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Creating MIKE21 Coastal Wave Propagation Model for OPW CFERM Study

Coastal and Offshore Symposium, UCC, 26th February 2026

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Company Overview

- MWP is an Irish owned company established in 1967.
- We have offices in Cork, Tralee, Limerick, Galway and London.
- We have approx. 220 Staff members.
- Engineering and Environmental Consulting Services
- Coastal Engineering Team
    - Coastal Erosion Risk Assessment
    - MARA Applications
    - Coastal Protection Design, Contract Preparation and Management
    - Coastal Studies and Associated Wave and Sediment Transport Modelling

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My Background

- Graduated from UCC Civil and Environmental Engineering in 2014
- PhD in Physical Scaled Model Testing Aspects of Floating Offshore Wind Platforms from UCD with MaREI Centre in 2019
- Chartered Engineer with Engineers Ireland, working as a Senior Design Engineer with MWP's Coastal Engineering Team
  - Coastal Protection Design
  - Contract Preparation and Management
  - Planning and MARA Consent
  - Coastal Studies and Risk Assessments
  - Ocean Wave Modelling

OPW Guidelines for Coastal Erosion Risk Management Measures

Schedule A : Scope & Terms of Reference of Coastal Erosion Risk Management Study

OPW Guidelines for Coastal Erosion Risk Management Measures and Funding Applications under the Minor Works Scheme

Coastal Erosion Risk Management Studies

OPW requires that proposals and funding applications for structural measures to prevent or mitigate erosion should be done in conjunction with an appropriate **coastal erosion risk management study**, which fully investigates, substantiates and demonstrates the merits of any measures being proposed. Such measures, in general, require the investment of substantial amounts of public funding and in order to ensure value for money, it would be considered best practice that a study be undertaken in advance of undertaking any measures. In addition, a study will ensure all options are onsidered.

4. Assessment of Existing Coastal Processes and Coastline Evolution

Identify and model the typical current scenario (seasonal, annual and extreme) wind, wave and tidal conditions and climates throughout the study area having regard to the existence of some of this information at a strategic level from previous studies (refer ICPSS and related studies).

Identify and model the typical current scenario (seasonal, annual and extreme) sediment transport processes and sediment budget throughout the study area including long-shore, cross-shore and aeolian sediment transport. Identify any natural sediment sources or strategic sediment reservoirs together with sediment transport pathways and sediment sinks.

Identify and model climate change impacts, associated primarily with sea level rise and based on mid range and high end future scenarios (MRFS and HEFS) for each of the above cases including wind, wave, tide and sediment transport.

Coastal Flood and Erosion Risk Management Studies

TRAMORE BAY, CO. WATERFORD

- Bay bound by two rocky headlands, wide sandy Beach, Sand spit of dunes which fronts a coastal lagoon area

BRITTAS BAY AND ENNEREILLY BEACH, CO, WICKLOW

- Sandy Coastline, two beaches, rocky headlands either end, backed by dunes, Arklow Sand Bank offshore

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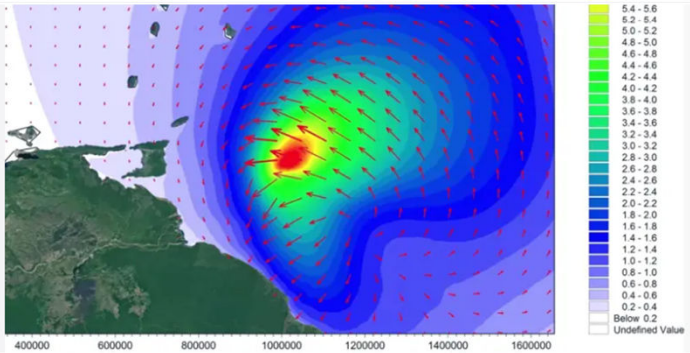
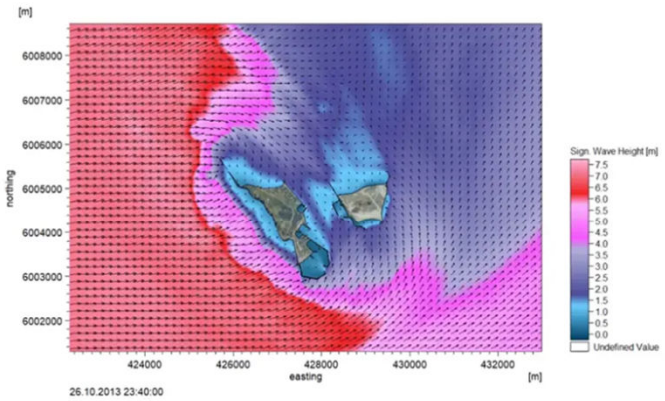
MIKE 21 Software by DHI – Spectral Wave (SW) Module

Calculate wind-waves in all seas - easily and accurately

Precisely calculate wind-generated waves and swell sizes as a reliable and cost-effective basis for offshore and nearshore wave-sensitive engineering tasks. This trusted software features a flexible mesh approach and efficient parallel processing for advanced 3rd- generation wind-wave modelling. **Watch video**

