Appendix 1: South West, West and North West Coast Model and Shannon Estuary Model Calibration

1.0 Model Calibration

In order to calibrate the Mike 21 Flexible Mesh model (ISTSM) used for simulating storm surges on the south west, west and north west coasts and the Mike 21 rectangular grid model used for the detailed modelling of the Shannon Estuary, a range of available tide gauge data was collated from various sources, along with information from the Admiralty tide tables. The locations selected for this ISTSM model calibration included Sligo, Killybegs, Malin Head, Cobh, Castletownbere, Moneycashen, Galway and Ballyglass, along with a number of other locations around the British Isles, as a verification of the hydrodynamics of the overall model. Admiralty data for Carrigaholt, Kilrush, Tarbert, Foynes Island and Mellon Point was used for the calibration of the detailed Shannon Estuary model.

1.1 South West, West and North West Coast Model Calibration

Although the number of long-term gauge records along the south west, west and north west coasts is limited, it was possible in some areas to use recorded gauge data of sufficient length to derive tidal harmonics for those locations. These harmonics were then used to predict the astronomic tide levels for the same time period as the model, for comparison with the simulated astronomic tides. The model and its parameters were then optimised as far as possible, whilst retaining manageable runtimes, to achieve the best correlation with the gauge data and to provide the most accurate results. In general, the final calibration data showed good correlation (within 100mm) between the gauge data and the model. A number of sample calibration plots are illustrated in Figure A1.1 to Figure A1.3 for Malin Head, Killybegs and Castletownbere, showing the comparison of the predicted tidal elevations derived using the gauge harmonics with the tidal elevations simulated by the model. It was noted that the calibration for the model applicable to the south west, west and north west coastlines of Ireland was much more straightforward than for the north east or south east coasts, with good correlation between the gauge data and model occurring much more frequently. This was due to the open Atlantic Ocean being the primary influence on the hydrodynamics along the south west, west and north west coastlines, without significant influences from complex water bodies, such as the Irish Sea.

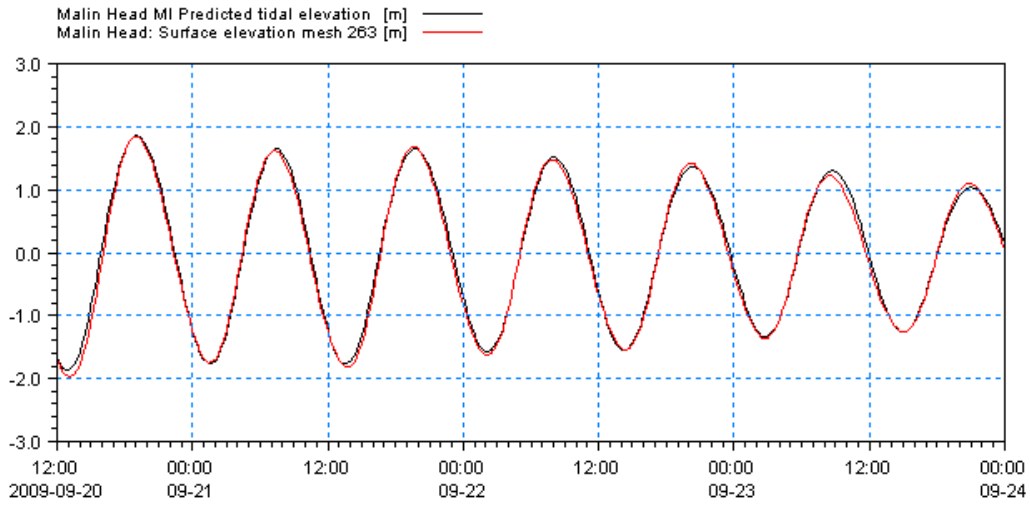

Figure A1.1: Comparison of Predicted Tidal Elevations derived from Tide Gauge Harmonics (black) with Simulated Tidal Elevations from the model (red) at Malin Head

