

The CCCL Erosion Model

By

Robert Wang and Michael Manausa

Sponsored by

**Florida Department of Environmental Protection,
Bureau of Beaches and Coastal Systems**



Submitted by

**Beaches and Shores Resource Center
Institute of Science and Public Affairs
Florida State University**

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Table of Contents

	<u>Page</u>
I. Introduction	1
II. History of Model Development	1
III. Model Background	2
IV. Model Calibrations	3
V. Discussion and Recommendation	12
VI. References	14
VII. Appendix	16

List of Figures

<u>Figure</u>	<u>Description</u>	<u>Page</u>
1	Characteristic Form of Berm Recession Versus Time for Increased Static Water Level.	2
2	Features of the Original Dean Erosion Model (ODEM).	3
3	Calibration of the 1.0 Factor ODEM by Comparison with Erosion Occurring at Various Elevation Due to Hurricane Eloise, 1975.	4
4	Comparison Between Average Measured and Calculated Erosion Distances For Walton County Due to Hurricane Eloise.	5
5	Peak Storm Tide Levels Surveyed Along the Panhandle Area After Hurricane Opal, 1995.	7
6	Comparison of Surveyed and BSRC Model Calculated Total Storm Tide for Hurricane Opal, 1995.	8
7	Comparison Between Average Measured and Calculated Erosion Distances for Walton County Due to Hurricane Opal.	9
8	Comparison Between Average Measured and Calculated Erosion Distances for Bay County Due to Hurricane Opal.	10
9	Factor Distribution in Walton County during Hurricane Opal.	13
10	Factor Distribution in West Bay County during Hurricane Opal.	13
11	Combined Factors Distributions and Regression Line for Walton and West Bay Counties during Hurricane Opal.	14

List of Table

<u>Table</u>	<u>Description</u>	<u>Page</u>
1	Contour Retreat/Advance for Bay and Walton Counties Due to Hurricane Eloise (Chiu, 1976).	5
2	Measured compared with the CCCL model calculated erosion distances for Walton County during Hurricane Eloise of 1975.	6
3	Measured compared with the CCCL model calculated erosion distances for Walton County during Hurricane Opal of 1995.	11
4	Measured compared with the CCCL model calculated erosion distances for Bay County during Hurricane Opal of 1995.	12
5	Factors Distribution for the RDEM2.	14

I. Introduction

This report is to fulfill the requirement by the FDEP for part of the sub-task D, Dune Erosion Model Development and Testing, under the main task III (Coastal Storm Impact Analyses and Scientific Support) of the DEP Contract No. ERP055, Beach Management Technical/Scientific Studies and Support, from July 1, 2005 through June 30, 2006.

II. History of Model Development

1. The Original Dean Erosion Model (ODEM) - The CCCL Dune Erosion Model was developed by Dean in 1984, and was usually referred to as the ODEM. The ODEM was modified from the EBEACH model, originally developed by Kriebel (1982) and was documented in the report, "Methodology on the Coastal Construction Control Line Establishment", by Chiu and Dean (1984). An open workshop of the methodology was provided to the coastal engineering community at the Marjorie Stoneman Douglas Building, Tallahassee, on July 11 and 12, 1984, to introduce the model and its application in the CCCL. The ODEM was first applied for Martin County's CCCL in July 1984 and then for 17 additional counties through 1994.

2. The Revised Dean Erosion Model (RDEM) - When Palm Beach County was in the process of the CCCL study, a Peer Review Group (PRG) was formed to evaluate the ODEM and effects of seawalls for the CCCL. The PRG was comprised of five members: Robert Wiegel, David Kriebel, Tom Jarrett, Billy Edge and Erik Olsen. Three meetings were held from February 1994 to January 1995. A completed report of the PRG meeting agendas, studies, comments and recommendations was addressed in the Addendum C of the updated "Methodology on the Coastal Construction Control Line Establishment" (2002).

Following the PRG recommendations, the ODEM made two revisions: 1. Recalibration of the model with beach erosion data in Walton County caused by Hurricane Eloise of 1975 in September 1995. 2. Balance the eroded and accreted volume for the model output in October 1995. As a result, the RDEM utilized more detailed erosion factors for the contours lower than 10 ft. The Revised Dean Erosion Model (RDEM) was then applied in Pinellas County's CCCL study and also for the 100-Year Storm and Design Grade Elevation for Florida Coastal Counties in October 1999.