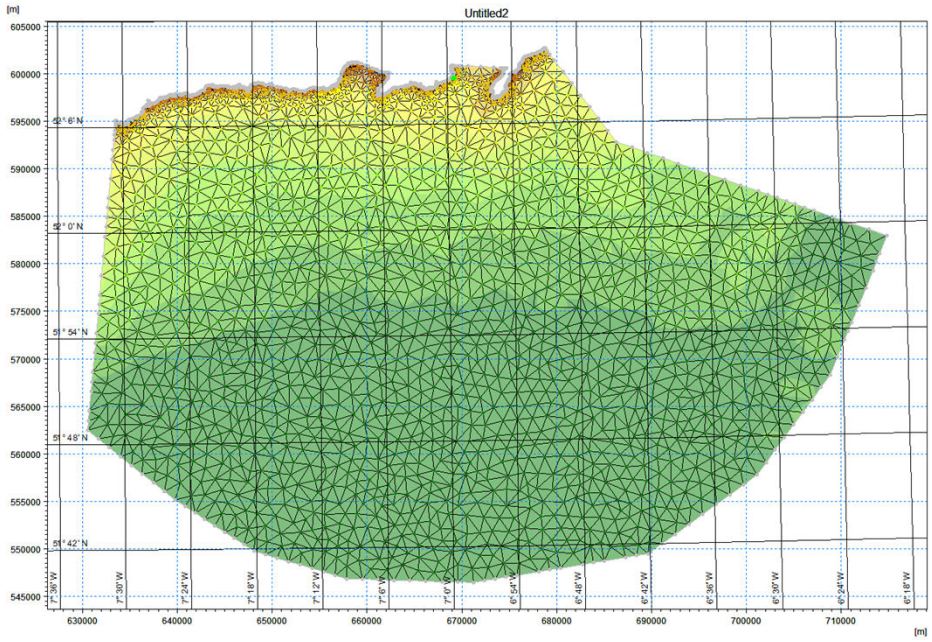




Efficiently transform offshore wave fields to coastal areas

Accurately model wave climates at regional and local scales with high spatial resolution to resolve physical environments and wave processes. Downscale offshore wave climates using dynamic spectral mode (2D wave spectrum) or fast parameterised mode (directional spectrum). **Watch video**

Creating a Mesh: Tramore



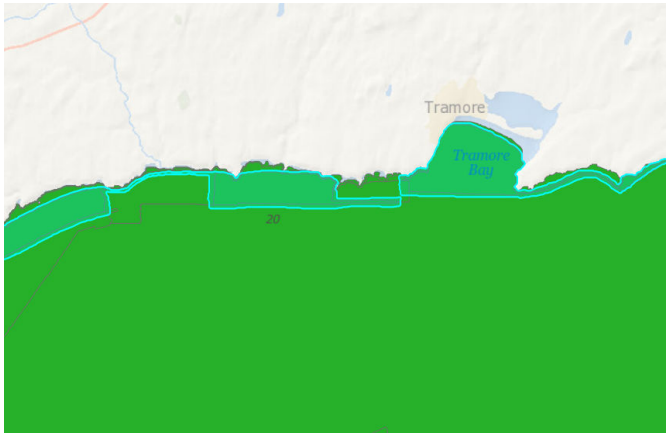
Land file

- (ICPSS 2010-2014 Baseline) – Dataset
- Up-to-date Satellite Imagery

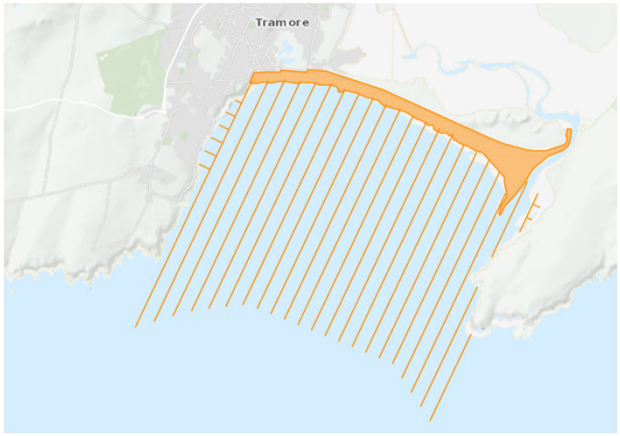
Bathymetric Data Points

- Infomar
- Pilot Coastal Monitoring Survey Programme
- Nearshore Bathymetric Survey procurement to fill gap

