A 3-D MODEL USING REPRESENTATIVE WAVES METHOD FOR SHORELINE MORPHODYNAMICS AROUND COASTAL STRUCTURES

Michael B. Kabiling, Taylor Engineering, Inc., mkabiling@taylorengineering.com

INTRODUCTION

The Fort Pierce Shore Protection Project nourishes a 2.1-km Atlantic Ocean shoreline south of Fort Pierce Inlet in St. Lucie County, Florida. The beach fill erodes nonuniformly with a hotspot along the northernmost 0.7 km requiring nourishment after about two years of normal wave regime. This study validated and applied to beach stabilization a shoreline morphology model to evaluate designs and combinations of coastal structures to increase the nourishment interval.

REPRESENTATIVE WAVES METHOD

Hydrodynamic and spectral wave models quasi-stationary time formulations allowed faster computation of long-term model validation. A littoral process model generated the equivalent effective waves to represent long-term wave climate and water levels at the model's offshore boundary. Figure 1 shows good agreement in the calculated cross-shore variations of the longshore transports for the full time series of waves and the selected representative waves for the one-year calibration period. This indicates the selected representative waves produce comparable net longshore transport as the full time series of waves and therefore can substitute for the full time series of waves to shorten the model computation time.

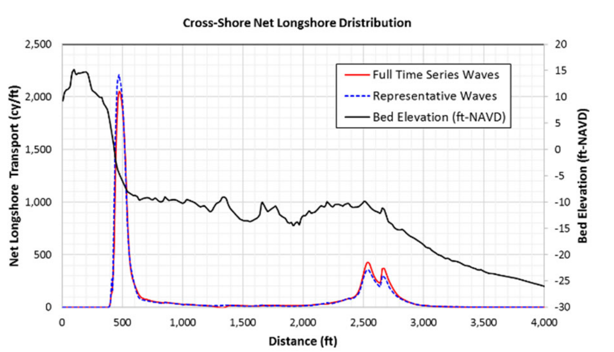

Figure 1 - Cross-shore distribution of longshore transport one year after 2007 beach nourishment

Table 1 shows the comparison of the shoreline morphology model calculated and measured onshore (negative) and offshore (positive) shoreline net movement one year after beach nourishment. The model provided good estimates of the erosion (shoreline recession) at monuments R-35, T-36, T-37, R-38, and T-40 where model results are within 6.7 m of data. The model overestimated erosion at monument R-34 and provided small accretion instead of erosion at monuments R-39 and T-41. The model results are generally consistent with the observed erosion pattern from monuments R-34 to R-38. Best agreement with measurement is from monuments R-35 to R-38–the specific area where the model was used to evaluate beach stabilization.

Table 1 - Measured and modeled shoreline net movement one year after beach nourishment

Monument	Measured (m)	Modeled (m)	Difference (m)
R-34	-78.9	-120.1	-41.1
R-35	-33.2	-39.9	-6.7
T-36	-26.5	-26.8	-0.3
T-37	-10.1	-13.1	-3.0
R-38	-8.5	-11.6	-3.0
R-39	-11.3	16.5	27.7
T-40	-8.5	-4.3	4.3
T-41	-8.8	4.6	13.4

RESULTS OF ANALYSIS

Simulations of long-term normal tides, waves, and storm conditions show (a) shoreline movement pattern similar to the general historical pattern observed in the project area, including accurately indicating the largest erosion rate and shoreline retreat along the first 0.7 km south of the jetty; (b) the coastal structures retain beach fill longer, resulting in lower erosion rates from 0.8 to 6.4 km south of the jetty (Figure 2); and (c) the coastal structures alternative extends the normal beach nourishment interval from the current two years to four years.

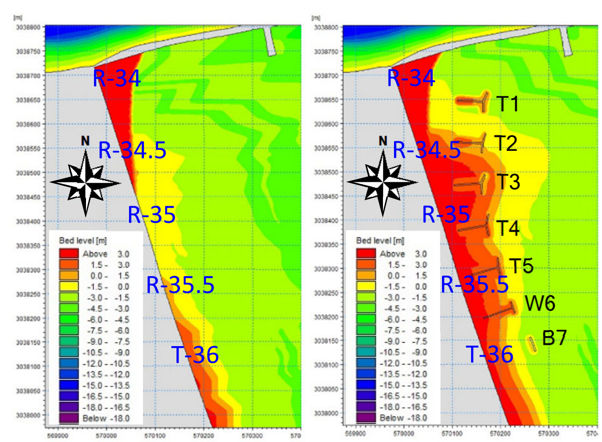

Figure 2 - Shoreline morphology after three years without coastal structures (left) and with coastal structures (right)

CONCLUSIONS

Application of representative waves allows accurate and efficient modeling of long-term 3-D beach and shoreline deformation. Finding the optimal set of coastal structures for a more uniform erosion rate requires further evaluation of different combinations of coastal structures including refining the locations and geometry of the structures.