3. The Revised Dean Erosion Model-2 (RDEM2) – Following Hurricane Opal in 1995, an additional calibration for the model was carried out by the BSRC by using the surveyed beach erosion data in Walton and Bay counties. The RDEM2 was similar to the RDEM, except the erosion factors for all the contours were different from the RDEM. The RDEM2 has not been applied to the CCCL or other permit cases.

III. Model Background

The erosion calculation methodology is based on measurements of beach profiles, both in an equilibrium and post-storm state, and reasonable approximations to the physics. Based

on a data set compromising more than 500 beach profiles ranging from the eastern tip of Long Island to the Texas-Mexico border, the equilibrium profile was proposed by Dean (1977) as

$$h(x) = Ax^m \quad (1)$$

where A and m are scale and shape parameters, respectively. Value of $m = 2/3$ was found to be the best fit for all these profiles.

The model is based on the characteristic response of berm recession during a storm exhibited in Figures 1 and 2. The exponential response in the analytical approach is expressed as

$$R(t) = R_{\infty} (1 - e^{-Kt}) \quad (2)$$

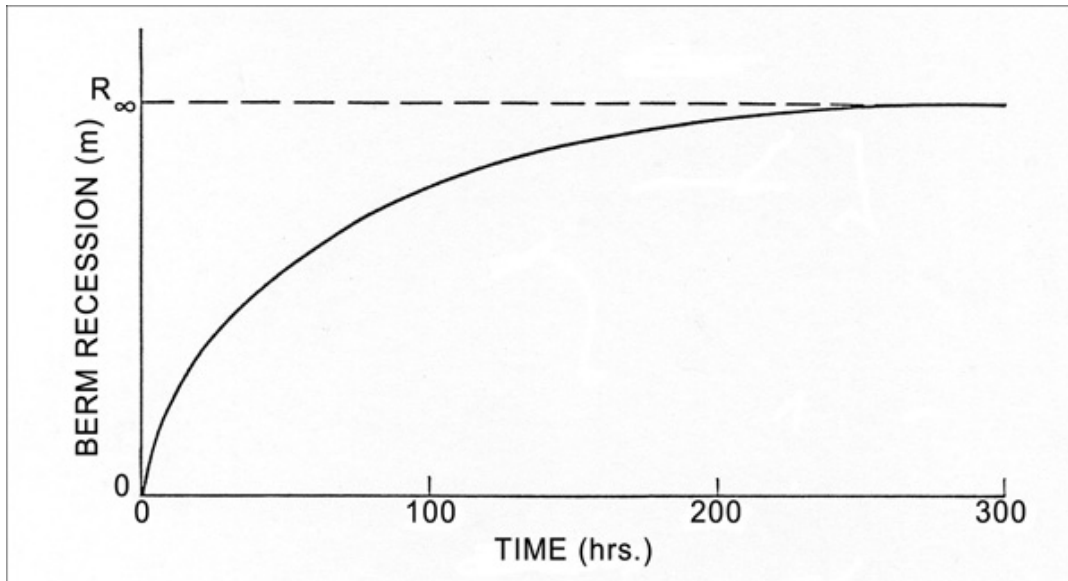


Figure 1: Characteristic Form of Berm Recession Versus Time for Increased Static Water Level.

