TAKING A DEEP DIVE INTO FDEP'S DUNE EROSION MODEL FOR 100-YEAR STORM EROSION ANALYSIS

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FDEP'S DUNE EROSION MODEL (CCCLr)

Why CCCLr model?

- Pursuant to section 3109, Florida Building Code, all habitable structures seaward of the Coastal Construction Control Line (CCCL) shall satisfy FDEP's 100-year storm elevation requirements.
- An applicant may request for a site-specific 100-year storm elevation for the proposed habitable structure as part of the CCCL permit application process.
- The Department uses 'CCCLr' Dune Erosion Model to simulate the erosion of beach and dune system following a major storm event of 100-year return interval.

FDEP'S DUNE EROSION MODEL (CCCLr)

Why CCCLr model?

- 100-year storm elevation – wave on top of storm surge.
- Design Grade – predicted eroded profile caused by 100-year storm event.

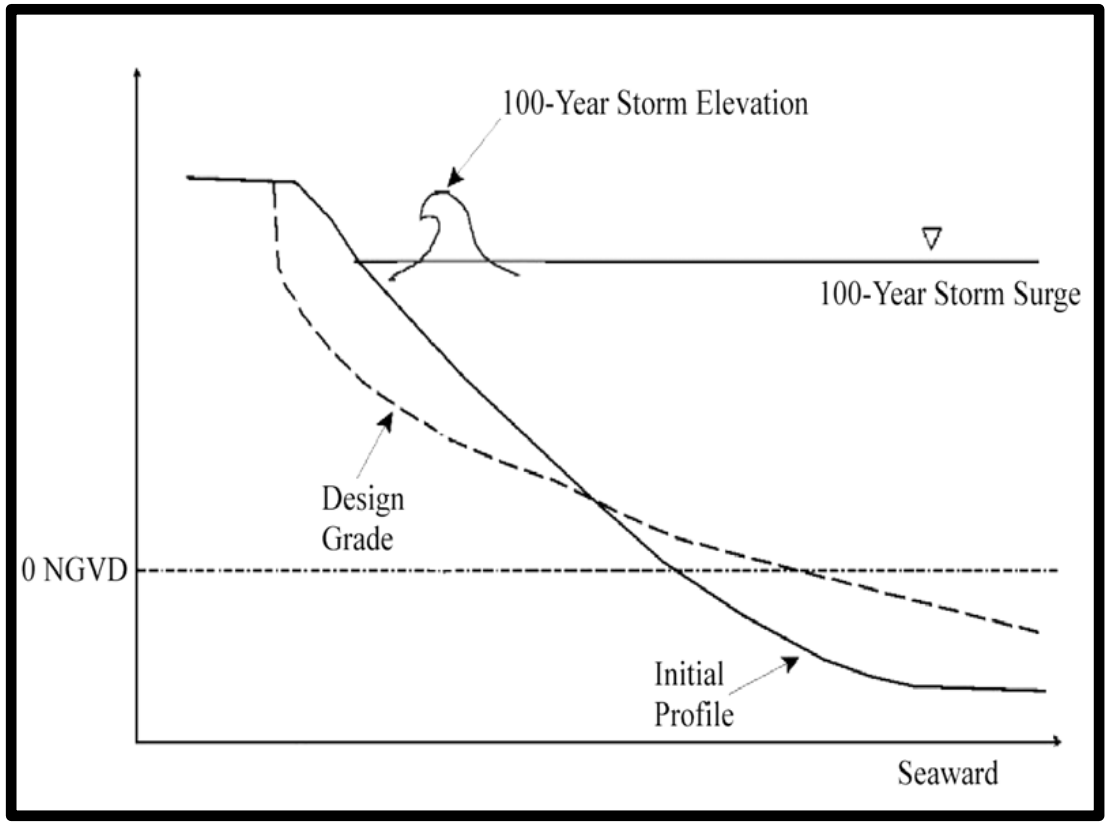


Image source: One-Hundred-Year Storm Elevation Requirements for Habitable Structures Located Seaward of a Coastal Construction Control Line

FDEP'S DUNE EROSION MODEL (CCCLr)

Why CCCLr model?

- Minimum elevation of the lowest horizontal structural member.
- Maximum elevation or minimum depth of the pile cap.

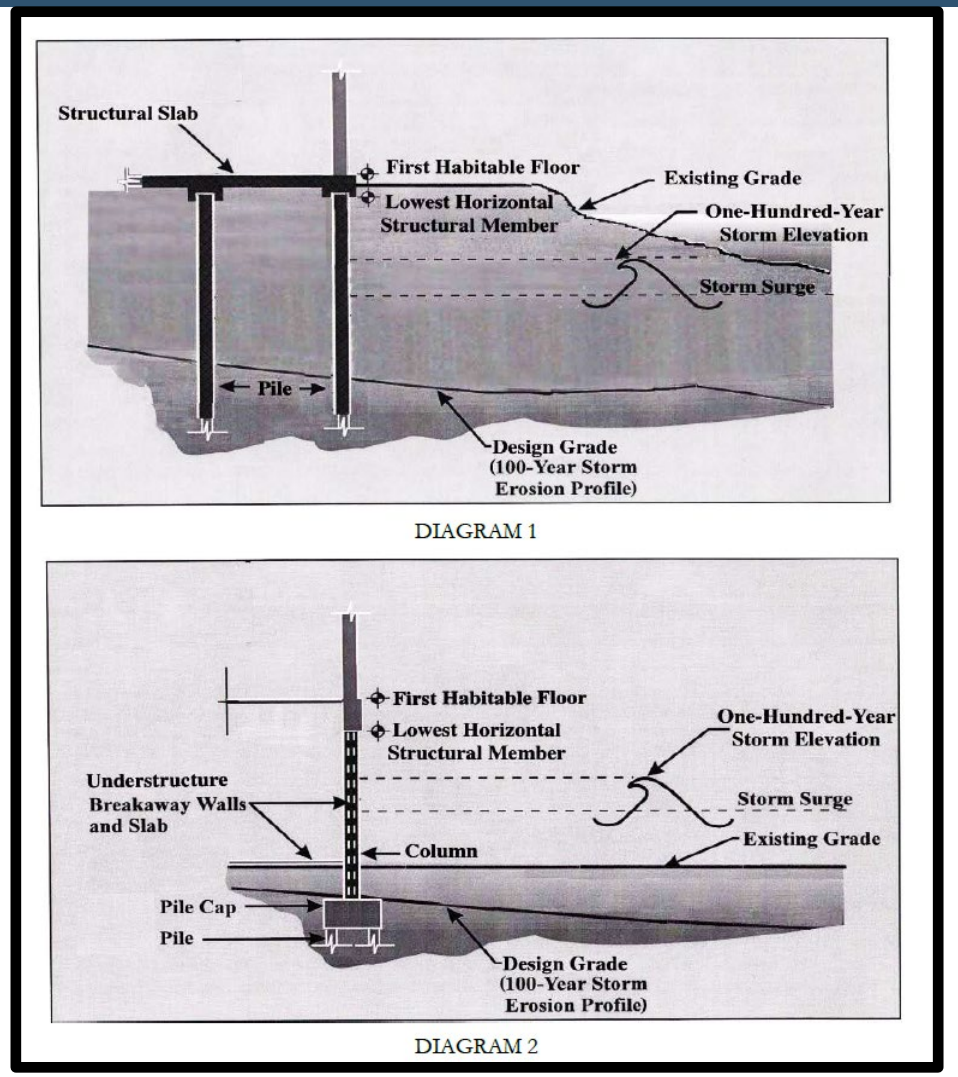
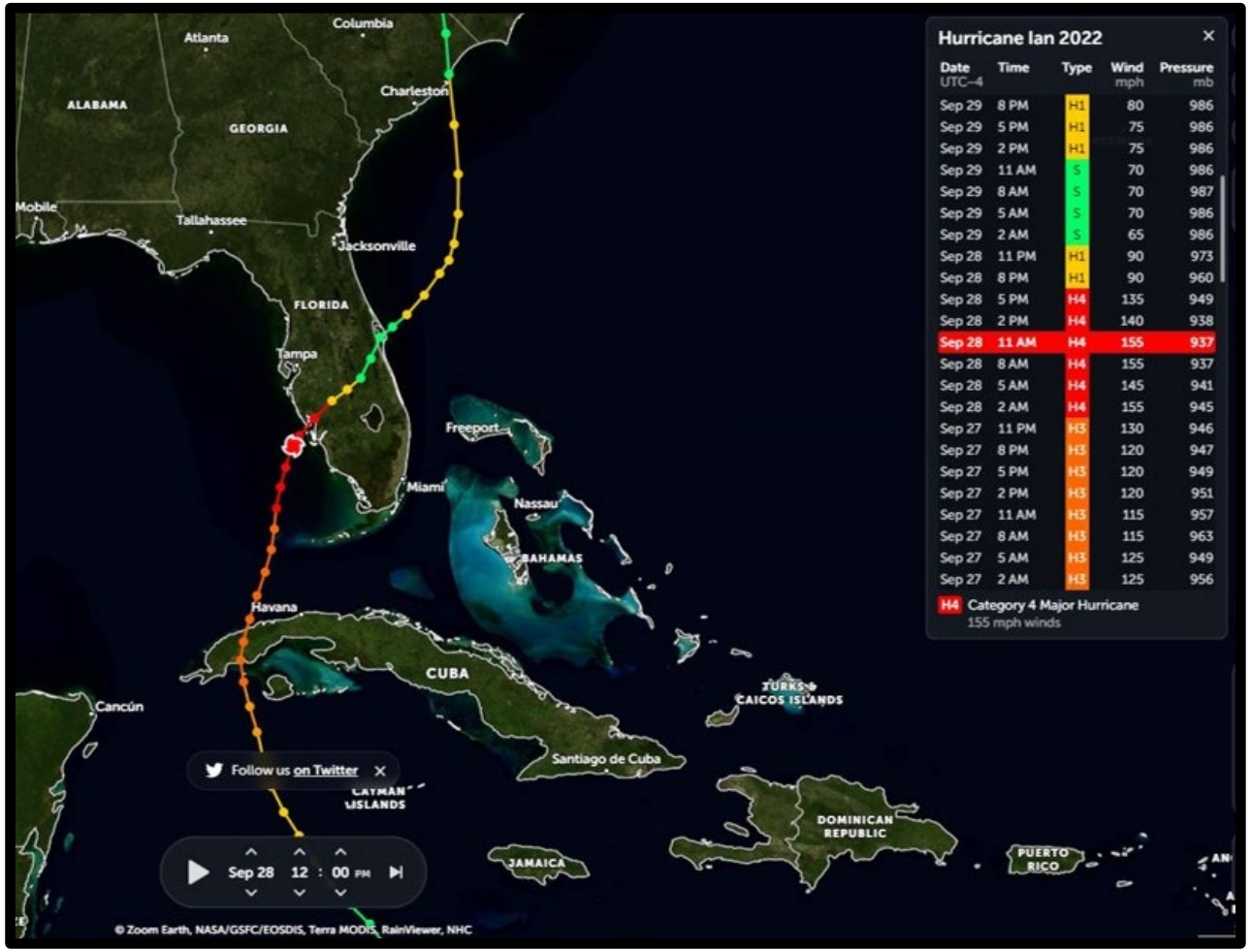


