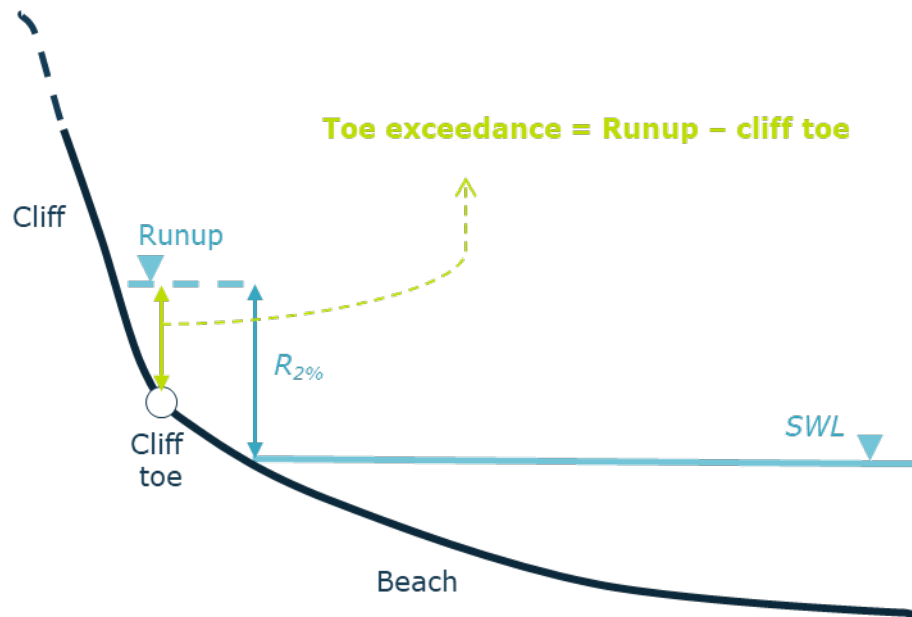
[Click here to download the video \(7.8MB\)](#)

Storm Event – December 2012



Vulnerability to extreme events

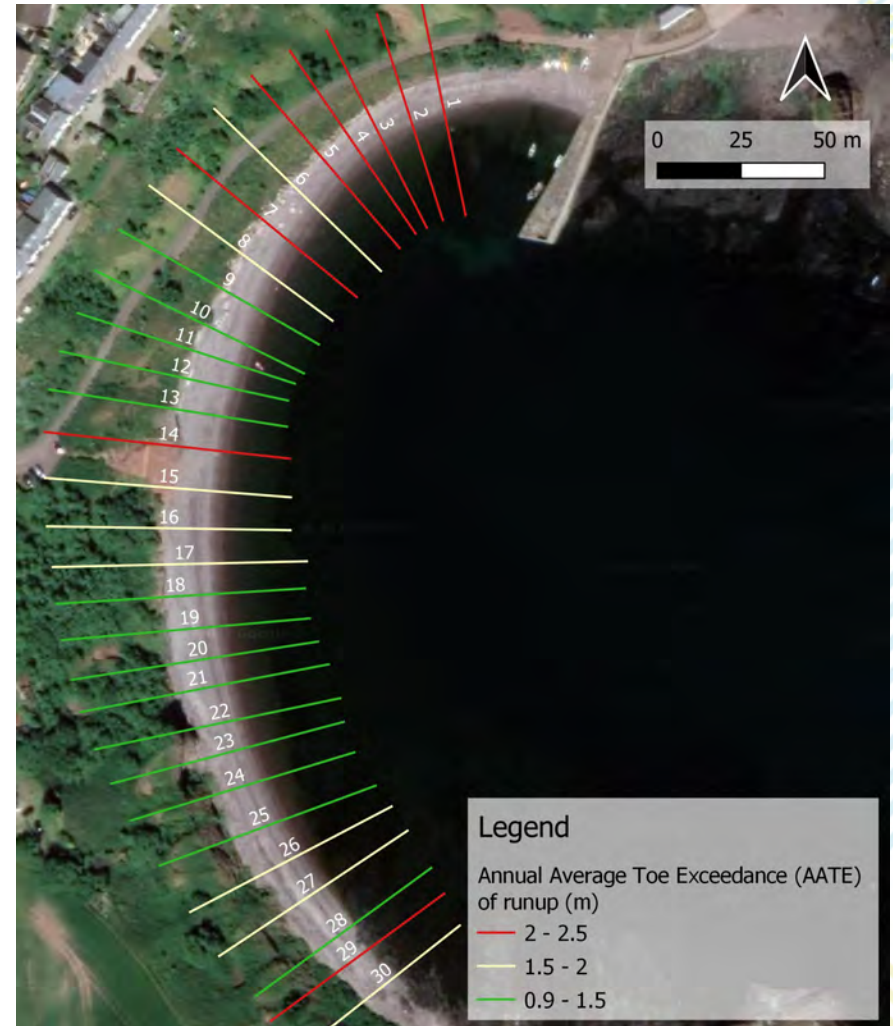
- Storm events can cause localised erosion
- Unreversible damages (loss of cliff material) can occur and drive long-term changes
- **Vertical runup** was used as the representative forcing



