Coastal & Offshore Modelling Symposium
COMS2026

Multi-Scale Numerical Modelling of Shoreline Dynamics Along the Cork Coastline

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Cork Coastline Vulnerability Assessment Project

- **Project Aim**

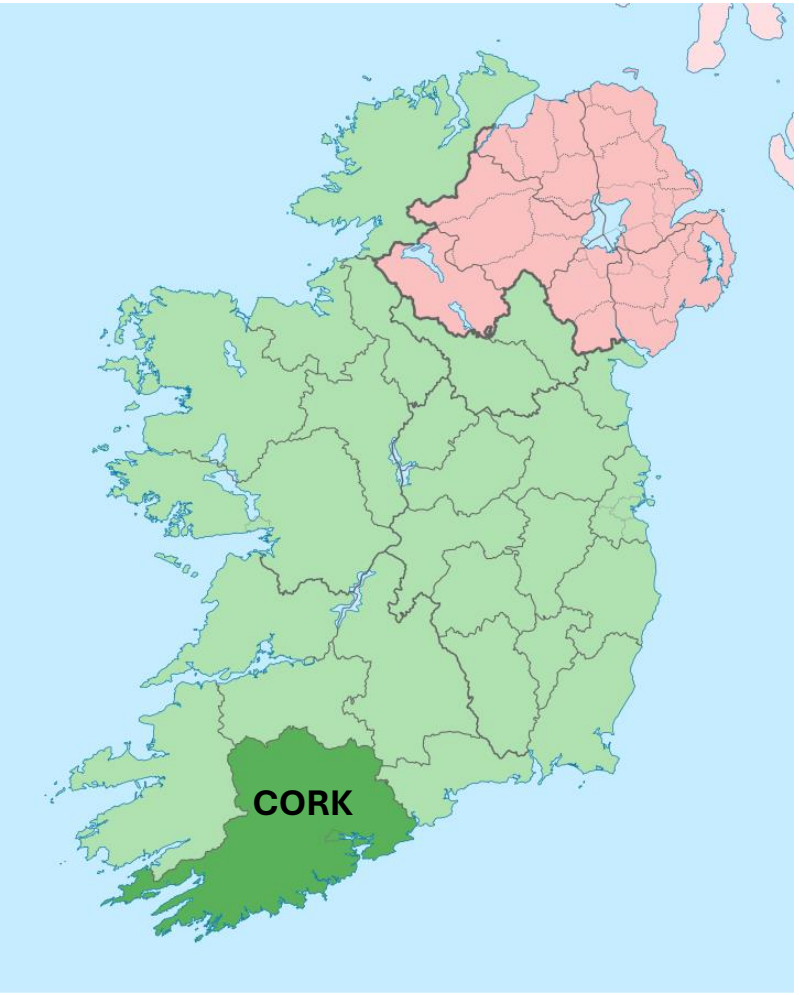
To understand wave dynamics, shoreline evolution and sediment transport along the Cork coastline

- **Project Context**

Funded by Cork County Council
Covers approximately 1,200 km of coastline
Focused on coastal risk and resilience

- **Research Structure**

Two PhD projects
Coastal Vulnerability Assessment (CVA)
Multi-stage numerical modelling (this study)



Why Multi-Scale Modelling?

Approach

Two-Stage Modelling:

- Stage 1: Offshore to Nearshore Wave Modelling
- Stage 2: Beach-Scale Coastal Evolution Modelling

Significance(remove)

- Enables prediction of future coastal risks and informs regional management
- An envelope of Coastal positions for the year 2050
- Provides a scientific foundation for sustainable coastal planning