Image source: [One-Hundred-Year Storm Elevation Requirements for Habitable Structures Located Seaward of a Coastal Construction Control Line]

100-YEAR STORM – A RECENT EXAMPLE

Hurricane Ian (September 2022)

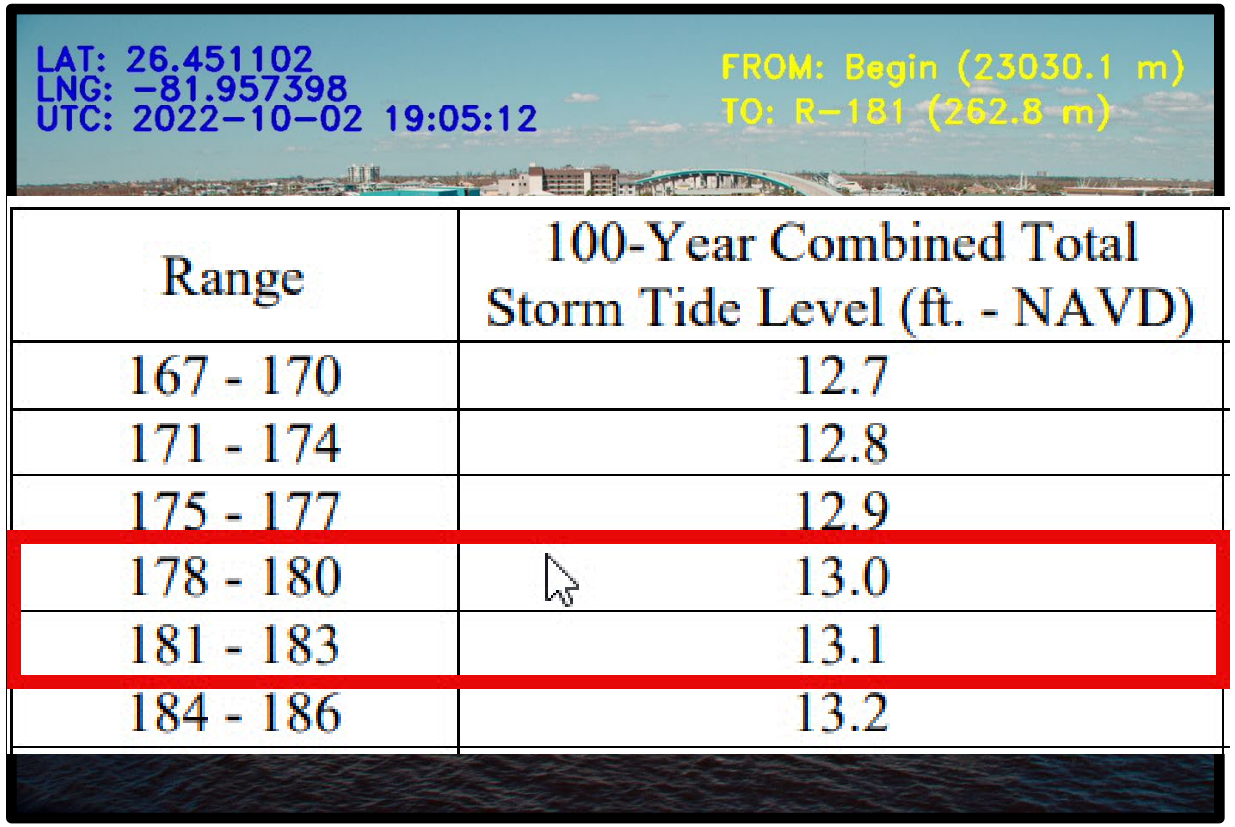
- Category 4 hurricane made landfall on southwest Florida at Cayo Costa in northern Lee County.
- Maximum sustained wind of 150 mph at landfall.
- Observed storm surge in excess of +13 ft-NAVD on Estero Island and southern Sanibel Island.



Hurricane Ian (2022) Track (source: Zoom Earth)

100-YEAR STORM – A RECENT EXAMPLE

Fort Myers Pier, Lee County (R-181)



Range	100-Year Combined Total Storm Tide Level (ft. - NAVD)
167 - 170	12.7
171 - 174	12.8
175 - 177	12.9
178 - 180	13.0
181 - 183	13.1
184 - 186	13.2