Vulnerability to extreme events

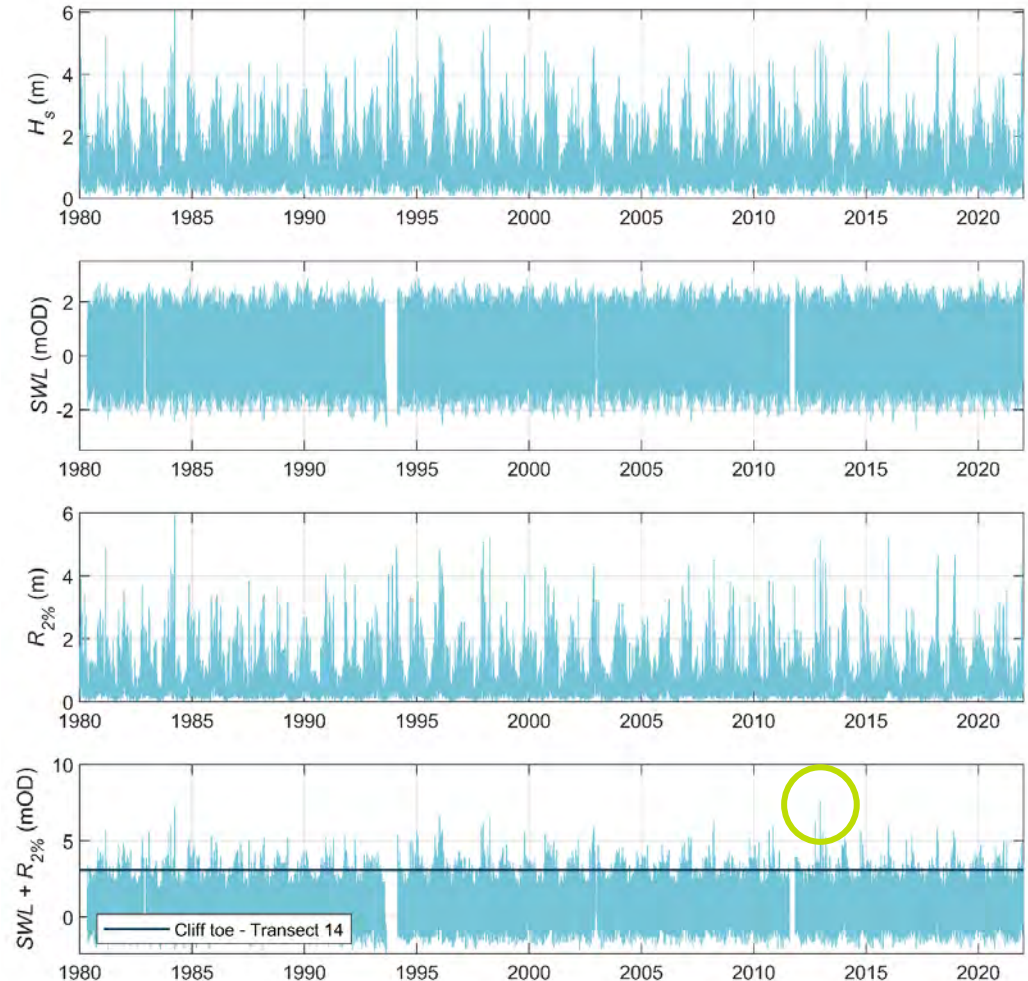
Cliff Vulnerability classification

- Annual average toe exceedance (AATE)
- Most vulnerable areas:
 - Centre of the Bay
 - North of the Bay