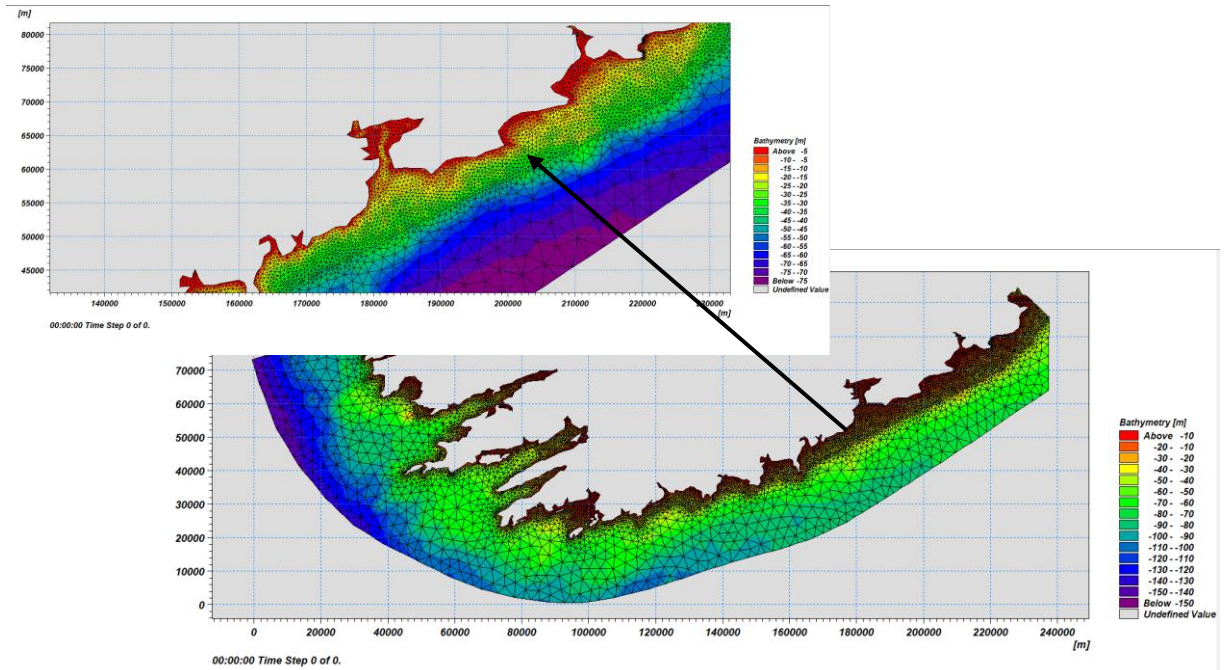
Stage 1 Overview

In Stage 1, MIKE 21 SW was applied to simulate nearshore wave conditions along the Cork coastline.

❖ **Inputs**

- Bathymetry (INFOMAR)
- Offshore wave boundary (Copernicus IBI)
- Model mesh & domain (~15 m isobath)
- Copernicus IBI boundary (Hs, Tp, Dir)
- 27 offshore points
- Unstructured mesh (400 m nearshore)

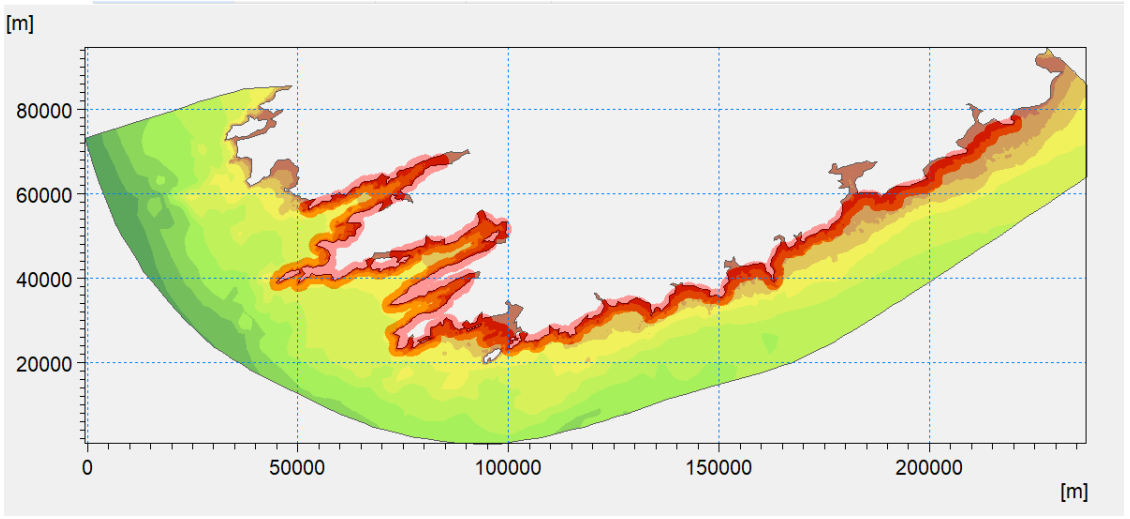
- ≤ 400 m resolution nearshore (≤ 40 m depth)