Max. Storm Tide Elevation +13.23 ft - NAVD

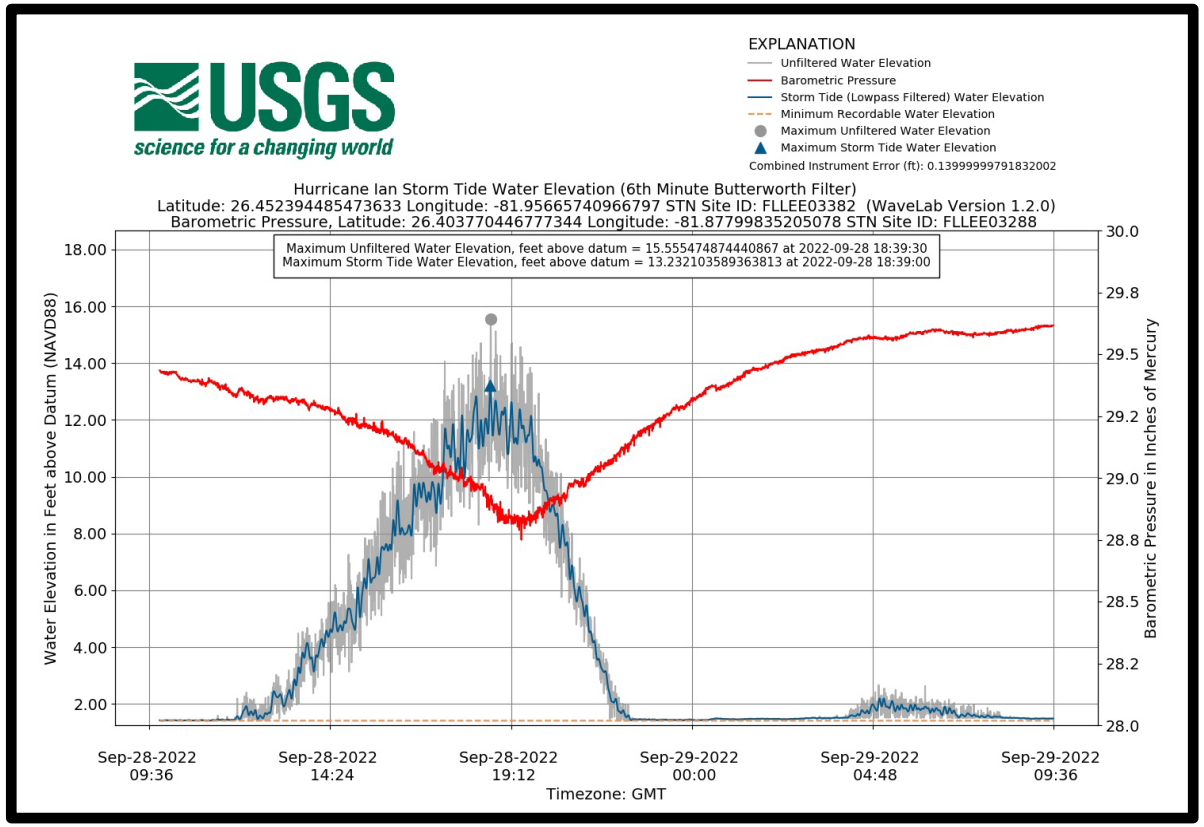
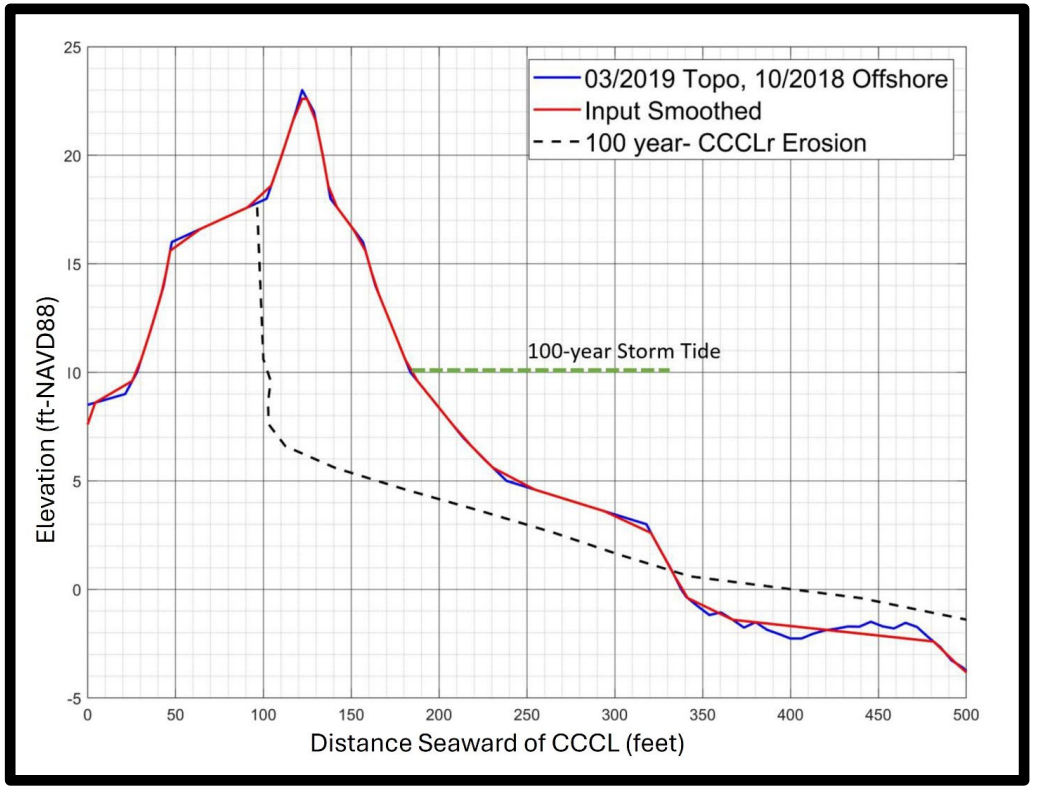


Image source: [Hurricane Ian & Hurricane Nicole Post Storm Beach Conditions and Coastal Impact Report | Florida Department of Environmental Protection]

FDEP'S DUNE EROSION MODEL (CCCLr)

What is FDEP's Dune Erosion Model?

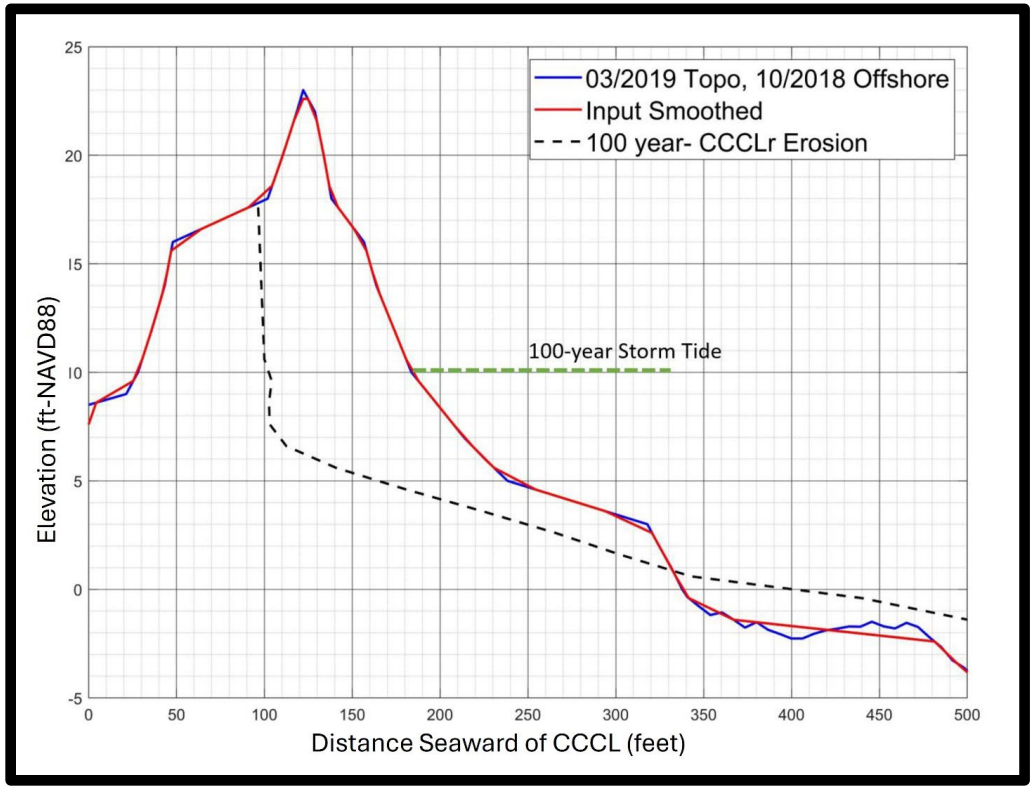
- The original version of the model was developed by Dr. Robert Dean at University of Florida.
- The model results formed the basis for establishing Florida's CCCL.
- Source code was written using FORTRAN programming language.
- Revisions were made in 1996 resulted in the version (CCCLr) that is currently in use.



FDEP'S DUNE EROSION MODEL (CCCLr)

What is FDEP's Dune Erosion Model?

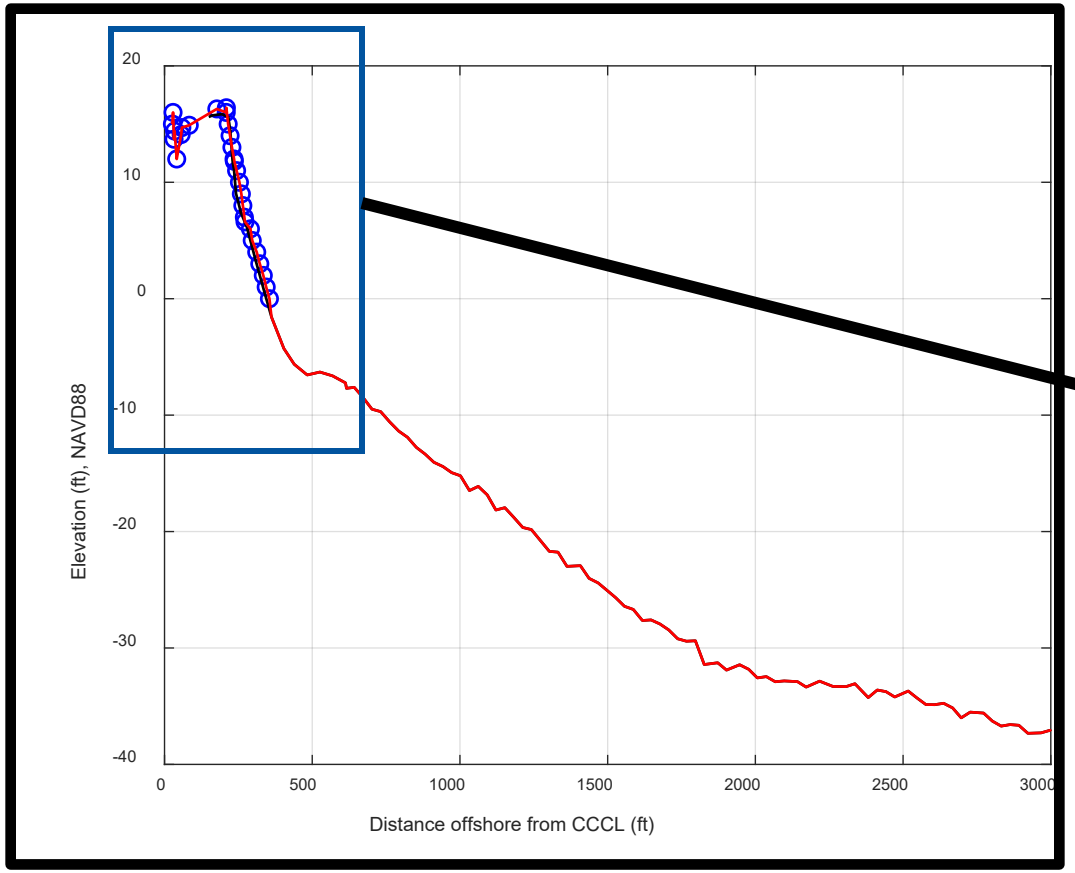
- A parameterized representation of the erosion process.
- Simultaneously solves cross-shore sediment transport and continuity equation.
- Simulates the erosion of beach and dune system following a 100-yr storm.