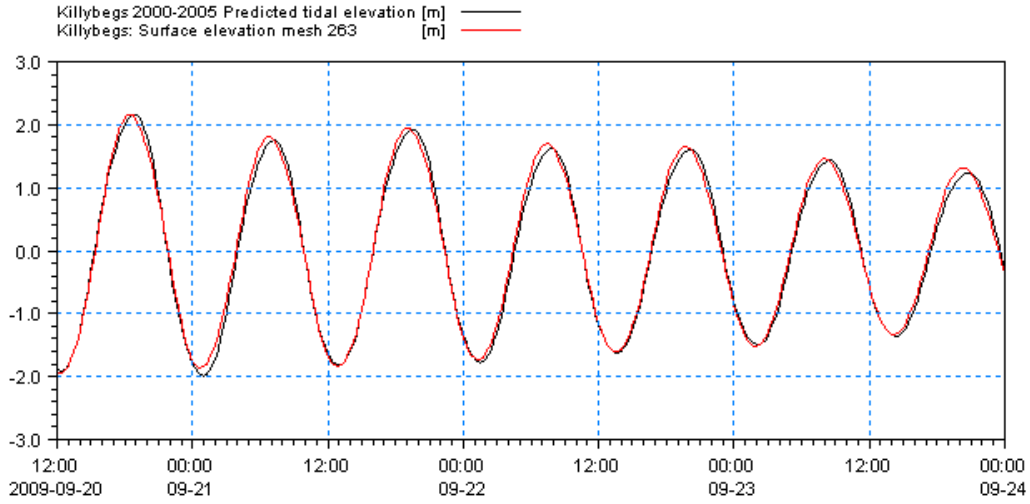

Figure A1.2: Comparison of Predicted Tidal Elevations derived from Tide Gauge Harmonics (black) with Simulated Tidal Elevations from the model (red) at Killybegs

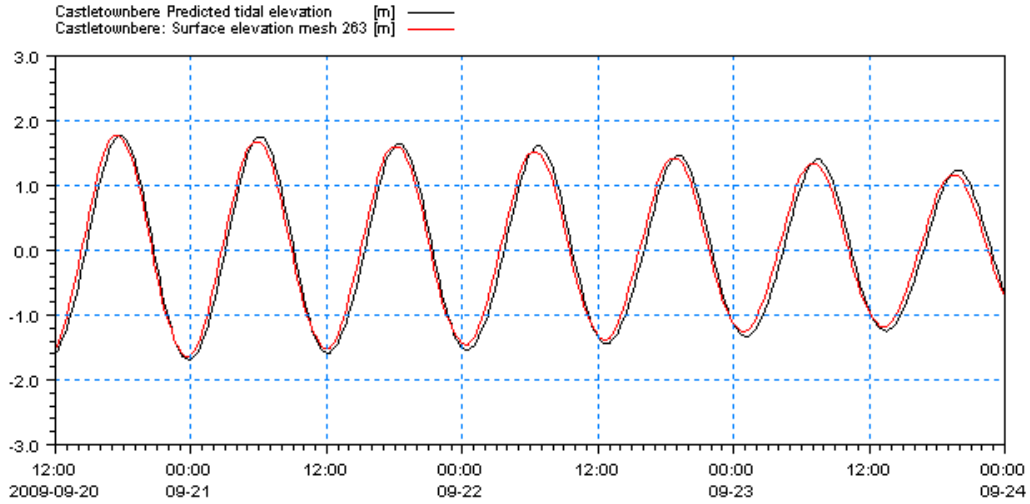

Figure A1.3: Comparison of Predicted Tidal Elevations derived from Tide Gauge Harmonics (black) with Simulated Tidal Elevations from the model (red) at Castletownbere

1.2 Shannon Estuary Model Calibration

Calibration of the Shannon Estuary model proved much more difficult than for the open south west, west and north west coasts, with extensive areas within the model domain, such as the Fergus Estuary, having very little available bathymetric data. The Shannon Estuary is much more complex than the open coastline, and hence required a long optimisation approach, with the adjustment of bathymetry and other model parameters, such as bed resistance and eddy viscosity.

Due to the limited availability of quality digital tide gauge data in the Shannon Estuary, astronomic tide values from the Admiralty tide tables were used for comparison with the model simulation results. Bathymetry adjustment and optimisation of the various modelling parameters were undertaken, until a satisfactory correlation between the model and the Admiralty data was achieved. The final calibration of the astronomic tidal component, indicated that the predicted Mean High Water Spring (MHWS) astronomical tide level at all test locations for which suitable data was available differed from the MHWS value quoted in the Admiralty tide tables by 100mm or less, as shown in Table A1.1.