- ~ 1 km resolution towards boundary

Stage 1-Output

- **Hourly resolution** over **25 years**
- **1543 points**, spaced approximately every **400 meters**
- For each point:
  - Hs (Significant Wave Height)
  - Tp (Peak Wave Period)
  - Wave Direction
  - Wave Power



- Spatial coverage of the large-scale wave model outputs along the Cork coastline

- **Extracted Nearshore Wave Dataset**

✔ 1543 points → high spatial resolution
✔ 24 years → temporal reliability
✔ Multi-parameter → enables multiple analysis
✔ Scalable → potential for use in other coastal regions

Stage 1 Model Validation

- **Primary Validation Parameter**

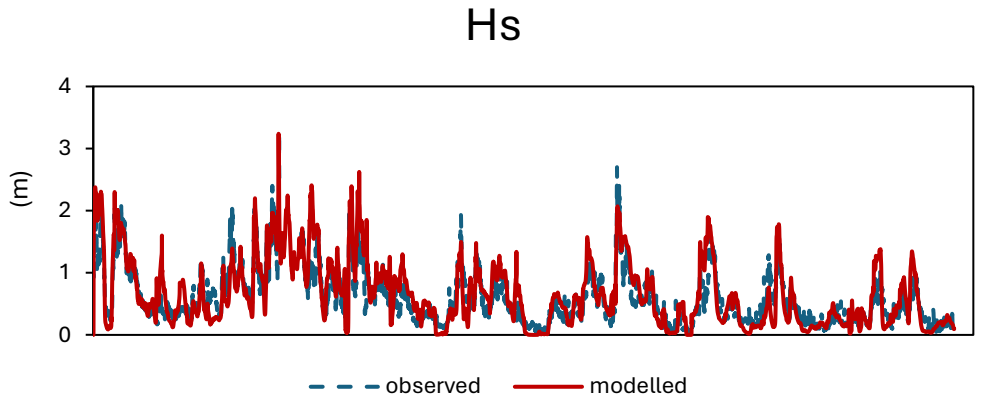
Significant Wave Height (Hs)

- **Additional Checks**

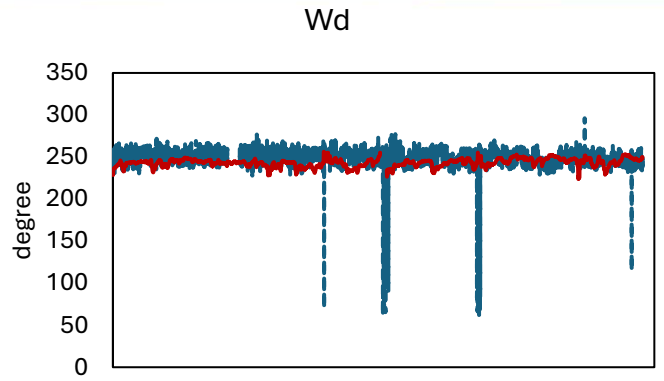
Peak Wave Period (Tp)
Wave Direction (Wd)

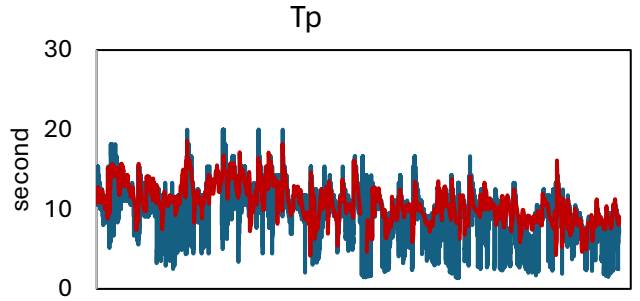
- **Performance Metrics**

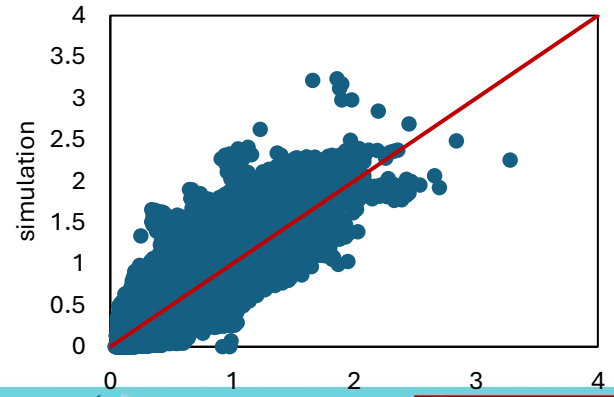
RMSE (Hs)