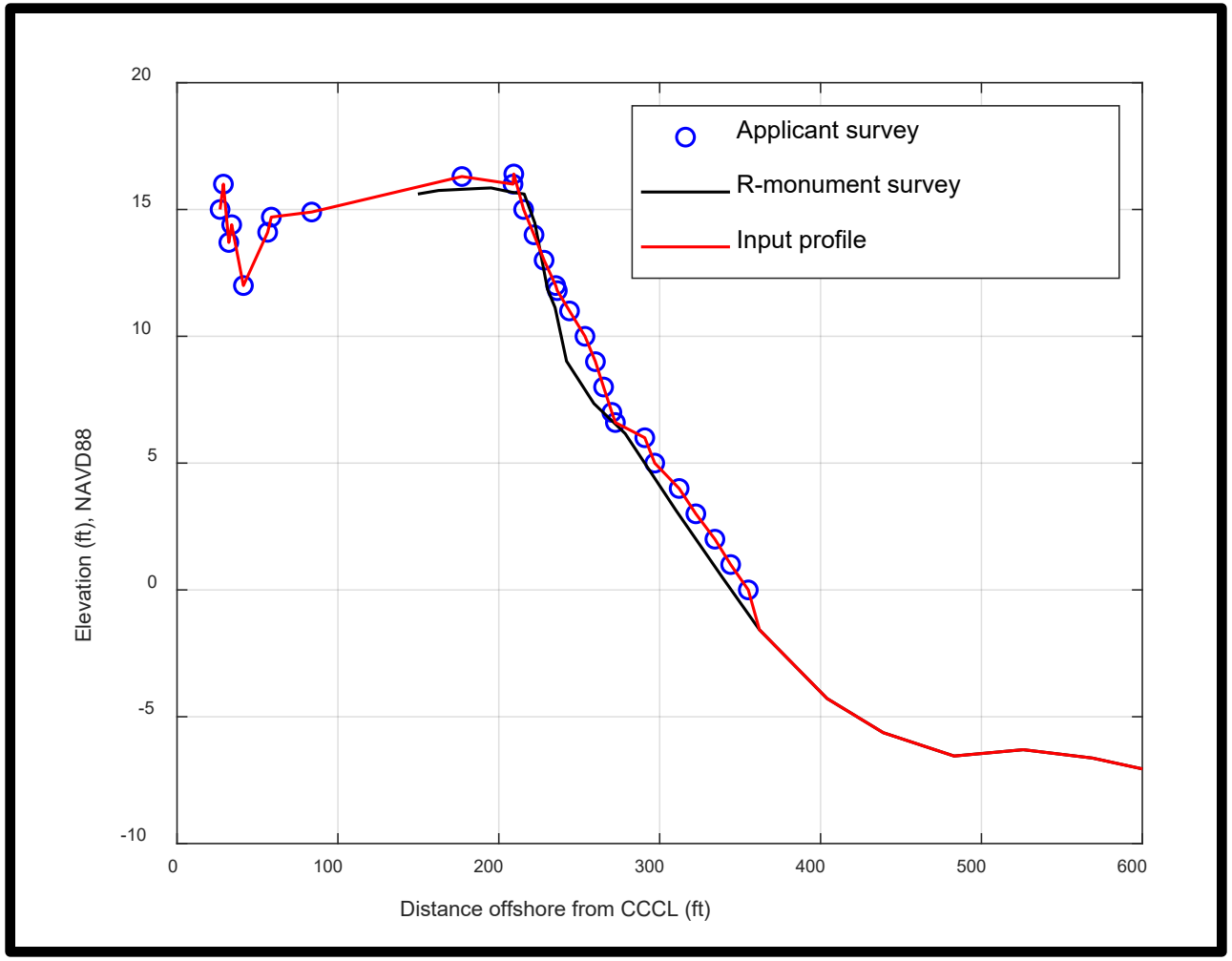


CCCLr MODEL – CREATING THE INPUT PROFILE

- A recent topographic survey from the applicant (*Rule 62B-33.0081 F.A.C.).*
- Beach and upland elevations from the applicant's survey.
- Within an active nourishment project area:
  - The nourishment section of the profile shall use a pre-construction survey from a nearby FDEP R-Monument.
  - The applicant's survey is used for non-nourishment areas or where it is deemed that equilibrium of the nourishment project has occurred.
- The offshore part of the profile is created from the nearest and most recent R- Monument survey (Historical Shoreline Database) and appended at the lowest contour.

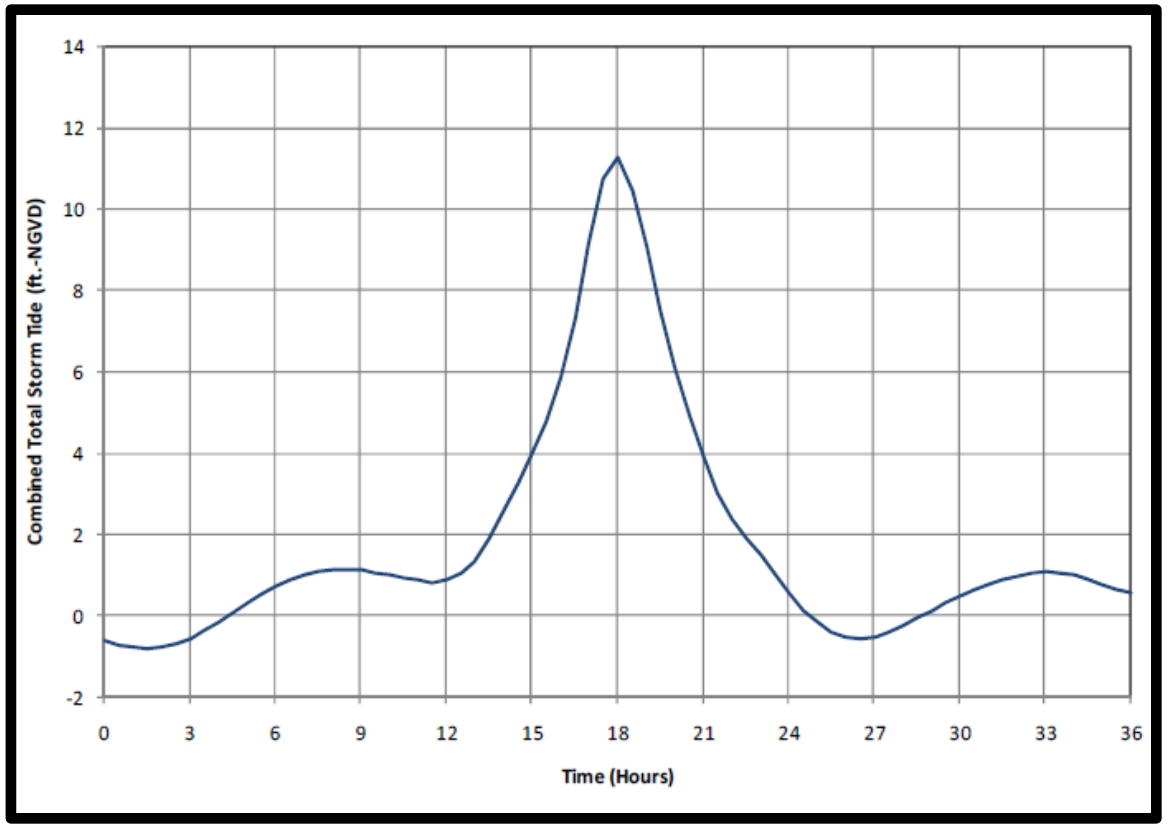
CCCLr MODEL – CREATING THE INPUT PROFILE





CCCLr MODEL INPUT – HYDROGRAPHS

- 100-Year Hydrograph and Surge Level correspond to the nearest R-Monument to the subject property.
- Different hydrographs were generated for all coastal counties in Florida in where a CCCL was established.
- 36-hour hydrograph for most of the counties, but a few have 48-hour hydrograph.
- Time step of hydrograph is 0.5 hour.