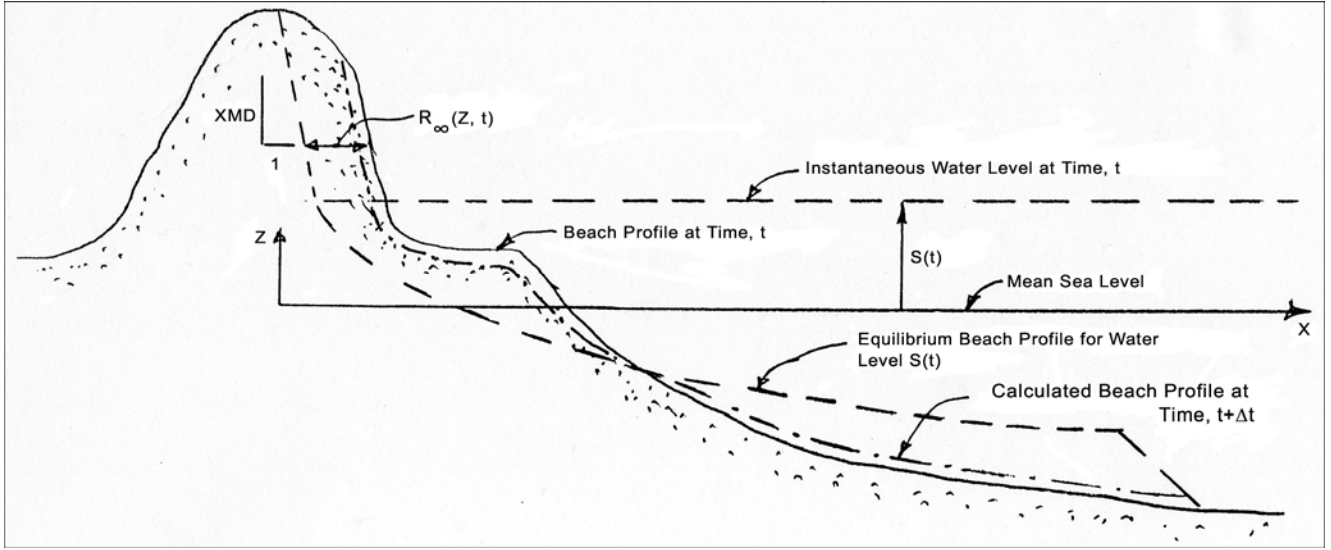


Figure 2: Features of the Original Dean Erosion Model (ODEM).

Where $R(t)$ is the berm recession at time t , R_∞ is the equilibrium recession and K is the sediment transport rate. At each time step, for the instantaneous value of the time-varying water level $S(t)$ and the selected breaking wave height, H_b , the equilibrium profile and R_∞ from the existing profile is established. The equilibrium profiles above the instantaneous water level is characterized by a uniform slope, XMD .

With the equilibrium profile established, the erosion occurring from time t to time $t+\Delta t$, Δx is given by

$$\Delta x = x(t+\Delta t) - x(t) = -R_\infty (1 - e^{-K\Delta t}) \quad (3)$$

IV. Model Calibrations

1. The ODEM – The model was verified against the average measured erosion distance at 0, 5, 10, 15 and 20 ft. contours in Walton County by Hurricane Eloise, as shown in Fig. 3. Through calibration, the best fitted values of dune slope (XMD), sediment transport rate (K), and breaking wave height (H_b), were found to be 2, 0.075 sec^{-1} , and 10 ft., respectively. The resulting model was calibrated with the average erosion distance in Walton County by Hurricane Eloise was usually called the 1.0 Factor ODEM.

As documented by Chiu (1976), there are a number of factors which result in considerable variability of the erosion distance along the Walton County shoreline caused by Hurricane Eloise. Chiu found that the maximum erosion was approximately 2.5 times the average erosion (Table 1).

The model with a 2.5 factor, which takes the maximum vulnerability along the shoreline into consideration, was used in the CCCL reestablishment and was referred to as the ODEM.

An additional comparison between computed and measured erosions by Hurricane Frederic of 1979 for Gulf Shores area, Alabama and by Hurricane Agnes of 1972 for St. George Island area, Florida were performed later by Chiu and Dean, (1986). They found that the ODEM with the 2.5 factor does not overestimate erosion.

This 2.5 factor is incorporated in the erosion consideration employed in the recommended CCCL position by modifying Eq. (3) as