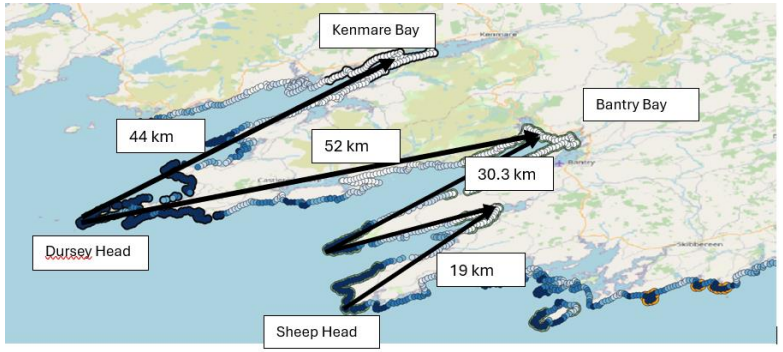


Bias	RMSE	CC	SI
0.0923	0.357	0.857	0.613





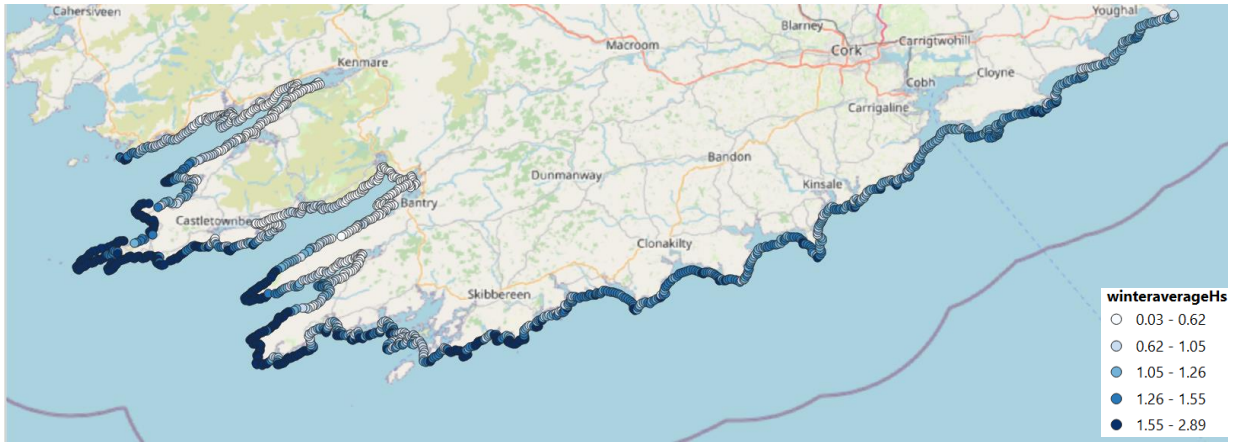




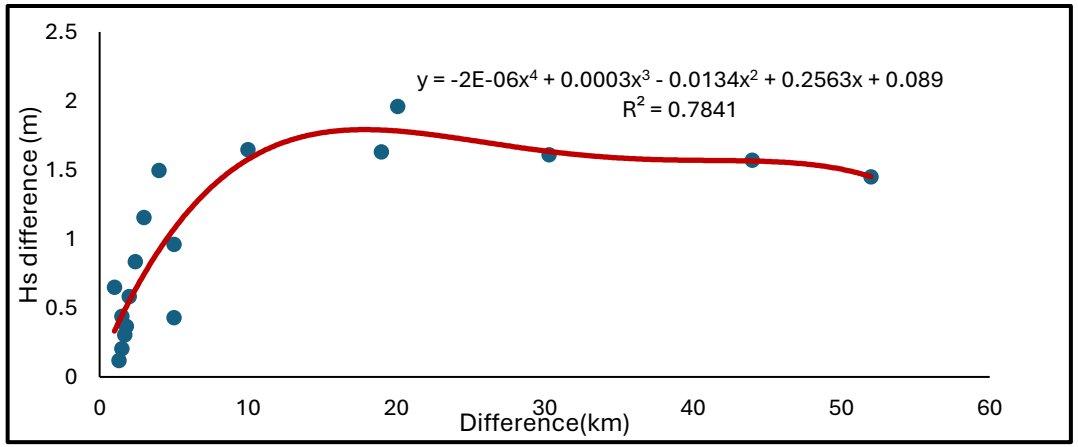
- *The wave height difference generally increases with the distance between headlands and sheltered bays*