Table A1.1: Comparison of Admiralty Predicated and Model Simulated Astronomical Tidal Elevations in the Shannon Estuary (Datum is Mean Sea Level)

	MHWS (to MSL)		
	Admiralty (m)	**Model (m)**	**Difference (m)**
Carrigaholt	2.17	2.21	-0.04
Kilrush	2.36	2.26	0.10
Tarbert	2.23	2.25	-0.02
Foynes	2.37	2.39	-0.02
Mellon Point	2.72	2.67	0.05

1.3 Extreme Value Analysis Validation

A limited analysis of the overall accuracy of the predicted AEP extreme total water levels was also undertaken to assess the combined influence of any error margins produced by both the modelling process itself and also the statistical approach adopted for the Extreme Value Analysis (EVA). This was based on a comparison of the results of EVA of the peak total water level events extracted from paper gauge records at Tarbert, with the corresponding model predictions. Tarbert is one of the longest gauge records available on the south west, west or north west coastlines in a central location and thus was used for this purpose.

For all AEP events, the difference in the EVA water levels produced from the Tarbert gauge data and the model results was within the tolerance of ±150mm, as illustrated in Table A1.2. It was noted that for the two AEP events of most interest to this study, the 0.5% and 0.1%, the difference between the results of the EVA of the model and gauge water levels was significantly less than for the other more frequent AEP events. Nonetheless, in all cases the overall accuracy in predicted extreme water levels remained within the predicted tolerance (+/-150mm), with the level derived from the model in all cases being higher and therefore conservative.

Table A1.2: Comparison of Extreme Value Analysis Total Water Levels using Model and Gauge Information at Tarbert (Datum is Mean Sea Level)

	Total Water Level at Tarbert (to MSL)		
Annual Exceedance Probability (AEP) (%)	Model (m)	Gauge (m)	Difference(m)
50	2.846	2.704	0.142
20	2.97	2.843	0.127
10	3.061	2.947	0.114
5	3.151	3.052	0.099
2	3.27	3.189	0.081
1	3.359	3.293	0.066
0.5	3.448	3.397	0.051
0.1	3.653	3.637	0.016

As well as checking the reliability of the extreme water levels at this central point in the Shannon Estuary, a comparison of water levels derived at the mouth of the Estuary showed good correlation between the flexible mesh south west, west and north west coast model water levels and the levels derived using the Shannon Estuary rectangular grid model. Furthermore, final water levels produced for the south west coast were in agreement with results produced for the south coast ICPSS at similar locations. Results for the north west coast fitted well with water levels produced for River's Agency on the north Antrim coast.

Overall the model calibration process indicated that all levels along the south west, west and north west coasts, including the Shannon Estuary, remained within the predicted ±150mm tolerance. As with all other sections of the Irish coastline, an additional ±30mm tolerance should be incorporated to account for possible inaccuracy in the Mean Sea Level (MSL) to O.D. Malin conversion, thus the overall tolerance for the south west, west, north west and Shannon Estuary extreme water levels is considered to be ±180mm. It should be noted that not all areas within the Shannon Estuary model domain may have water levels predicted within this tolerance, as calibration data was only available in certain areas. This was considered when choosing the prediction point locations within the Shannon Estuary.

2.0 Conclusions

In order to produce extreme water levels along the south west, west and north west coastlines of Ireland, including the Shannon Estuary, extensive calibration was undertaken to ensure the results were within the predicted tolerance of ±150mm. The Mike 21 Irish Seas Tidal and Surge Model produced for the south west, west and north west coast storm surge simulations showed good correlation with the majority of the tide gauge data at the various locations available for comparison. The Mike 21 Shannon Estuary Model also showed good correlation with Admiralty tide data, where available.

Both models were therefore considered to be successfully calibrated and fit for the purpose of simulating storm surge water levels along the south west, west and north west coastlines of Ireland and for the prediction of extreme water levels associated with the production of strategic coastal flood hazard (extent and depth) maps. The overall tolerance for the south west, west, north west and Shannon Estuary extreme water levels is considered to be ±180mm, when referenced to OD Malin. It should be noted that not all areas within the Shannon Estuary model domain may have water levels predicted within this tolerance, as calibration data was only available in certain areas. This was considered when choosing the prediction point locations within the Shannon Estuary. It should also be noted for this reason that all prediction points east of the Fergus Estuary hold less reliability than those to the west.