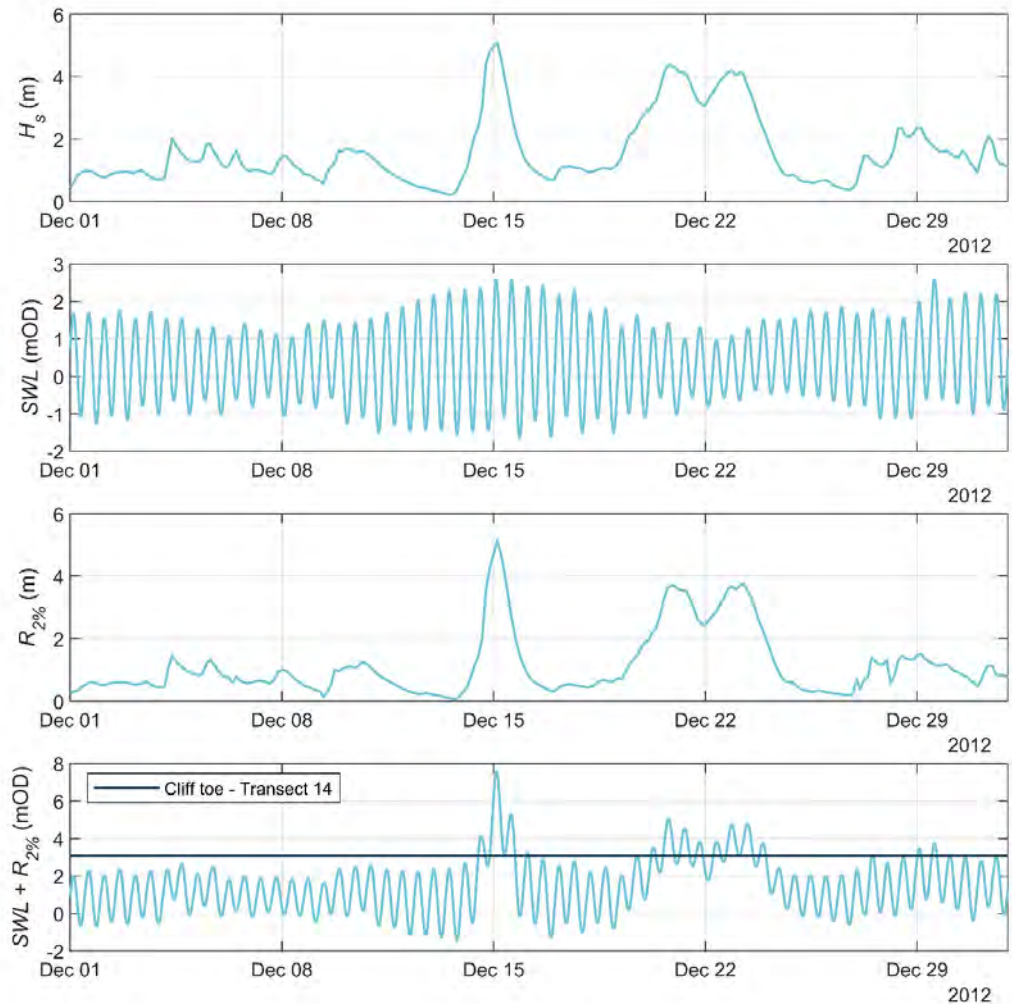
Vulnerability to extreme events

- Runup calculated for the full historic record of sea state (total water level and wave conditions)
- 15 December 2012 confirmed to be the most intense event in recent years



Vulnerability to extreme events

- Peak of a spring tide
- High significant wave height
- 1 in 20 years return period