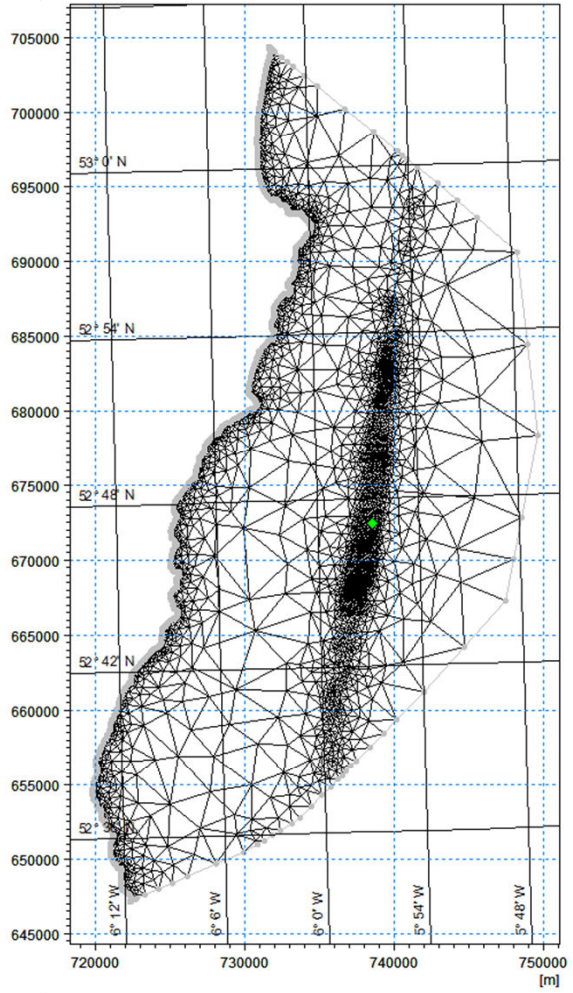
INFOMAR LIDAR COVERAGE

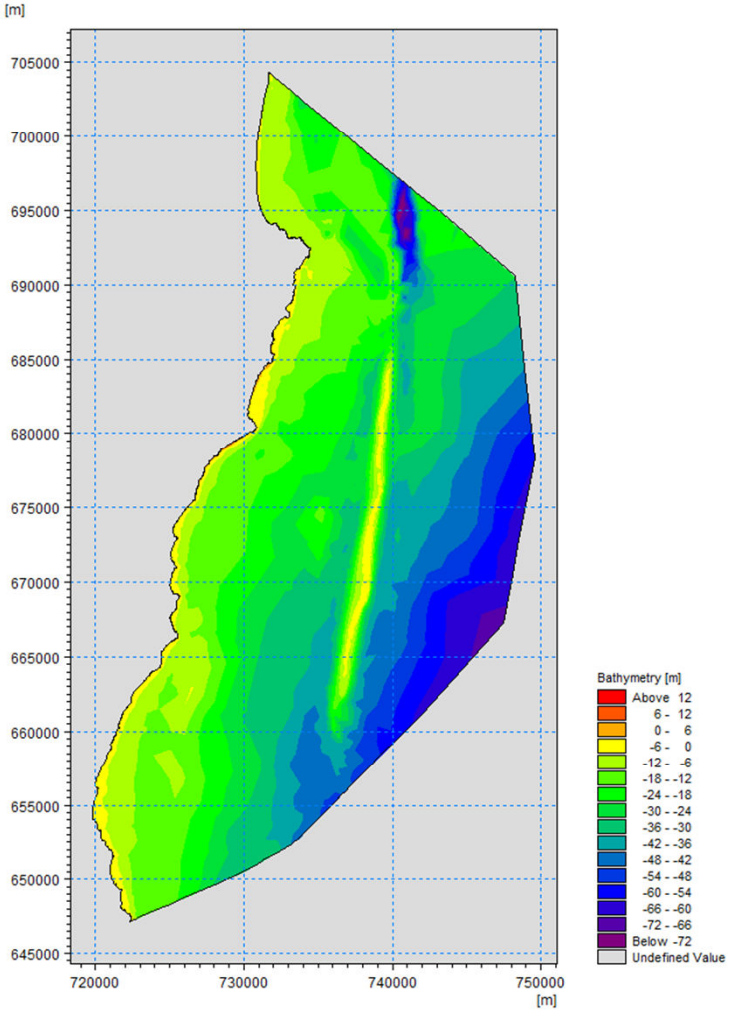


COASTAL MONITORING SURVEY PROGRAMME 2022



Mesh Refinement: Brittas Bay & Arklow Bank





Environmental Data – Waves and Wind

Copernicus Marine Service ‘CMEMS’