CCCLr MODEL – STRICT FORMAT OF INPUT FILES

- Input files must adhere to specific formatting requirements to successfully run the Model in FORTRAN.
  - number of columns (10)
  - precise spacings
  - number of profile points must be known

```
2023-JAN INDIAN RIVER MONITORING SURVEY BY MAE |NAVD88 FL-EAST SPC
R-1   JAN2023 00 1172816.410  875696.950  70.0010.17
      11JAN23 10JAN23 176  0 25145

  22.0   9.50  41.1   8.60  58.6   9.50 125.6  11.20 128.8  11.50
 141.4  12.60 175.3  13.50 188.8  13.50 191.5  12.00 194.4  12.00
 201.6  12.30 209.6  12.30 217.0  12.30 241.1  11.50 256.2  10.70
 271.6  11.50 291.0  11.50 312.6   9.50 332.8   7.70 348.8   7.90
 373.6   9.50 421.8  11.50 430.6  11.50 448.0   9.50 479.8   7.50
 498.5   5.50 518.7   3.50 543.5   1.50 553.2   1.20 573.1  -1.10
 599.1  -1.90 621.4  -2.90 645.2  -4.60 665.7  -6.10 681.8  -7.05
 690.8  -7.10 702.7  -7.83 723.6  -8.75 743.0  -9.99 764.0 -10.99
 783.7 -11.70 803.5 -12.25 822.5 -13.03 844.9 -13.72 871.6 -14.35
 891.5 -15.44 921.4 -15.36 941.1 -15.97 961.9 -16.24 981.8 -16.05
1006.3 -15.86 1027.8 -16.17 1059.6 -15.58 1093.0 -15.86 1119.4 -15.93
1138.6 -16.31 1170.3 -16.34 1190.6 -16.92 1211.3 -16.53 1230.3 -15.27
1250.4 -15.66 1278.3 -16.10 1302.8 -14.69 1327.9 -14.87 1348.7 -14.37
1368.3 -14.69 1398.9 -15.38 1418.2 -15.69 1449.2 -15.59 1470.8 -15.98
1496.2 -15.90 1515.7 -16.08 1535.5 -15.27 1565.1 -15.38 1595.1 -14.00
1616.6 -14.93 1645.4 -13.43 1666.8 -12.93 1686.0 -13.76 1706.5 -14.32
1736.4 -13.91 1758.9 -14.67 1796.5 -14.19 1821.0 -14.47 1840.1 -13.12
1859.1 -14.12 1891.2 -14.15 1910.6 -14.69 1933.9 -13.43 1953.3 -12.64
1979.2 -13.75 2009.0 -13.98 2041.3 -13.43 2062.9 -13.91 2082.4 -13.12
2102.8 -13.18 2122.1 -13.66 2154.3 -13.28 2181.9 -13.25 2203.4 -13.81
2222.6 -12.76 2242.2 -13.58 2261.4 -14.04 2294.5 -14.34 2314.0 -13.32
2339.4 -14.65 2359.6 -15.34 2391.9 -14.63 2417.0 -15.03 2442.1 -14.48
```

DEEP DIVE INTO CCCLr MODEL

Two Major Objectives

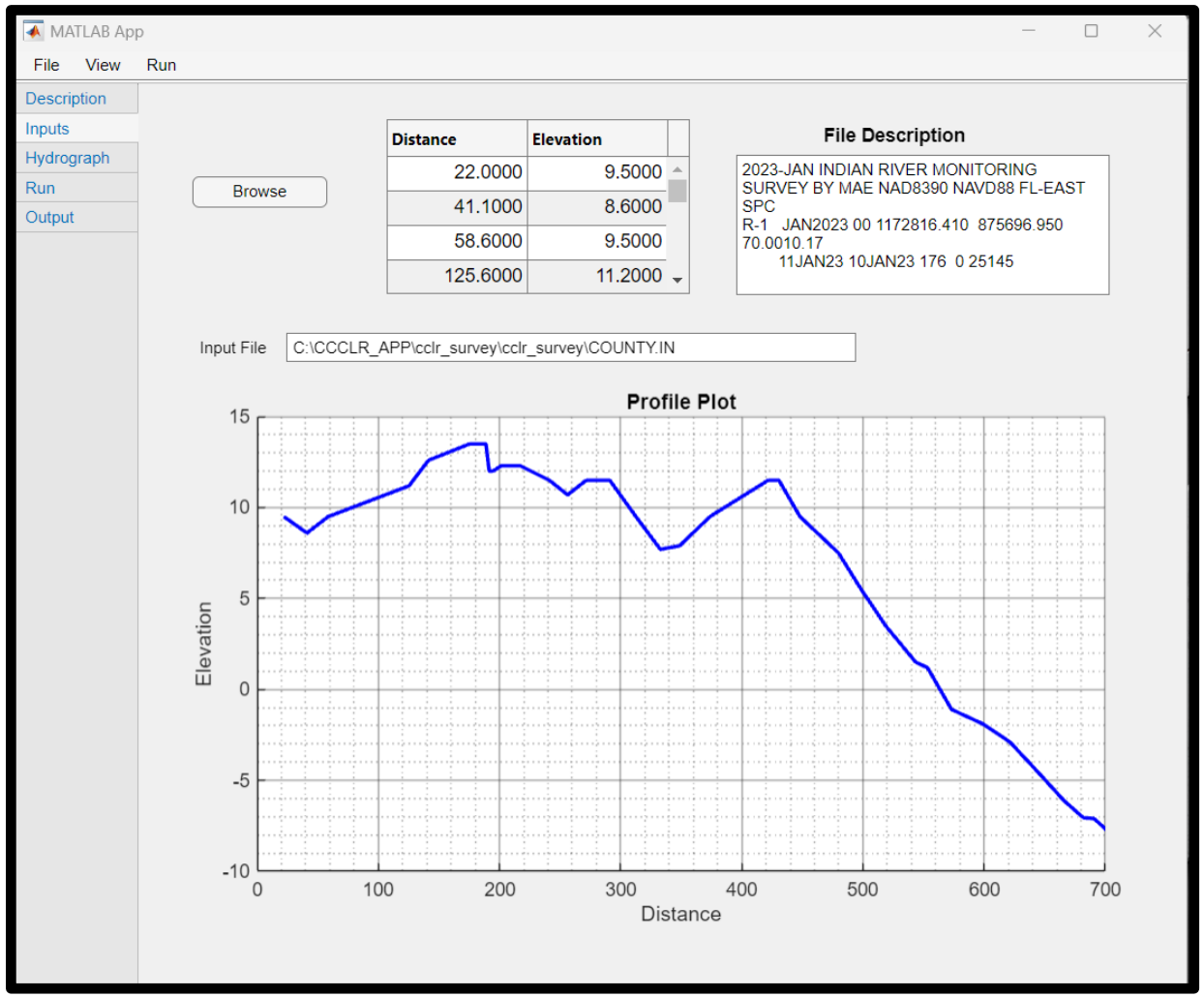
- Firstly, better understanding of the model structure and execution steps of the source code.
- Secondly, convert the source code to other widely used programming languages such as MATLAB and Python.
- This brings flexibility in the formatting of input files and eliminates additional steps in post-processing of model results for visualization.
- Develop a Graphical User Interface (GUI) - enhanced user experience.