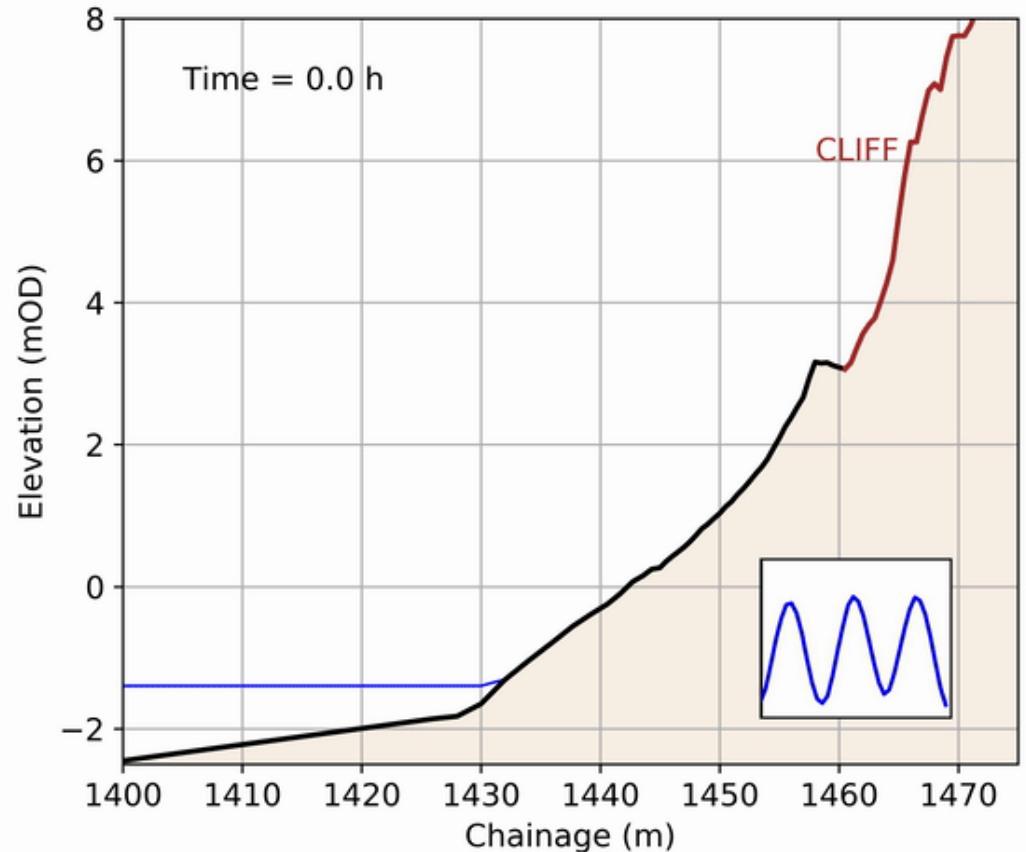


Short-term prediction

Erosional processes of
shingle beaches

- **Rising** tide - **Landward** transport
- **Falling** tide - **Seaward** transport

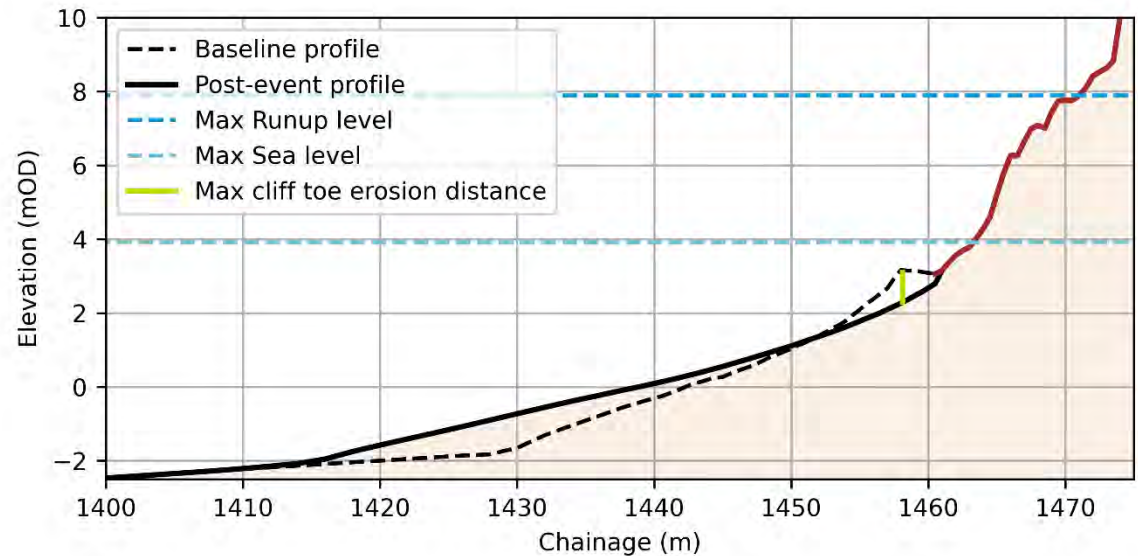
Shingle beach being the first
line of defence of the cliff toe