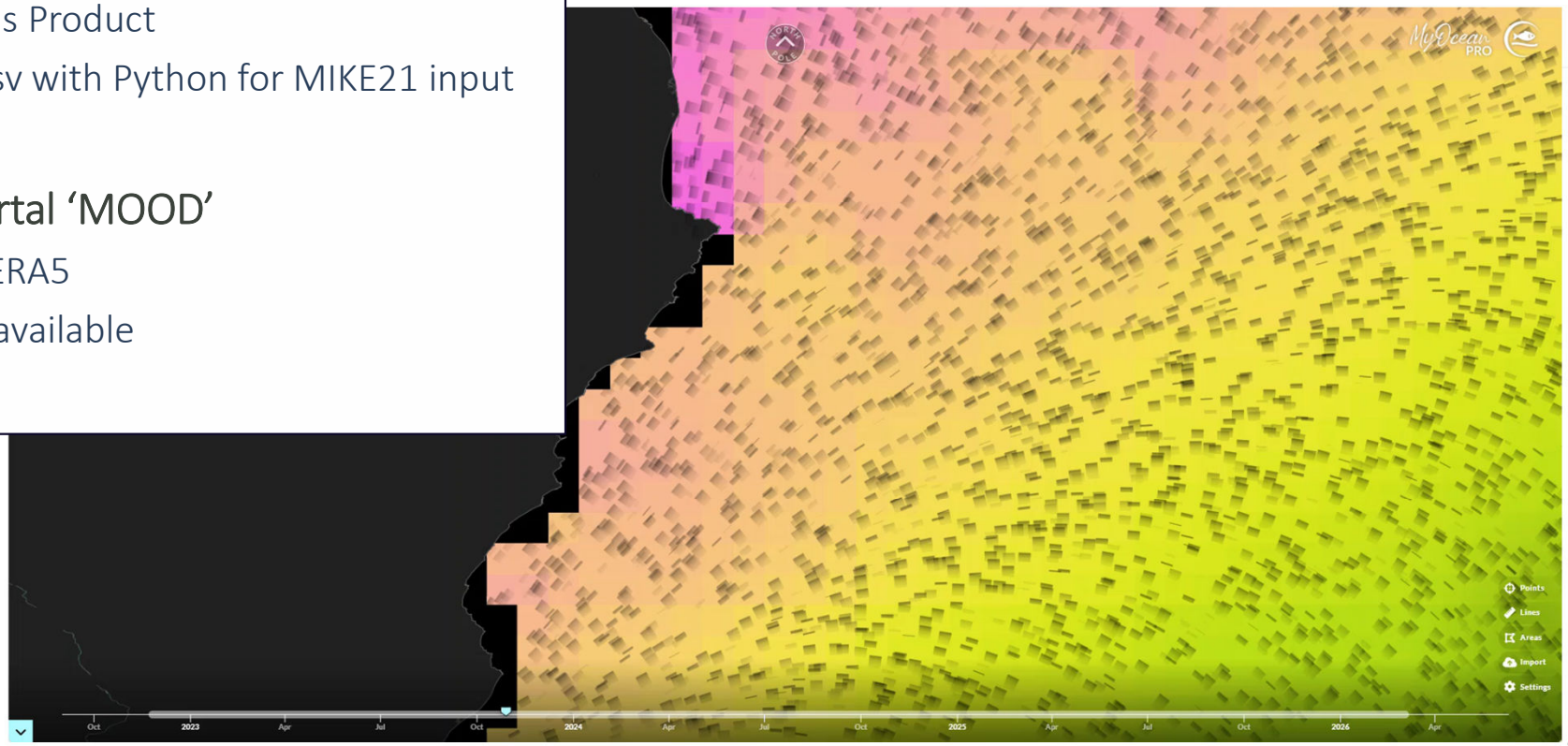
- Ocean Wave Reanalysis Product

netCDF files, convert to .csv with Python for MIKE21 input

DHI MetOcean Data Portal ‘MOOD’