$$\Delta x = - (2.5) R_{\infty} (1 - e^{-K\Delta t}) \quad (4)$$

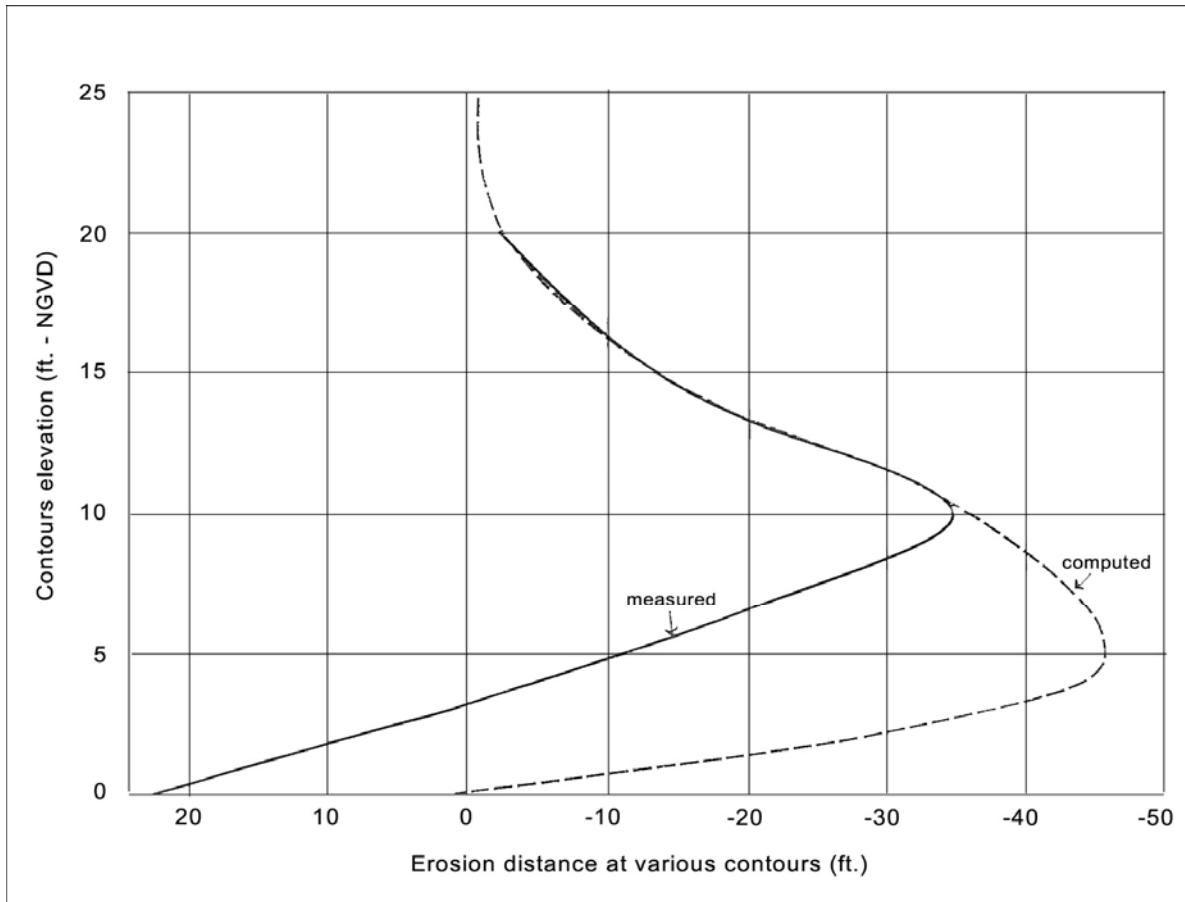


Figure 3: Calibration of the 1.0 Factor ODEM by Comparison with Erosion Occurring at Various Elevation Due to Hurricane Eloise, 1975.

Table 1: Contour Retreat/Advance for Bay and Walton Counties Due to Hurricane Eloise (Chiu, 1976).

Contour Retreat/Advance Due to Hurricane Eloise (excluding profiles influenced by seawalls)				
Contour Elevation (ft.)	Retreat (-)/Advance (+) (ft.) Average		Retreat (-)/Advance (+) (ft.) Maximum	
	Bay	Walton	Bay	Walton
0	+26.5	+22.5	+106	+157
5	-5.9	-11.3	-117	-130
10	-23.5	-35.0	-75	-78
15	-8.9	-12.8	-34	-40
20	---	-2.5	---	-26

2. The RDEM - A more detailed comparison for each contour from 0 to 25 ft. was carried out in 1995. A total of 97 Walton County profiles were selected for the study. An A-value of 0.1352, which is the average for all 97 profiles calculated from MSL to a water depth of 12.8 ft. was used in the model calculation. Fig. 4 shows the comparison between average measured and calculated results.