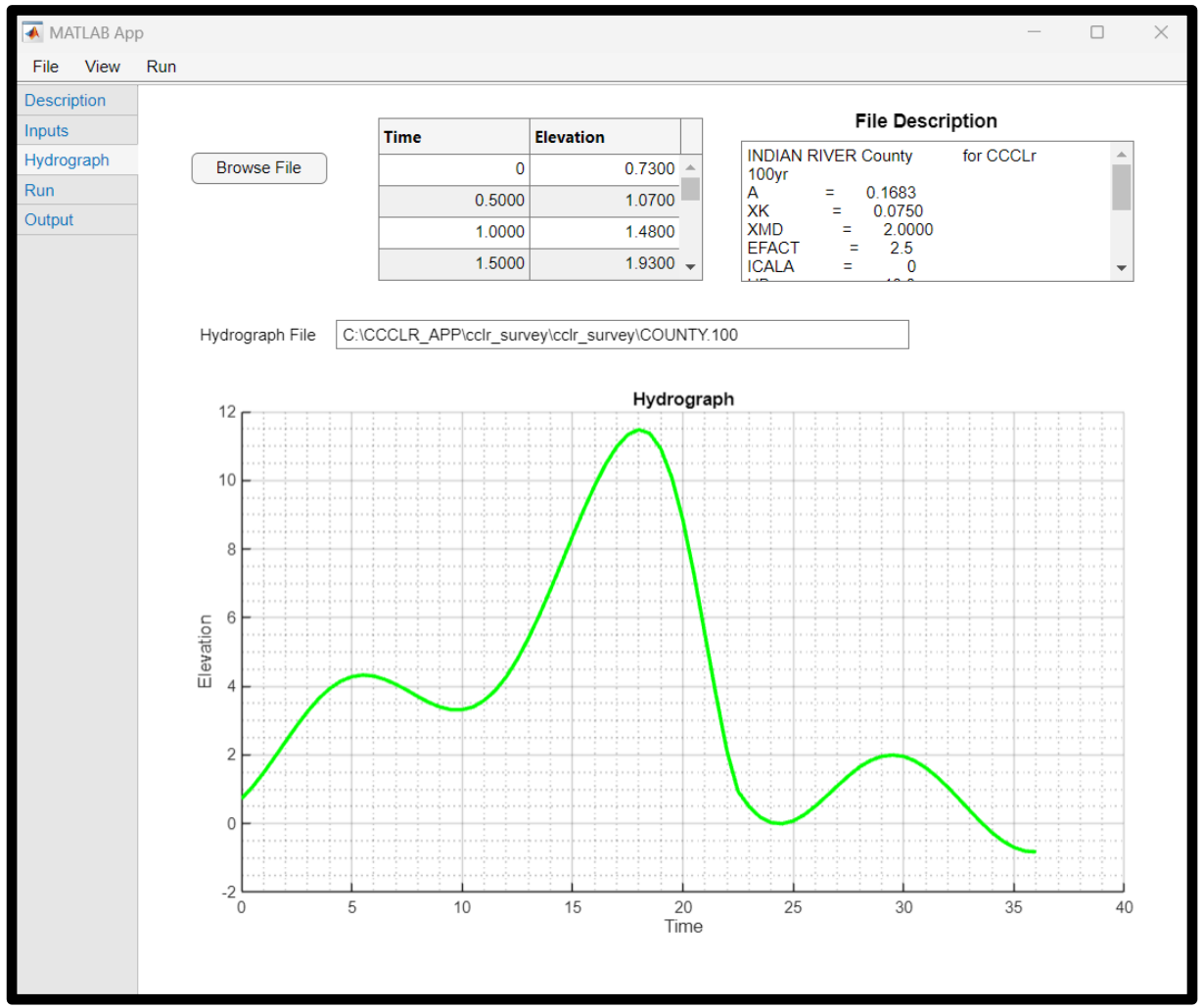
CCCLr MODEL – GRAPHICAL USER INTERFACE (GUI)

- Strict file formatting is not required, ensuring flexibility in workflows.
- Input data can be modified and visualized seamlessly through the GUI.
- Visualize intermediate steps of model simulations.
- The model's sensitivity to various parameters can be thoroughly analyzed.
- Experiments can be conducted to evaluate the model's response to changes in critical parameters.
- Model outputs, including images and animations, are available for real-time viewing and export.

CCCLr MODEL – GRAPHICAL USER INTERFACE (GUI)

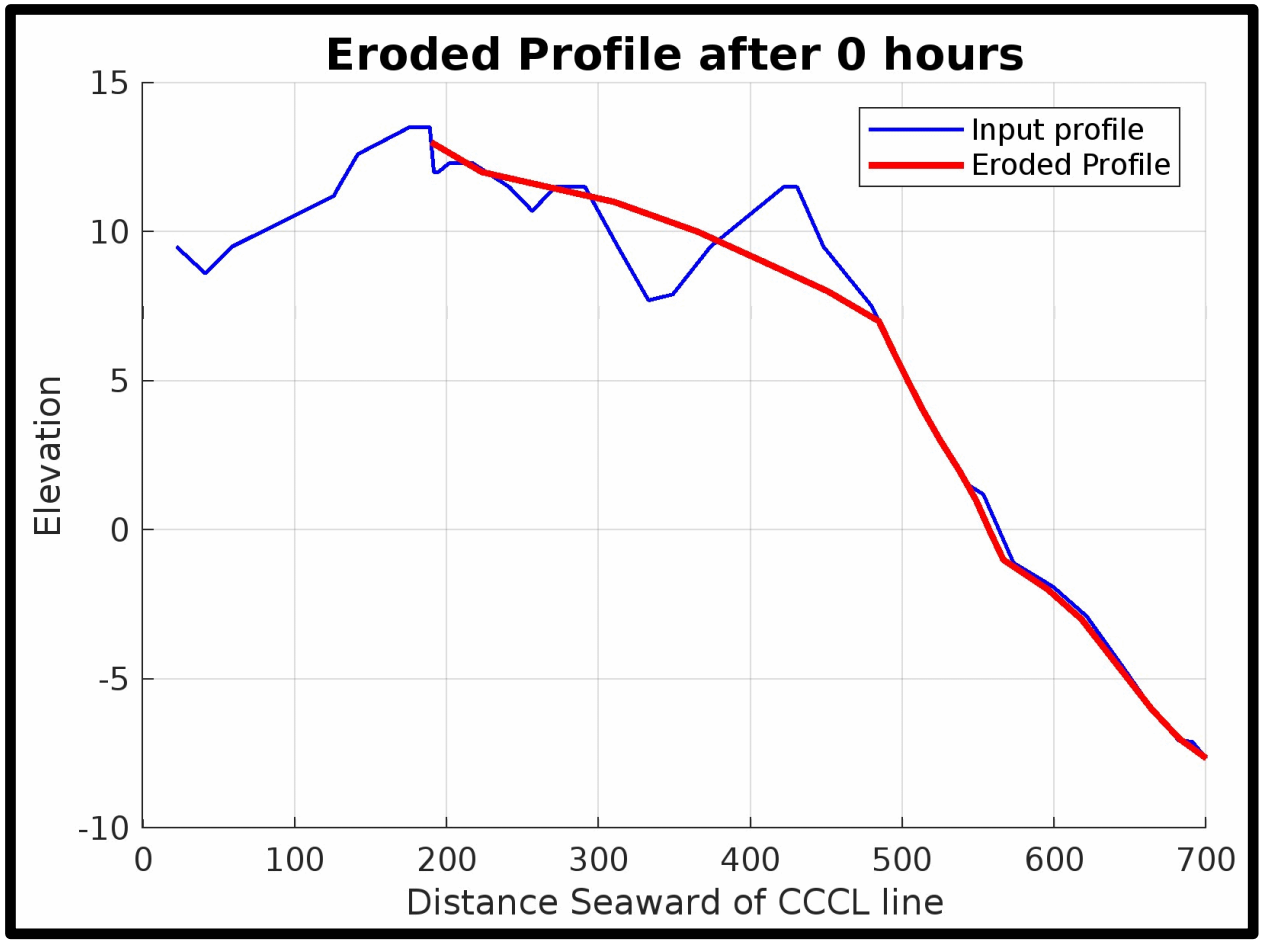
Input data can be modified and visualized