- *Shorter distances between headlands and sheltered areas correspond to smaller wave height differences*

- *At Old Head, wave height differences vary significantly between the west and east sides at similar distances, reflecting the influence of exposure and coastal orientation*



- *Clear west–east gradient in winter-average wave energy due to Atlantic exposure.*



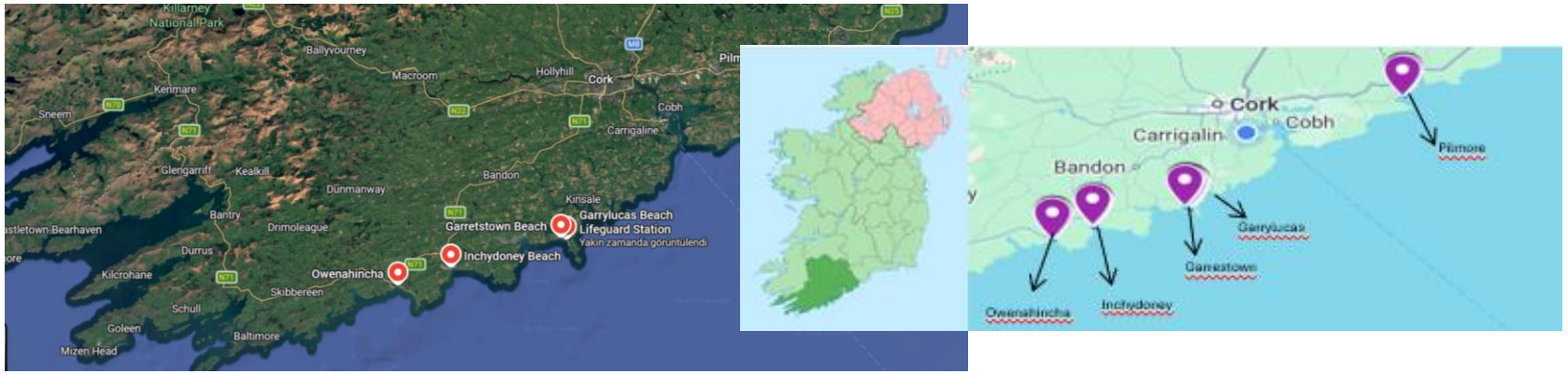
Stage 2:Beach Modelling

- Modeling coastal position changes and sediment transport to assess future erosion scenarios and climate impact.

Content:

- Objective: Simulating coastal position changes at five beaches and examining sediment transport.

- Inchdoney
- Garreststown,
- Garrylucas
- Owenanhinca
- Pilmore



- Focus Areas: How the beaches respond to various wave conditions and sediment transport.
- Model Used: LITPACK for local beach modeling.(keep it)
- Climate Impact: Examining future erosion scenarios under climate change.

Field Data Collection Campaign

OVERVIEW OF MONITORING SITES

- Garretstown
- Garrylucas
- Owenahincha
- Pilmore
- Inchydoney

FIELDWORK TIMELINE

Baseline Surveys:

- March
- September

Post-Storm Surveys:

- April 2024: After Storm Kathleen.
- November 2024: After Storm Ashley.