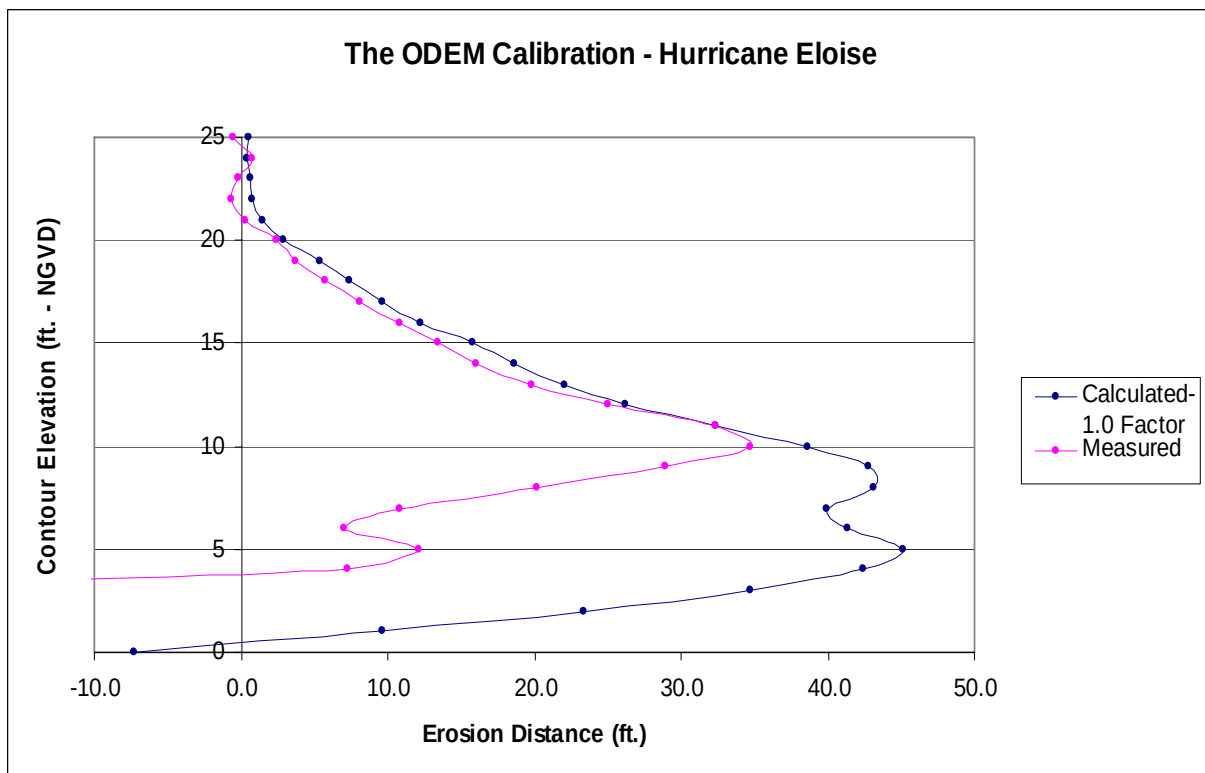


Figure 4: Comparison Between Average Measured and Calculated Erosion Distances for Walton County Due to Hurricane Eloise.

In order to take into account the alongshore erosion variability, two standard deviations from the average erosion distance, which represents the maximum erosion was divided by model calculated erosion, to generate a factor for each contour. A detailed result is listed in Table 2. The final factors used in the model was smoothed down for the 10 to 0 ft. contours in order to present an immediate after storm erosion profile, without the effect of recovery sand bars near the shoreline.

Table 2: Measured compared with the CCCL model calculated erosion distances for Walton County during Hurricane Eloise of 1975.

Contour	Measured Erosion (ft.)		Calculated (ft.) A= 0.1352 1.0 Factor	Factor = 2SD/Calculated	Factors Used in the Model
	Mean	With 2SD			
0	20.0	-53.5	7.3	-7.3	1.1
1	24.3	-41.3	-9.6	4.3	1.1
2	28.6	-35.9	-23.4	1.5	1.1
3	26.5	-37.1	-34.7	1.1	1.3
4	-7.3	-71.1	-42.4	1.7	1.5
5	-12.2	-64.5	-45.1	1.4	1.7
6	-7.1	-49.0	-41.4	1.2	1.9
7	-10.8	-45.8	-40.0	1.1	2.1
8	-20.2	-49.1	-43.1	1.1	2.3
9	-28.9	-56.2	-42.8	1.3	2.5
10	-34.7	-64.0	-38.6	1.7	2.5
11	-32.3	-60.7	-32.4	1.9	2.5
12	-25.1	-51.6	-26.2	2.0	2.5
13	-19.9	-45.6	-22.1	2.1	2.5
14	-16.1	-39.6	-18.6	2.1	2.5
15	-13.4	-35.3	-15.8	2.2	2.5
16	-10.8	-28.8	-12.3	2.3	2.5
17	-8.1	-23.7	-9.6	2.5	2.5
18	-5.8	-24.7	-7.4	3.3	2.5
19	-3.7	-30.0	-5.4	5.5	2.5
20	-2.5	-13.5	-2.9	4.7	2.5
21	-0.3	-18.4	-1.5	12.3	2.5
22	0.6	-22.8	-0.8	28.5	2.5
23	0.2	-16.4	-0.7	23.5	2.5
24	-0.8	-5.2	-0.4	13.1	2.5
25	0.5	-5.9	-0.5	11.7	2.5

3. The RDEM2 – The model calibration process is the same as the one applied to the RDEM, except the beach profile data of Walton and Bay counties were collected just a few months apart between pre and post Hurricane Opal, 1995.