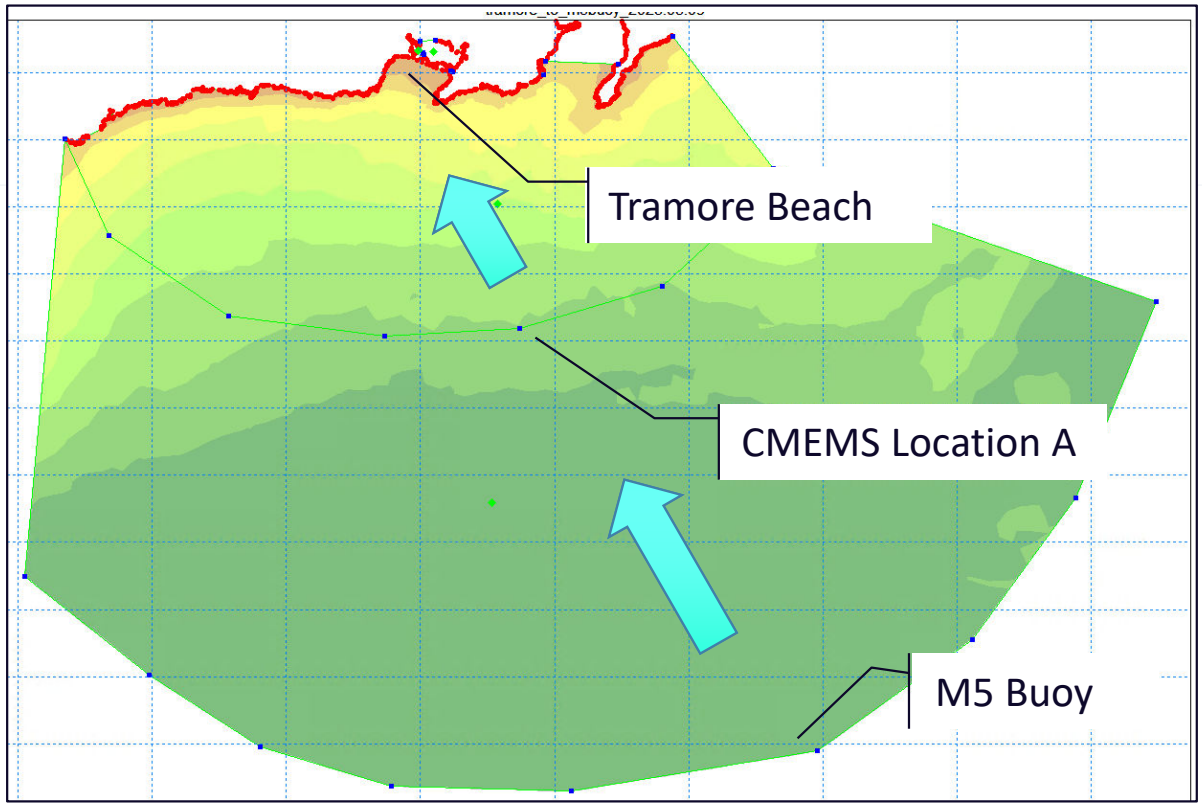
- Wind from NORA3 & ERA5

netCDF, .csv or .dfs0 files available

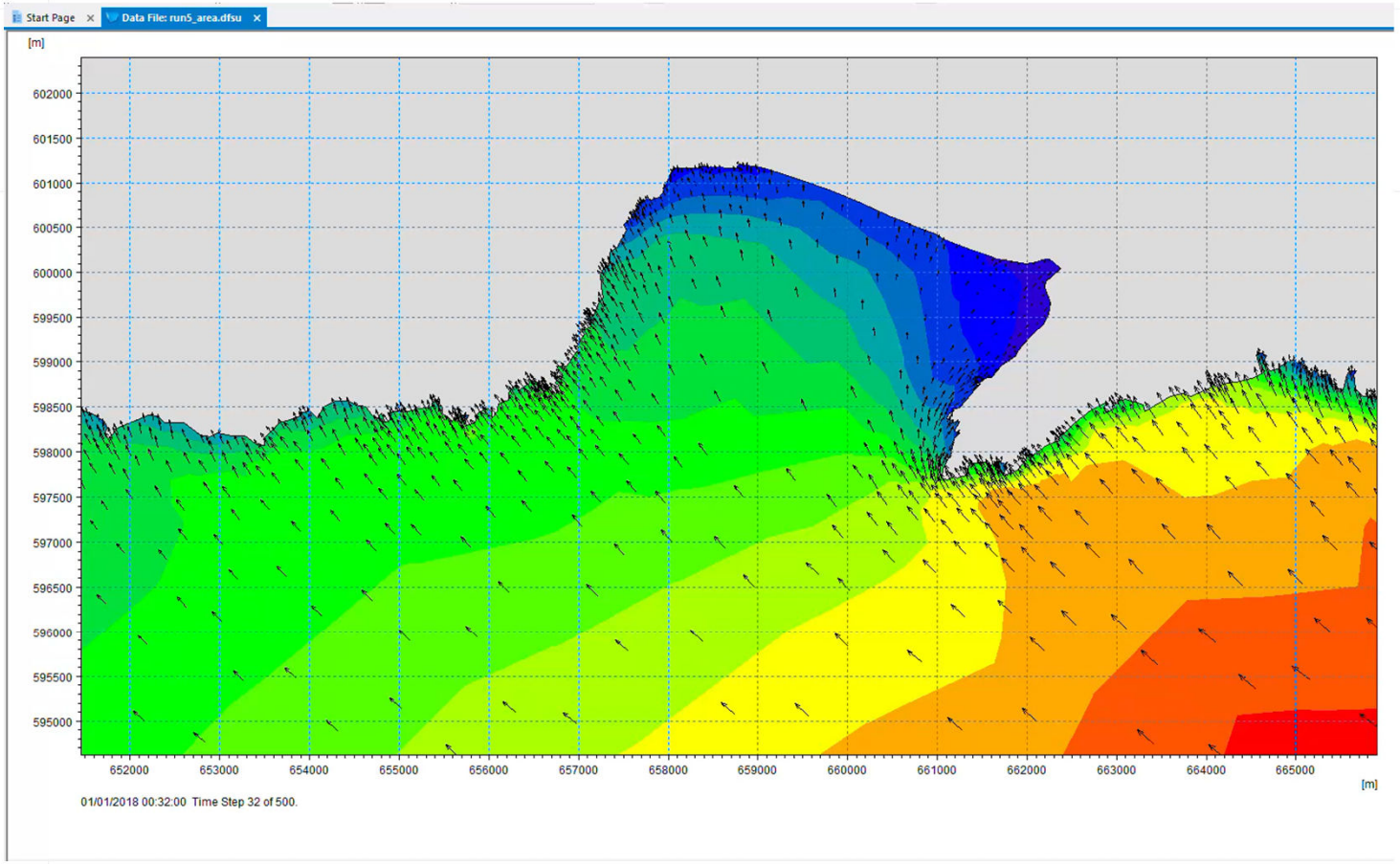


Model Input Validation & Wave Propagation

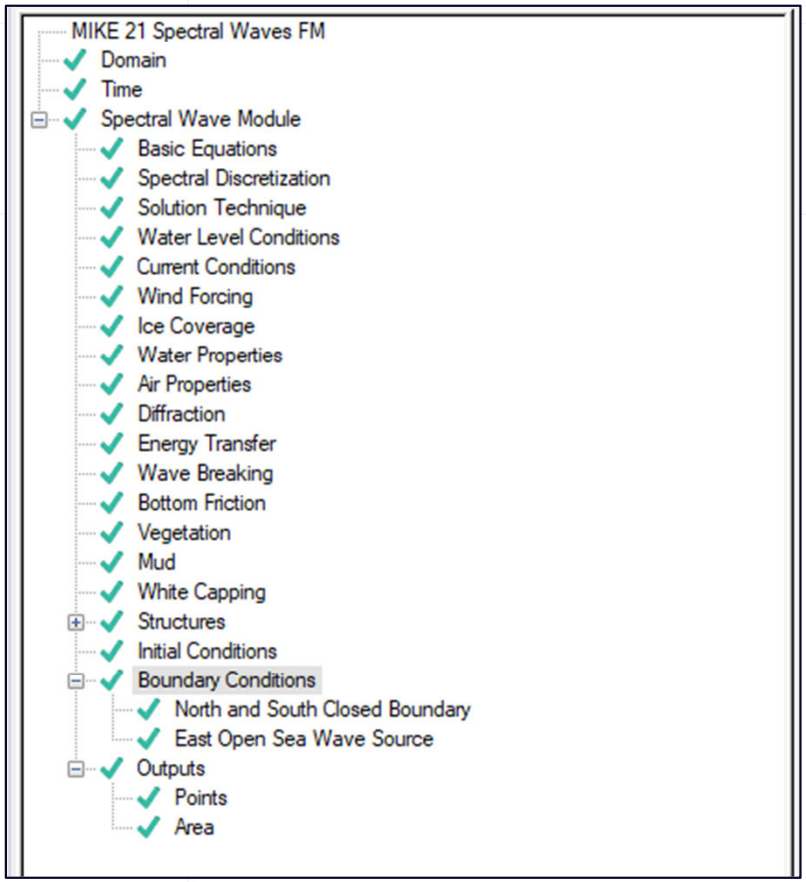
- Measured quantities at a known location; Marine Institute M2 Buoy
  - Validates CMEMS reanalysis data
- Trusted CMEMS verification data at Location A replicated by model
- Further propagated using the model inshore beyond the extent of available CMEMS reanalysis product data