FIELDWORK

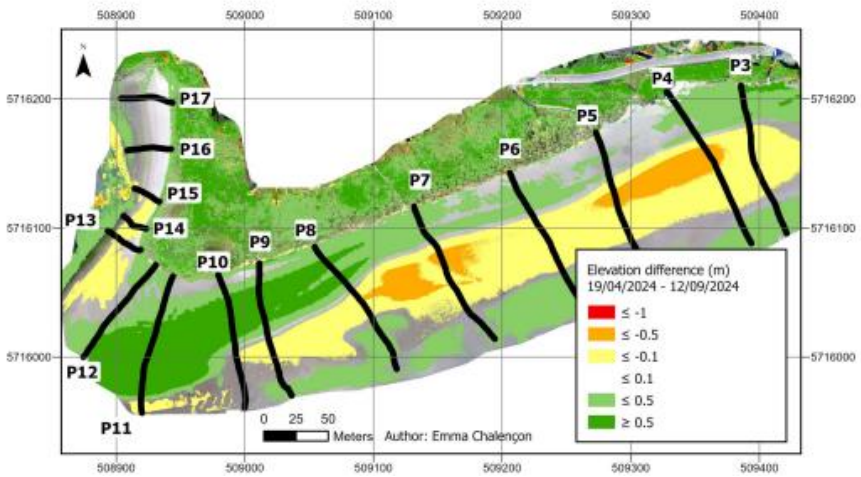
Sediment Sampling: Collected sediment samples and measured size distribution.

Cross-Profile Measurements: Conducted along the coastline for shoreline profiling.

Drone Surveys: Used to map the coastal areas and assess erosion impacts.

Pictures taken on the 23rd of October 2024 after Storm Ashley (20th of October) and a period of exceptionally high spring tides

- *Sediment sampling locations across four beach zones at Inchydoney Beach*

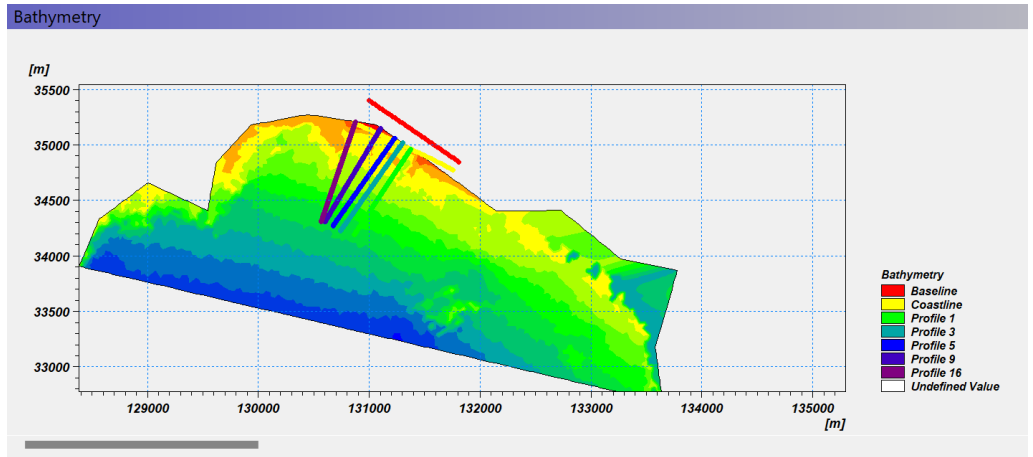


- *Cross-shore elevation profiles measured at Inchdoney Beach*

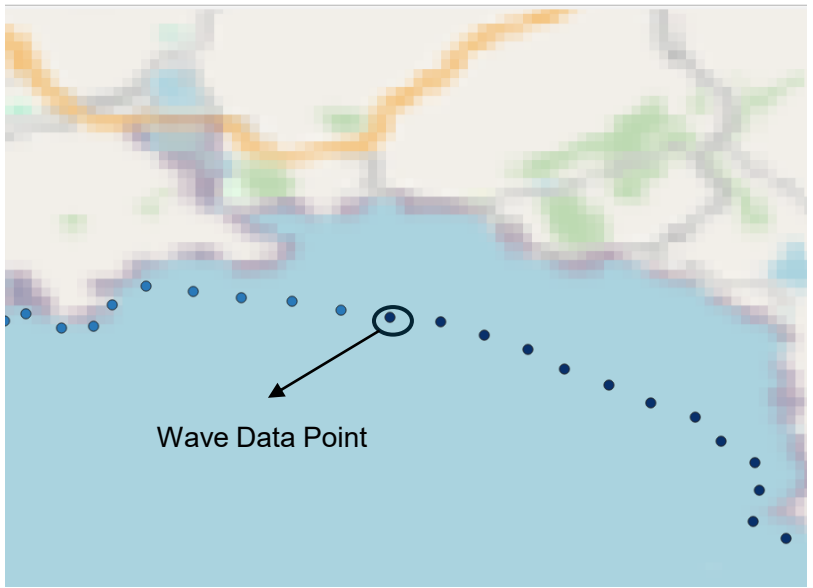
Local Coastal Evolution Model (LITPACK)