Hurricane Opal's Storm Tide Evaluation - The peak storm tide elevation recorded from a National Ocean Survey (NOS) tide gage located on the Panama City Beach pier is 8.3 feet above NGVD. The tide gauge is located about 700 ft. seaward from the Bay County

monument between R-40 and R-41. A method by Dean (1996) to calculate the wave set up due to wave break at Panama City Beach for Hurricane Opal was estimated at 13 feet peak storm tide might occur on the beach. A series of interior High Water Mark (HWM) data were surveyed along the Panhandle area after Hurricane Opal by FEMA and FDEP and summarized by Leadon, et al.(1998) as shown in Fig. 5.

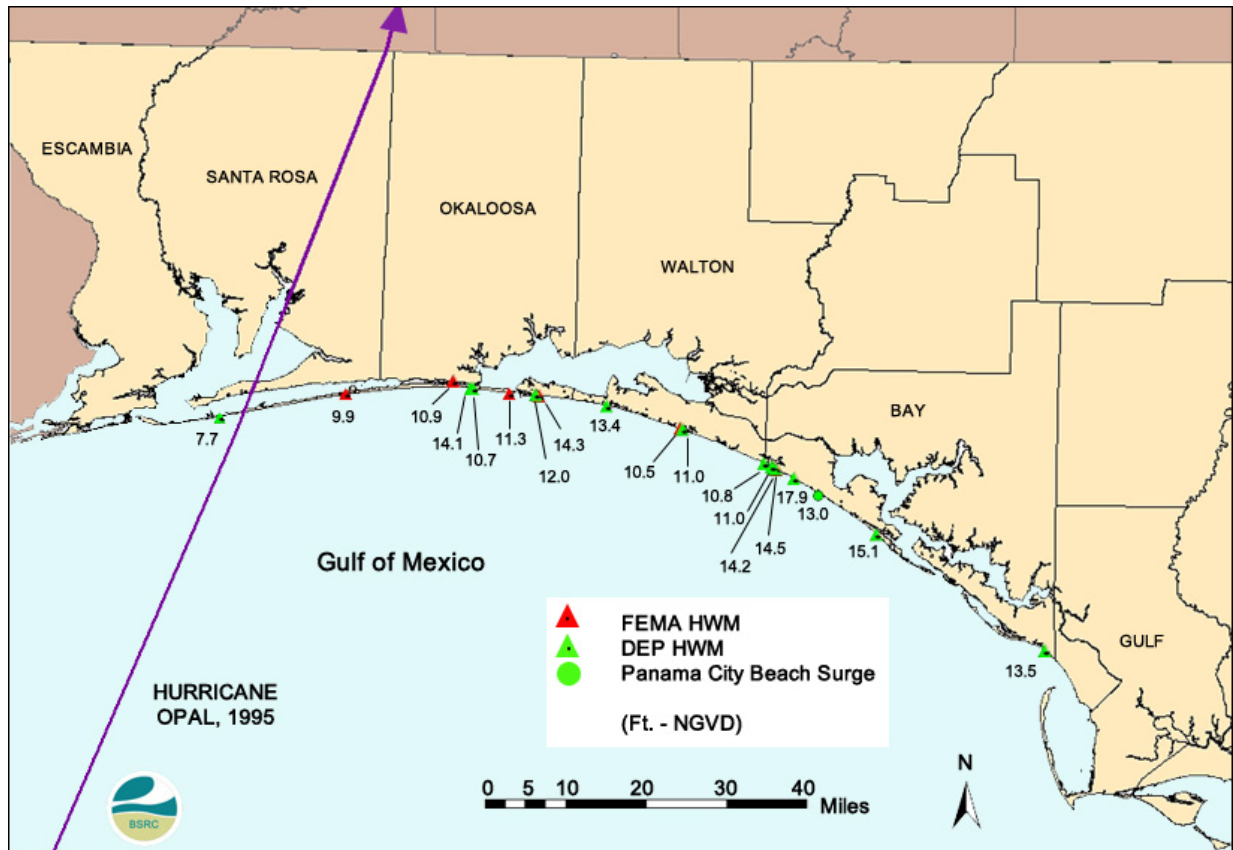


Figure 5: Peak Storm Tide Levels Surveyed Along the Panhandle Area After Hurricane Opal, 1995.