- Notable high wave events from the last 20 years on record to validate model behaviour



Model Checks – Behaviour as expected e.g. Tramore

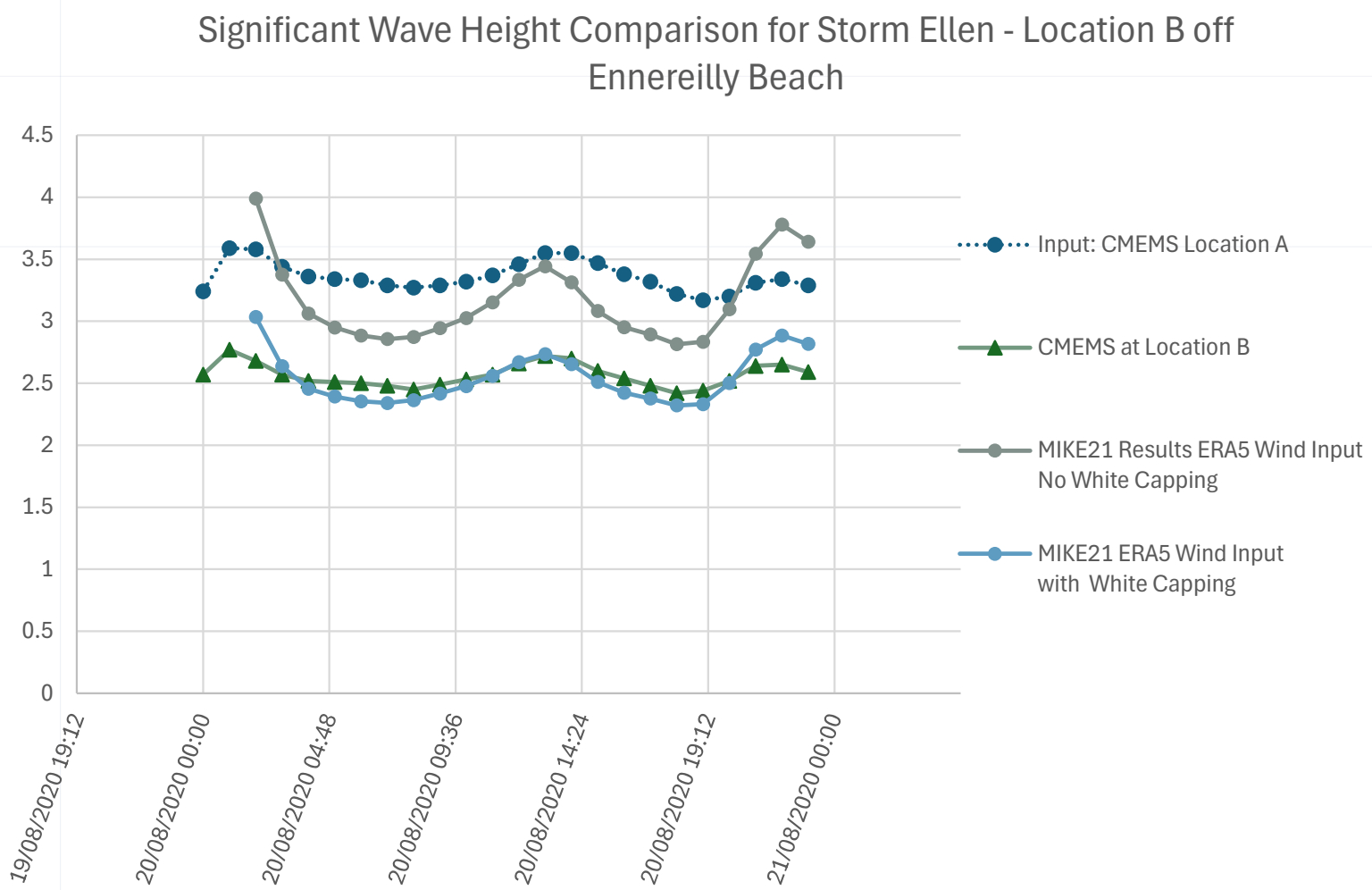


Model Calibration



- Water Level Conditions (fixed or Tidal over hours/days)
- Boundary Conditions
  - **Closed**
  - **Open – Wave Parameters Input**
- Wave breaking (on/off)
- White capping (on/off)
- Bottom Friction (grain size data)