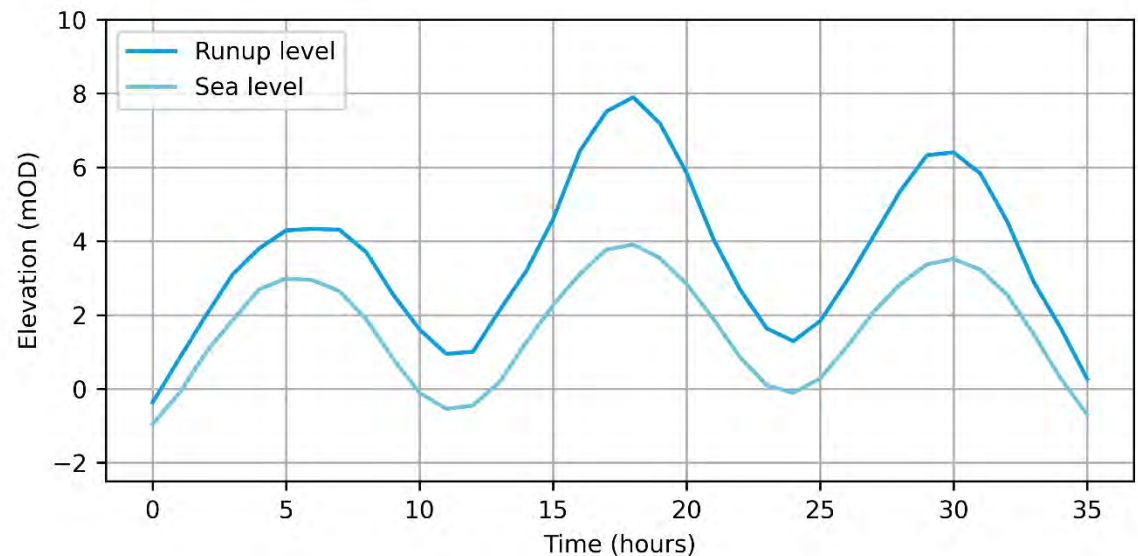
Short-term prediction

Quantification

- Peak sea level = 4 mOD
- Peak runup = 8 mOD
- 0.8 m max elevation change in front of the cliff