❖ Inputs

- Nearshore wave conditions (from large-scale model)
- Sediment grain size (D50)
- Tidal Data

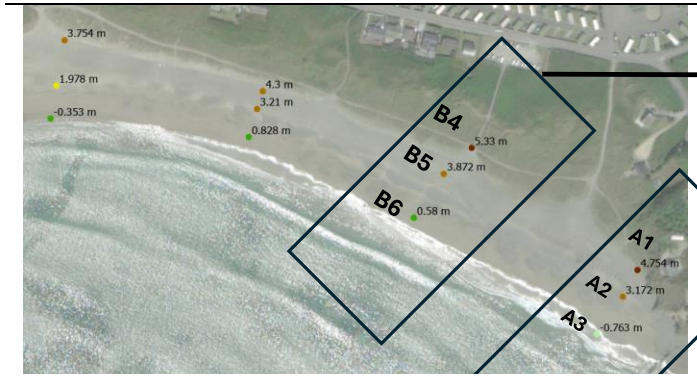


Union Hall 2 tidal gauge station

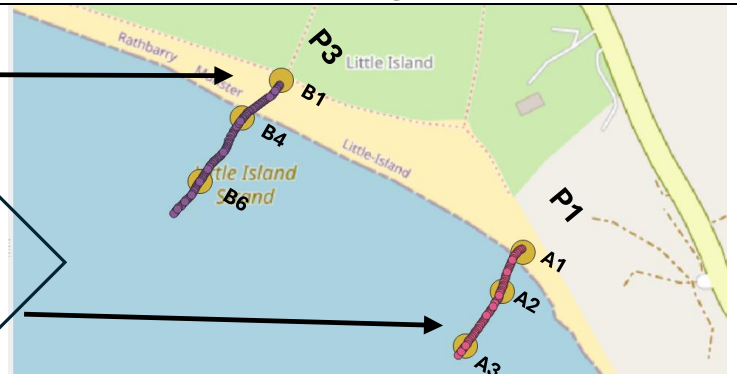


Profile Input Parameters

Field sediment measurements



Profile lines with matching sediment locations



- ✓ **Bathymetry**
- ✓ **Mean Grain Diameter (D50)**
- ✓ **Roughness**
- ✓ **Fall Velocity**
- ✓ **Sediment Gradation (√D84/D16)**

All sediment parameters were derived from field samples to ensure realistic profile behavior in LITPACK

Local Model Validation – Field Measurements

- **Field Data Collection**

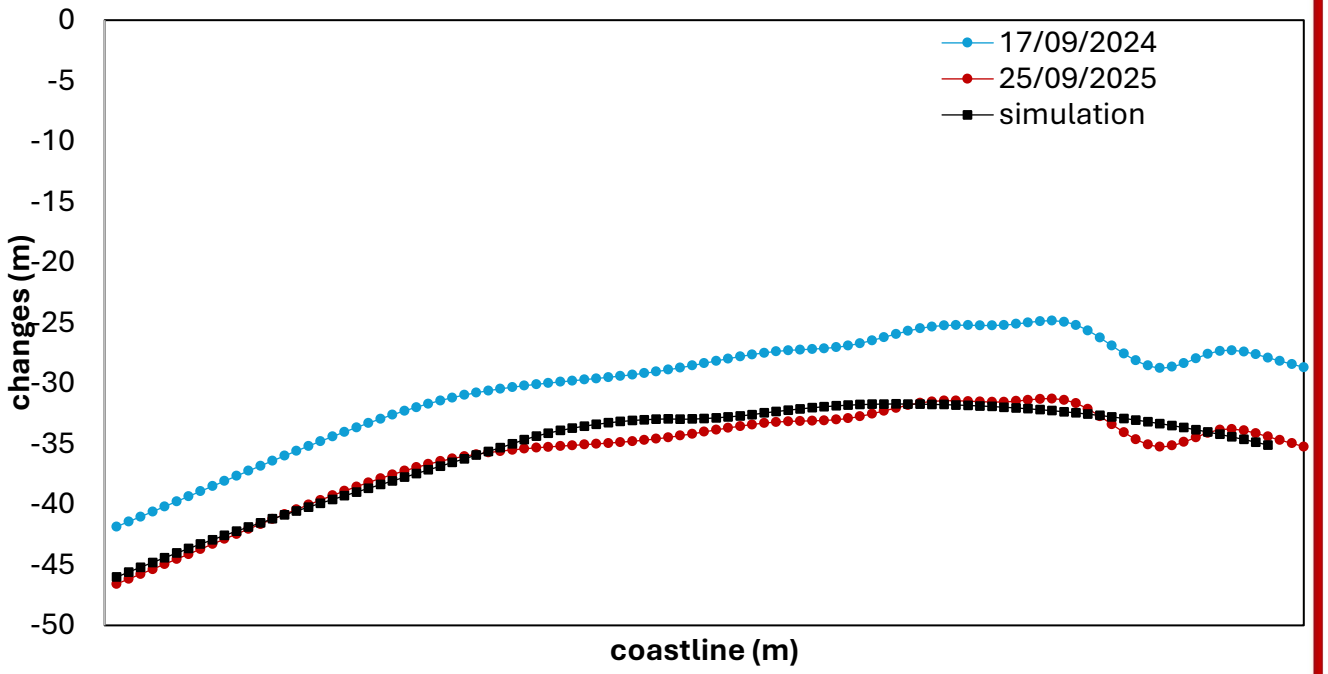
Biannual surveys (March & September)
Cross-profile measurements
Mean Water Level (MWL) shoreline extraction