Model Setup Calibration – e.g. Brittas Bay & Ennereilly Model



Input Wave Range

Hs Intervals (m)	MWD (degrees) 90°	120 °	150 °	180 °	210 °	240 °	270 °
0.5	64	64	66	104	428	592	79
1	125	107	107	167	791	882	95
1.5	58	67	82	143	827	542	23
2	27	31	47	116	638	288	2
2.5	13	20	28	69	442	152	0
3	2	5	13	41	280	86	0
3.5	0	3	7	21	172	48	0
4	0	2	3	13	105	25	0
4.5	0	0	1	7	54	13	0
5	0	0	1	3	27	6	0
5.5	0	0	0	2	14	3	0
6	0	0	0	1	5	1	0
6.5	0	0	0	0	2	1	0
7	0	0	0	0	1	0	0
7.5	0	0					
8	0	0					
8.5	0	0					

CMEMS Wave data south of Tramore Bay

Frequency Distribution of Wave Height by Wave Direction

Representative set of input wave conditions to MIKE21

Input Wave Conditions			Mean wave and wind direction						
Hs (m)	Tp (s)	Wind speed (m/s)	90°	120 °	150 °	180 °	210 °	240 °	270 °
1	4.3	10	run1	run6	run11	run16	run21	run26	run31
2	6.0	15	run2	run7	run12	run17	run22	run27	run32
4	8.5	20	run3	run8	run13	run18	run23	run28	run33
8	12.0	25	run4	run9	run14	run19	run24	run29	run34
12	14.7	30	run5	run10	run15	run20	run25	run30	run35

Wave Runs – Examples in Brittas Bay Model

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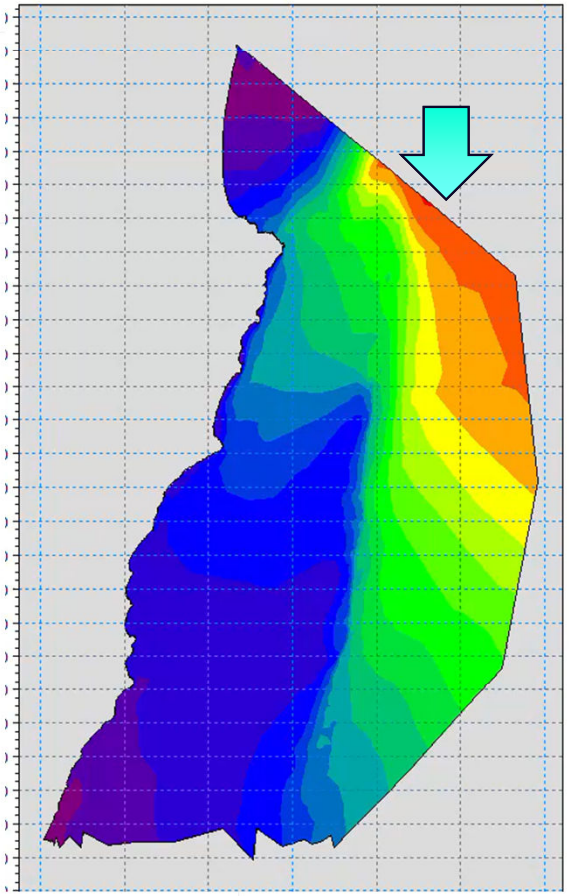