To verify those surveyed HWM, the 2-D Storm Surge Model of BSRC was employed to calculate the total storm tide, i.e. surge generated from barometric pressure and wind stress plus dynamic wave setup and astronomical tide. The 2-D grid systems and associated hydrological data of Escambia, Okaloosa, Walton and Bay counties from the CCCL study were chosen to cover the study area. Hurricane track, pressure deficit, Radius to the Maximum Wind (RMW) of Opal for the last 36 hours before landfall were input to the 2-D storm Surge Model. The model then ran and calculated the total storm tide for a total of 14 locations along the Panhandle area.

Figure 6 displays the results of model calculated total storm tides and a comparison with the surveyed HWM data. The model result produced a good agreement not only with the HWM data trend, but also with the HWM regression value throughout the study area. The

storm tide reaching its peak around Walton County's central area verified that RMW of 54 miles (47 n.m.) used in the model was appropriate. As a result, the model's calculated storm tide levels, 12.8, 13.1, 12.9, 12.8, 11.8, 11.3 ft. were used for west, middle, and east Walton and Bay counties, respectively.

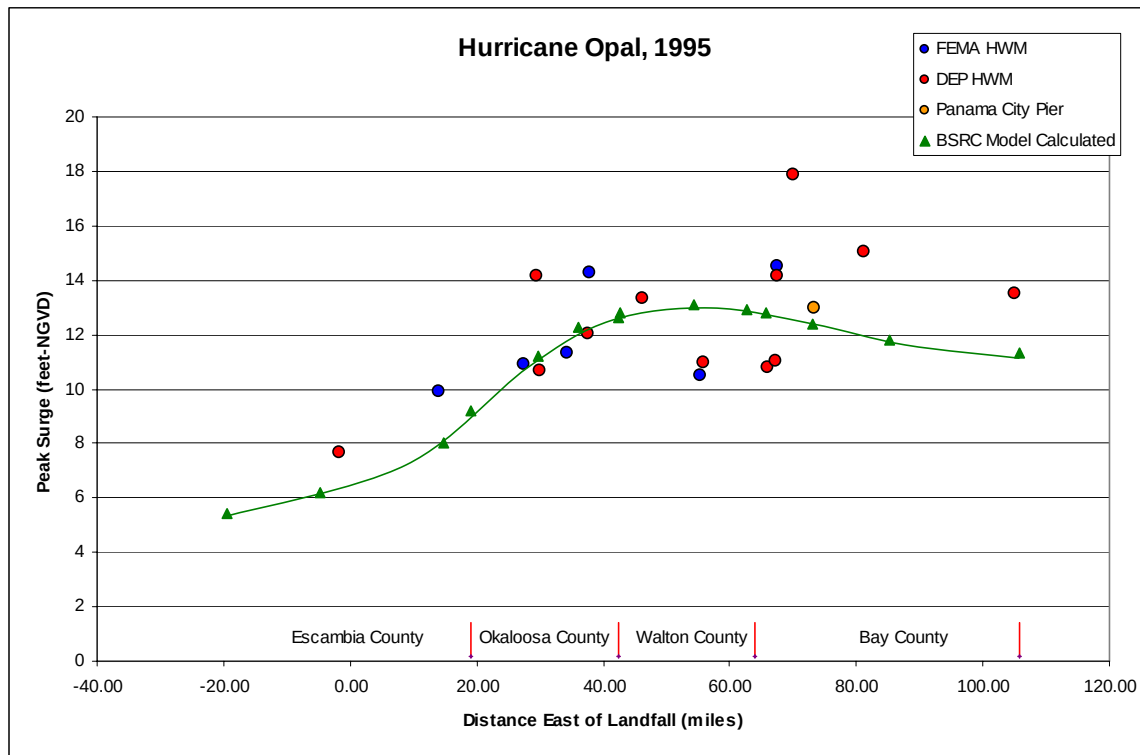


Figure 6: Comparison of Surveyed and BSRC Model Calculated Total Storm Tide for Hurricane Opal, 1995.