- **Validation Period**

September 2024 – September 2025

- **Comparison**

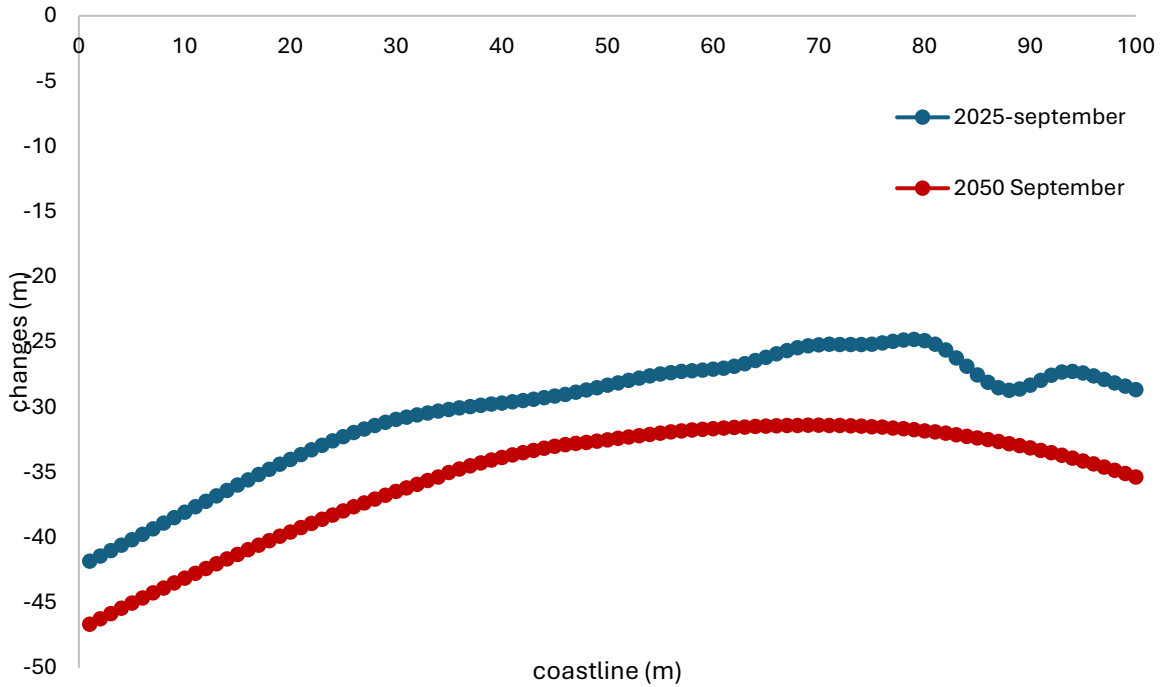
Observed MWL shoreline position
Simulated shoreline position



Bias	RMSE	CC
0.35	0.87	0.98

25-Year Shoreline Evolution – Baseline Simulation

- Driven by 25-year validated wave dataset
- No sea-level rise included
- No storm surge amplification



Thank You

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