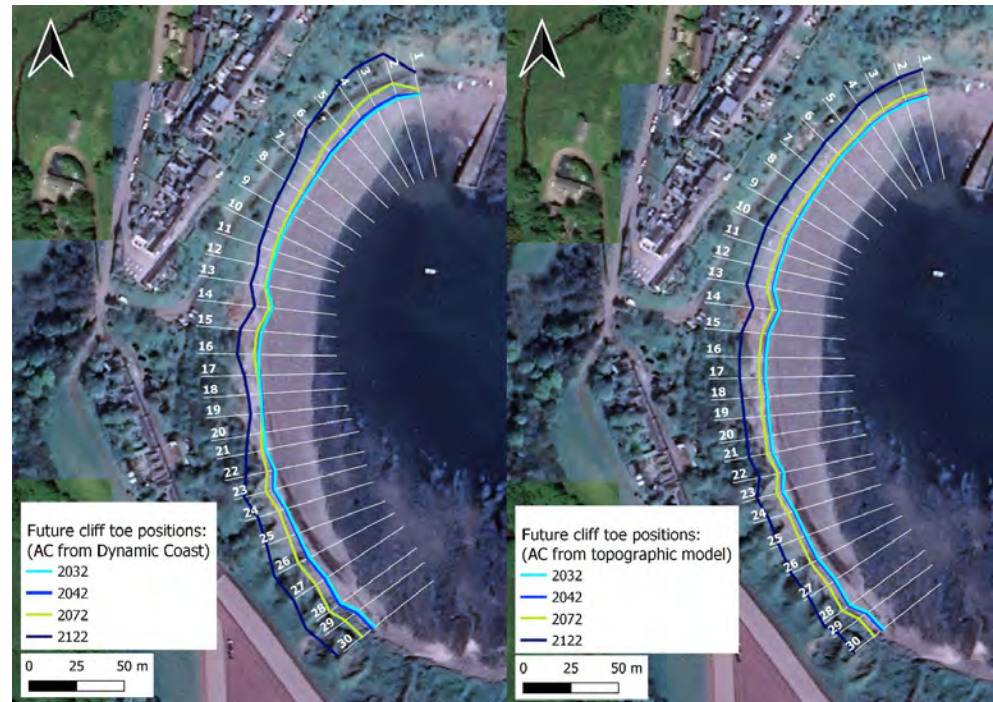
Localised erosion
(undermining) potentially
leads to destabilisation of
the wider slope
(not captured in this model)



Economic Valuation

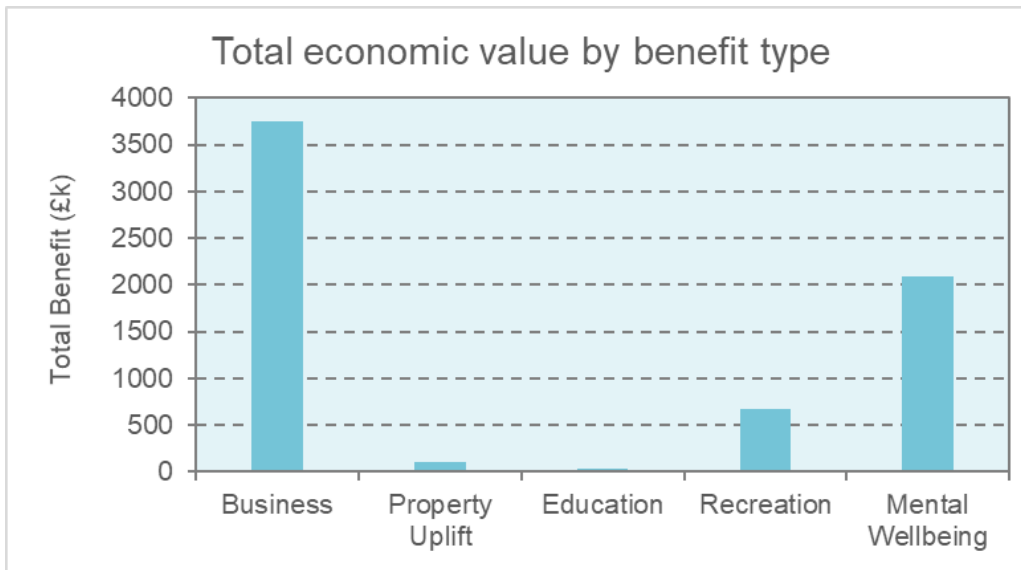
Economic valuation

- Assessing the benefits that access to the bay provides to the community, users, and the local economy
- Assessed impacts to the following areas:
 - Local businesses
 - Property premiums (proximity to green or blue space)
 - Education
 - Recreational activities
 - Mental health



Economic valuation

Appraisal period	Benefits (£)
30yr	6,645,000
60yr	10,948,000
100yr	14,681,000



- It does not take into account the timing of any potential loss of access to the bay at this stage (value if access was lost today).