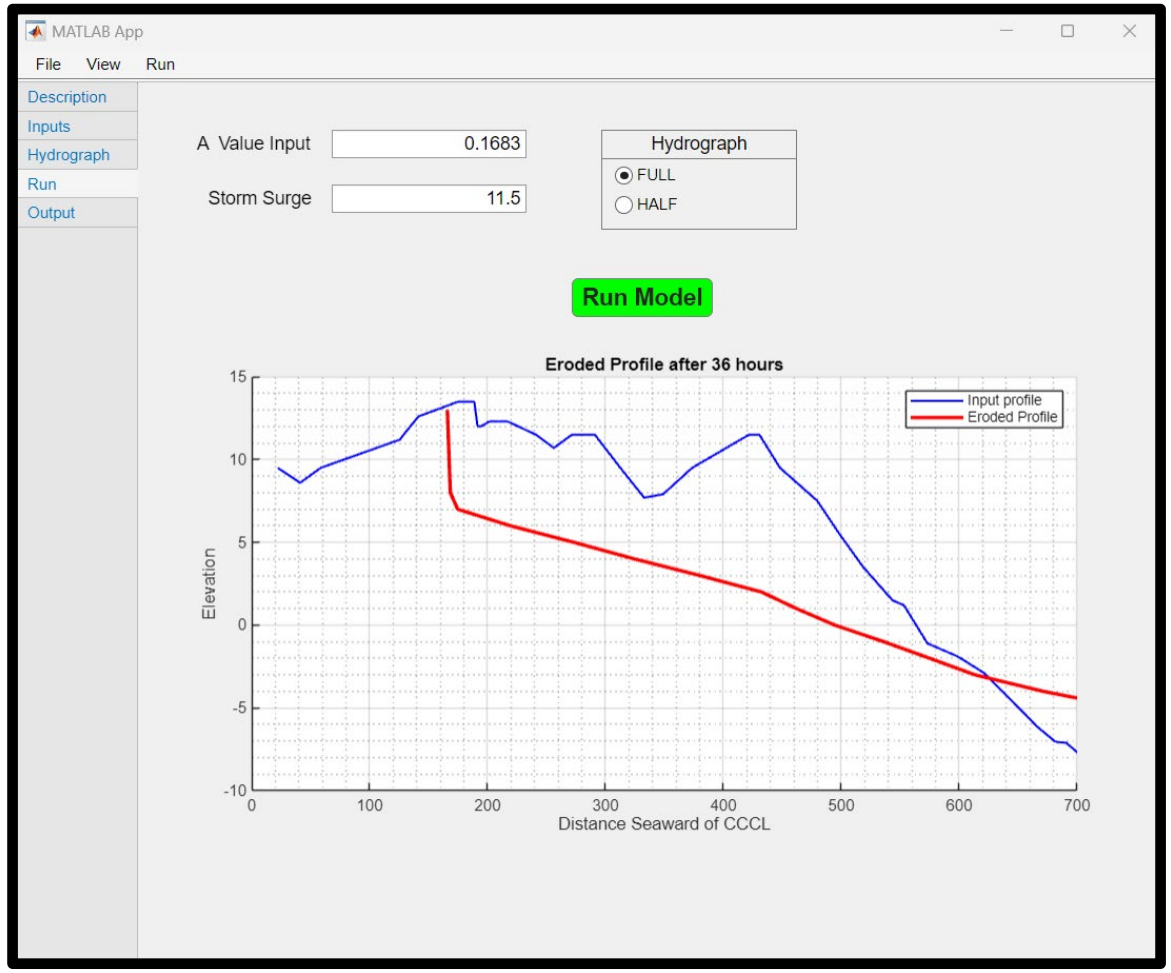
CCCLr MODEL – SIMULATION

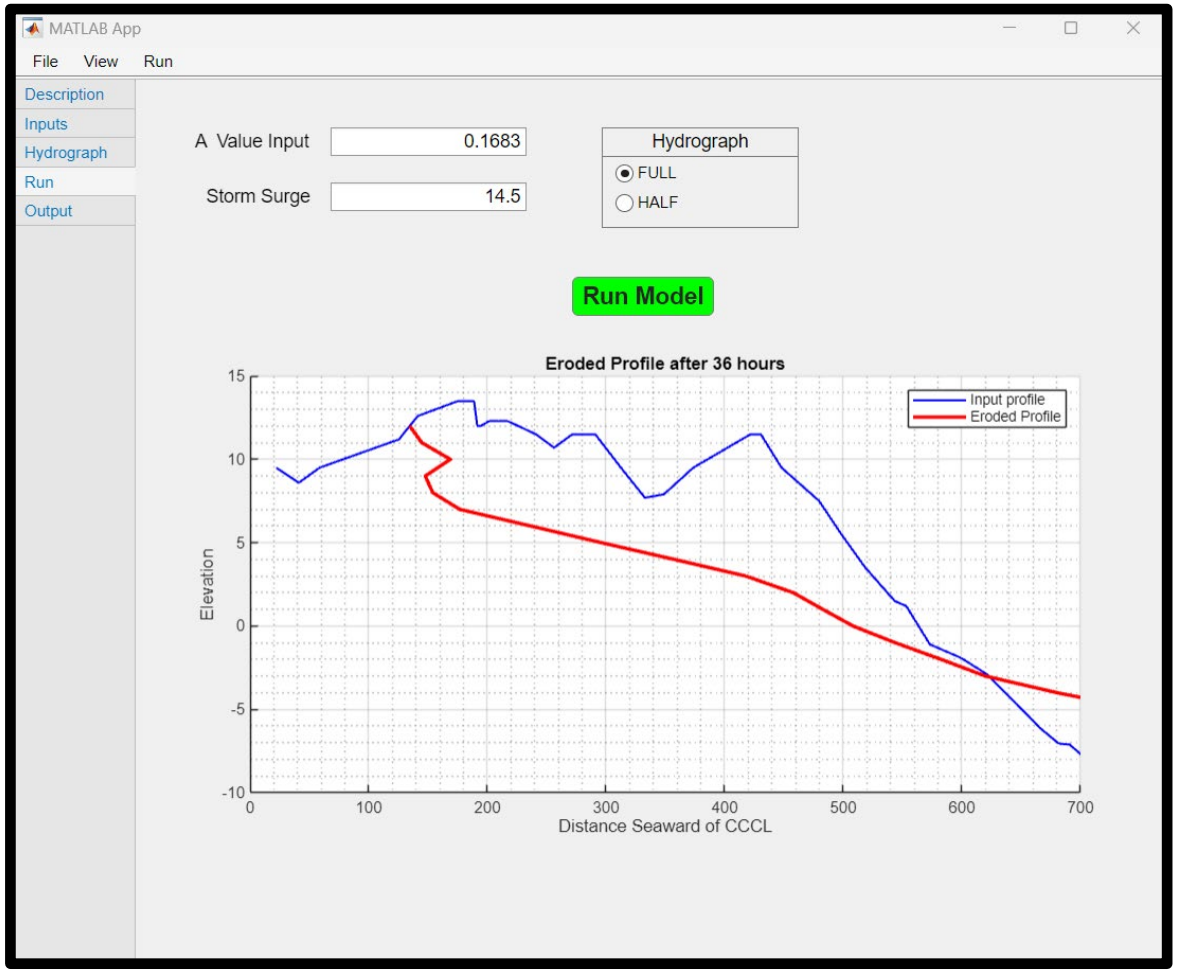
Intermediate steps can be explored



CCCLr MODEL – EXPERIMENTS

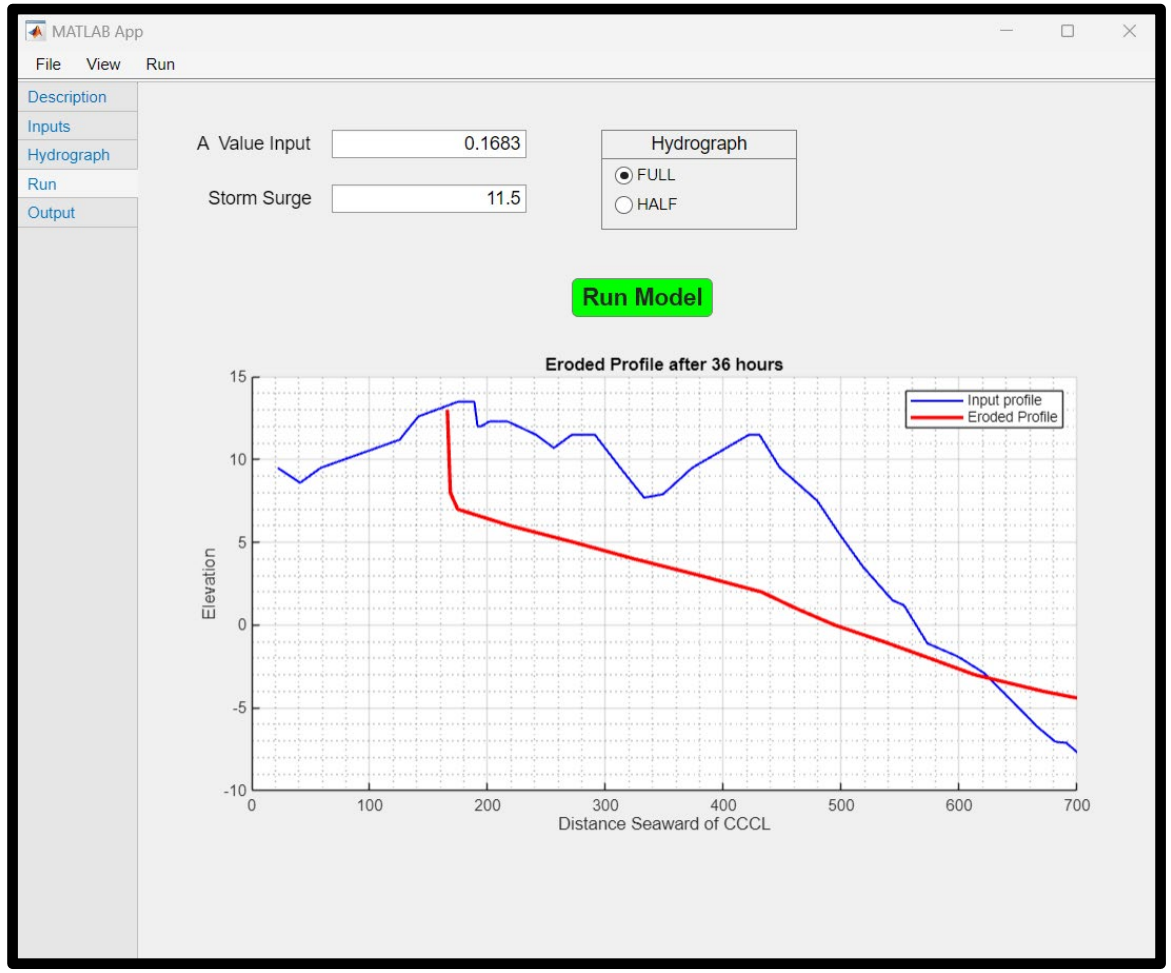
Model's sensitivity to critical parameter – Storm Surge