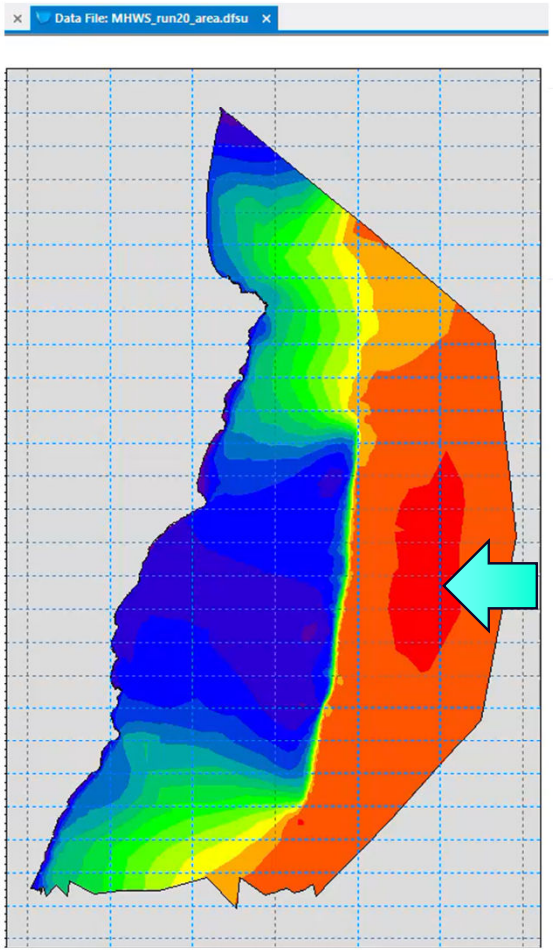

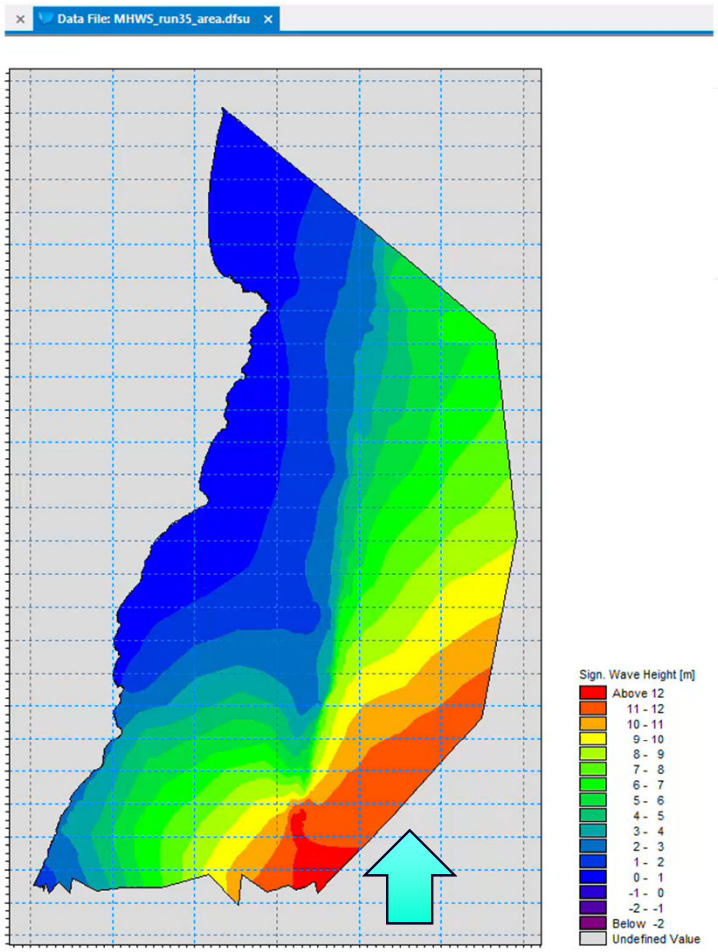

CERC Formula for Sediment Transport

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- Offshore Wave Condition frequency Table
- Transformation Coefficients
- Nearshore Wave Condition Frequency Table
- CERC Formula/Shore Normal
- Net Longshore Sediment Transport

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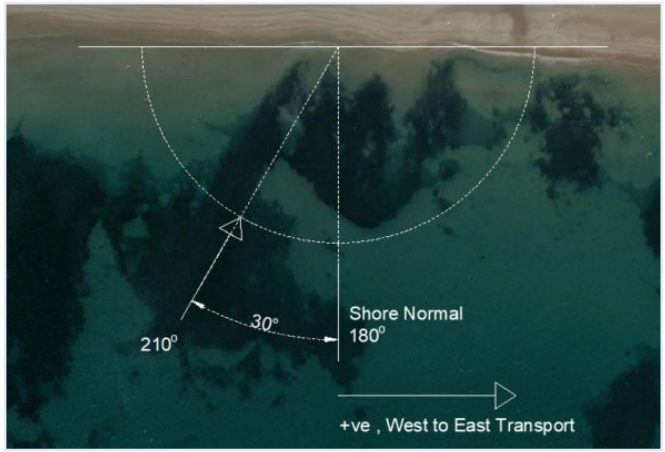
Eg. Tramore Sediment Transport

Net average across all tides, estimate of annual net transport volume (m3)

	T1	T2	T3	T4	T5	T6
East	180,556	373,524	528,150	363,612	826,708	1,903,175
West	- 124,883	- 108,312	- 86,751	- 208,708	- 82,056	-
Total (east plus West)						
Net	55,674	265,212	441,398	154 ,903	744,651	1,903,175



Sample 3-hourly sediment transport volumes (m^3) for Storm Scenarios - 4m waves from the S & SW at High tide

	T1	T2	T3	T4	T5	T6
4m wave						
180°	- 463	- 333	- 224	- 2,336	- 1,366	2,505
210°	830	1,236	1,442	458	989	3,716
240°	1,137	1,919	2,318	2,403	2,968	**4,458**

Summarising Findings and Relevance to CFERM Study

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- Modelling allows us to detail the **typical, prevailing coastal processes** in a study area
  - The inshore wave conditions can be estimated/quantified for changing water level conditions
  - Net transport indicates potential areas of erosion or accretion
- By modelling **extreme storm/wave events** and **changes in sea level** as defined by Mid Range and High End Future Scenarios (MRFS and HEFS), climate change impacts are modelled
- This will inform the potential risks in the area which may need to be mitigated for
- CFERM Plan for any proposed measures of coastal protection or other preferred measures will draw on these findings

1
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