Coastal Protection Measures

Coastal protection measures

- Long list of options

ID	Option	Option description
1	Do Nothing	No intervention. Cease any current work such as nature-based cliff stabilisation.
2	Do Minimum	Basic maintenance and monitoring in areas of major erosion.
3	Repair and strengthen	Repair existing defects and strengthen existing defences.
4	Concrete sea wall	Seawall at toe of cliffs for entire frontage.
5	Rock revetment	Rock revetment at toe of cliffs for entire frontage.
6	Offshore breakwater	Underwater breakwater constructed offshore using rock armour.
7	Living shoreline	Examples include kelp beds, biogenic reefs, or an underwater breakwater with an outer 'living' layer
8	Dynamic Revetment	Shingle or cobble beach recharge and recycling.
9	Green cliff toe stabilisation	Reduce the cliff slope at the toe and plant vegetation.

Coastal protection measures

- **SWOT analysis of the long list**

- Strengths, weaknesses, opportunities and threats

Option	Type	Option Description	Strengths	Weaknesses	Opportunities	Threats
1	Do Nothing.	No intervention. Cease any current works.	<p>No capital cost.</p> <p>No maintenance costs.</p> <p>No immediate disruption to properties, businesses and infrastructure.</p> <p>No immediate impact to heritage.</p> <p>No carbon cost.</p> <p>Allows for natural cliff recession.</p>	<p>Economic impacts of not protecting businesses and infrastructure.</p> <p>Failure of the defences.</p> <p>Social disruption of not protecting properties, businesses and infrastructure.</p> <p>Does not provide technical solution to protecting homes, businesses or infrastructure.</p>	<p>Cliff erosion may be slower than predicted and may not require intervention in the short to medium term (<50 years).</p>	<p>Possible political and community objections of allowing cliffs to erode and fail and affects properties, businesses and infrastructure.</p> <p>Requires consistent and competent monitoring to understand risk of changes in coastal processes.</p> <p>Long-term damage to environment and heritage assets at the top of the cliff.</p> <p>Loss of recreation site.</p> <p>Possible political and community</p>

- **Costing estimates**

- Indicative unit costs

Component	Material Cost (Capital)
Concrete sea wall	£4,000 / m
Rock revetment	£15,000 / m
Offshore breakwater	£30,000 / m
Living shorelines	Kelp Seeding: £500 /tonne Oyster Baskets: £200 / unit Oyster shells: £300 / m ³
Dynamic Revetment	£35 / m ³

Conclusions & Recommendations

Decorative geometric patterns in the bottom right corner, consisting of overlapping triangles and quadrilaterals filled with diagonal blue and green lines.

Conclusions

- **Three main aspects to the work undertaken by JBA:**
 - coastal assessment
 - economic valuation
 - listing and reviewing coastal protection measures

Conclusions:

- Cliff toe: no net lowering but some seaward shift
- Stable beach (volume conserved)
- Predicted cliff toe retreat: 9m (by 2072) and 25m (by 2122) *subject to geology*
- Most vulnerable part of bay: centre (directly exposed to shore-normal waves)
- Extreme events likely to cause localised erosion and contribute to the long-term changes
- High economic benefits from protecting access to the beach and pier.

Recommendations

Recommendations:

- Acknowledge that the climate is changing - explore adaptive solutions which will protect the Bay, the infrastructure and the village
- Continue to be a proactive community
- Data collection – CoastSnap, regular drone surveys, wave monitoring
- Report to be used as a basis to determine future actions that would enable Catterline adapting to climate and coastal change

CoastSnap

Community Beach Monitoring

What is it? How does it work?

- Originated in 2017 by University of New South Wales (Sidney, Australia)
- Global citizen science project
- Track coastline change through time



CoastSnap in the world



<https://www.coastsnap.com/>

CoastSnap in Scotland



Qualitative analysis



[Click here to download the video \(6.92MB\)](#)

Quantitative analysis



Catterline CoastSnap Station

The station



Your contribution



Catterline CoastSnap Station

March 2022

October 2022



Catterline CoastSnap Station

How to use CoastSnap



CoastSnap

community beach monitoring

**Catterline
CoastSnap Station**



Scottish CoastSnap Network

Find us on  Twitter

 CoastSnap Scotland
or @CoastSnapSco

How to use CoastSnap

- 1 Download**
Get the free CoastSnap Citizen Science App
- 2 Register**
Create your own user account
- 3 Start!**
Start monitoring:
 - On the app, click on the existing Catterline spot
 - Place your smartphone on the phone-holder
 - Snap & Share





**Thank
You**