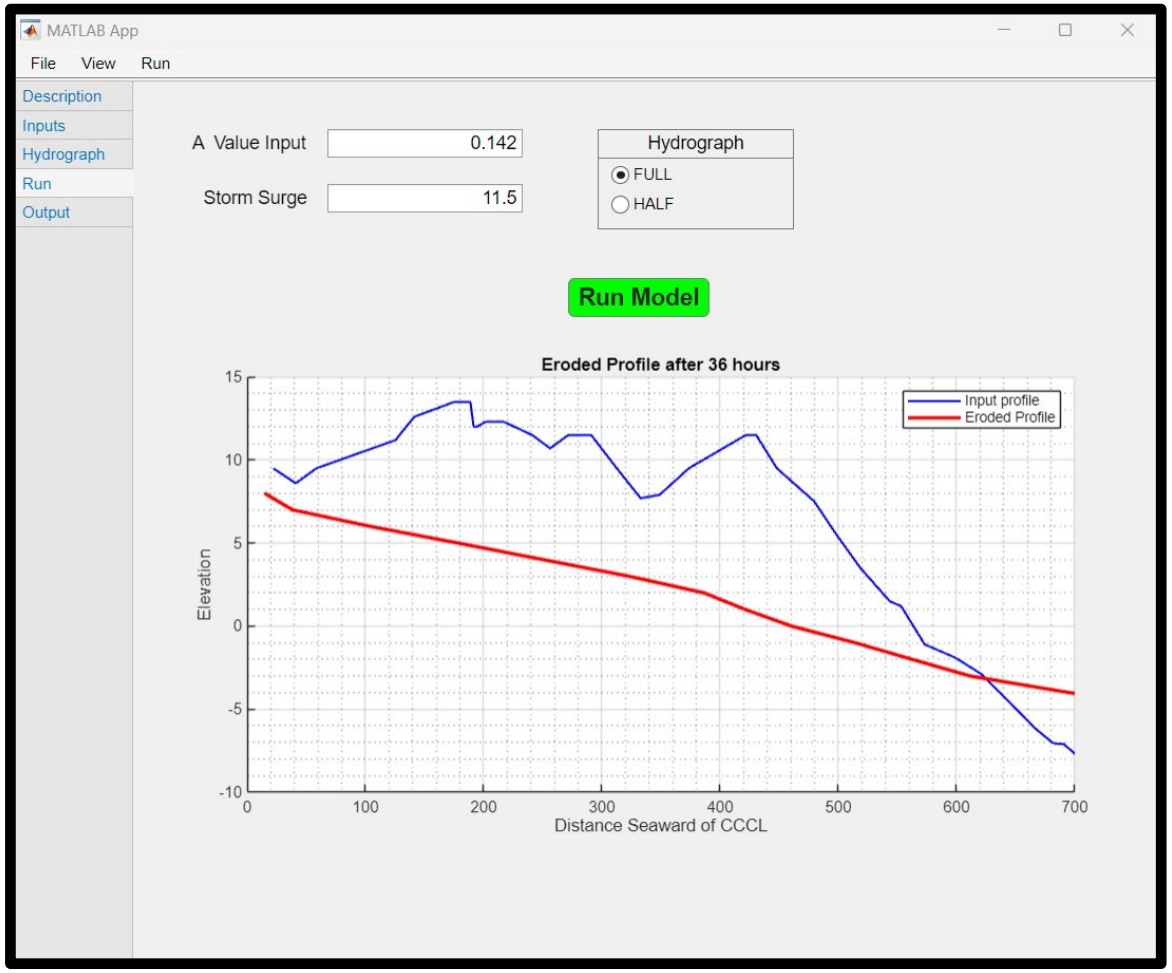




CCCLr MODEL – EXPERIMENTS

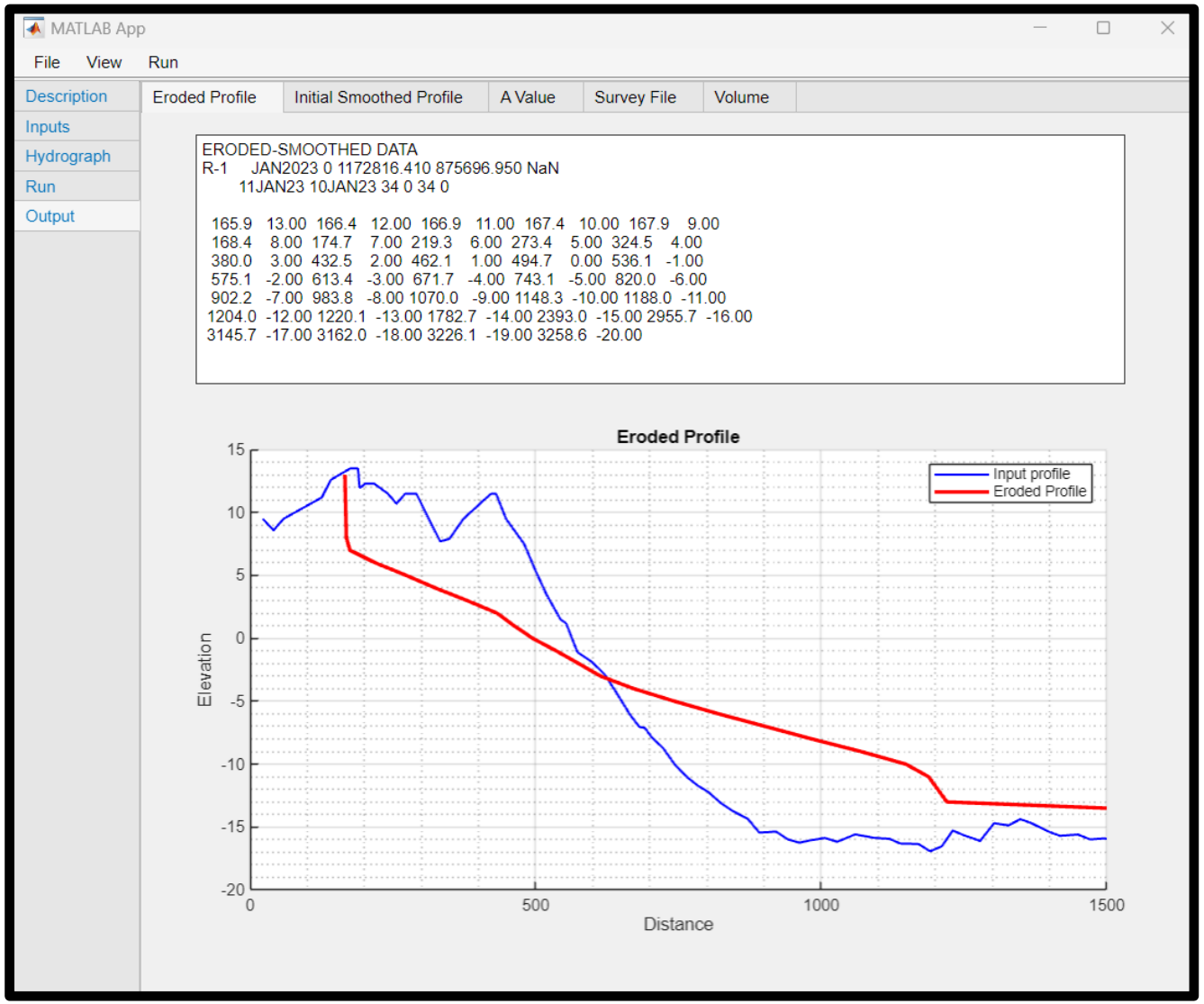
Model's sensitivity to critical parameters – A Value





CCCLr MODEL – OUTPUTS

Model outputs can be visualized and exported.



CONCLUSION

- On an average, 70 – 100 site specific analysis every year.
- The new version aims to enhance functionality and user experience through data visualization without changing the original source code and algorithm.
- Testing of the GUI version is ongoing.

- Looking forward:
  - Re-calibrate the model for Florida counties as needed.
  - Re-evaluate recommended 100-year storm tide.

THANK YOU

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