Selection of Profiles – Hurricane Opal's substantial storm tides and waves severely eroded the beach and dune system throughout the Panhandle Coast. Beach and offshore profile data was collected by the FDEP in March of 1995 in Bay County and in June of 1995 in Walton County. The post Opal profile data was surveyed in October 1995, in many cases within 4-5 days of Opal's landfall on October 4. This pre and post Opal profile data provided a good data base to evaluate storm impact and for the model calibration analysis.

Since the CCCL erosion model doesn't take into account the sea wall and over wash effects, surveyed profiles which were influenced by these two effects were removed from the data set. Some profiles showing possible beach scraping and fill activities were also excluded. As a result, a total of 102 and 51 profiles were selected for the model calibration for Walton and west Bay counties, respectively.

The RDEM2 Calibration - Figures 7 and 8 shows that the ODEM with a 1.0 factor matched well to the averaged measured erosion distance for contours above 11 feet in

both Walton and Bay counties. The model over-predicted the lower contour erosion distance, which is similar to the Hurricane Eloise calibration (Figure 4). Two standard deviations was also added to the average erosion in order to encompass 95% of the eroded profiles. This was then divided by model calculated erosion to generate a factor for each contour. The detailed data for this calculation are listed in Tables 3 and 4.

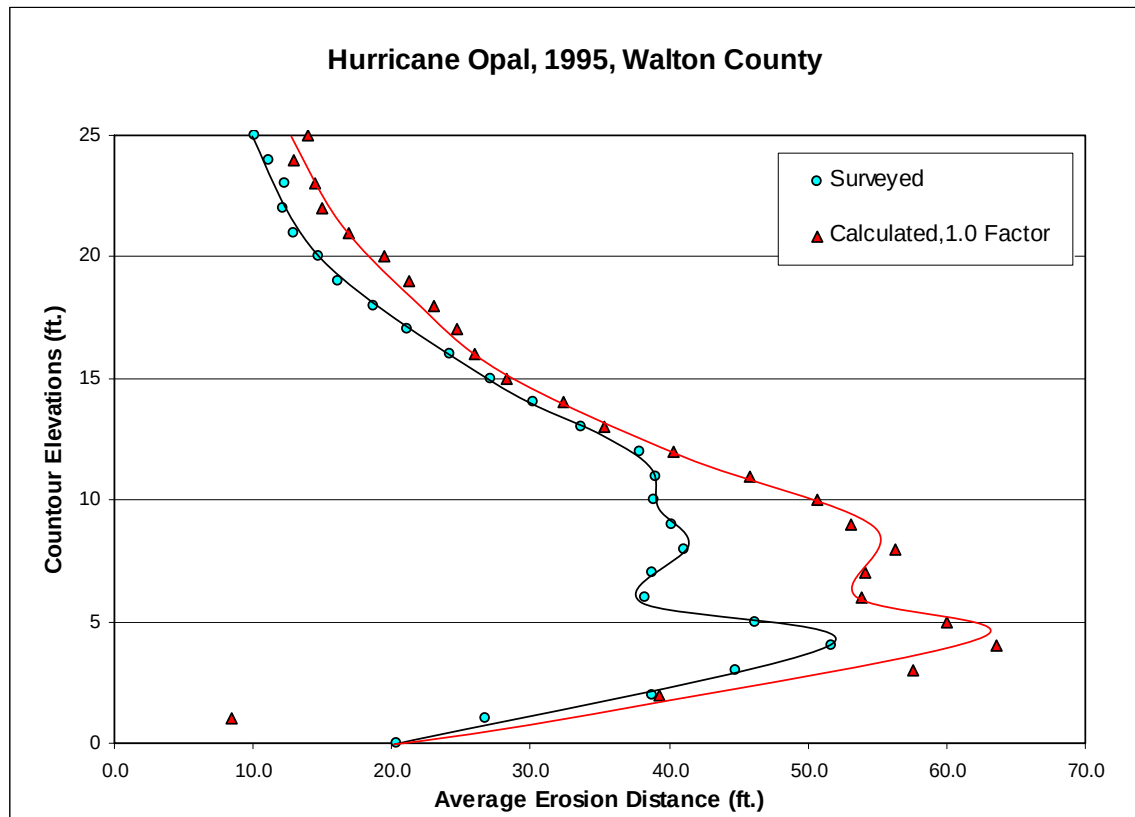


Figure 7: Comparison Between Average Measured and Calculated Erosion Distances for Walton County Due to Hurricane Opal.

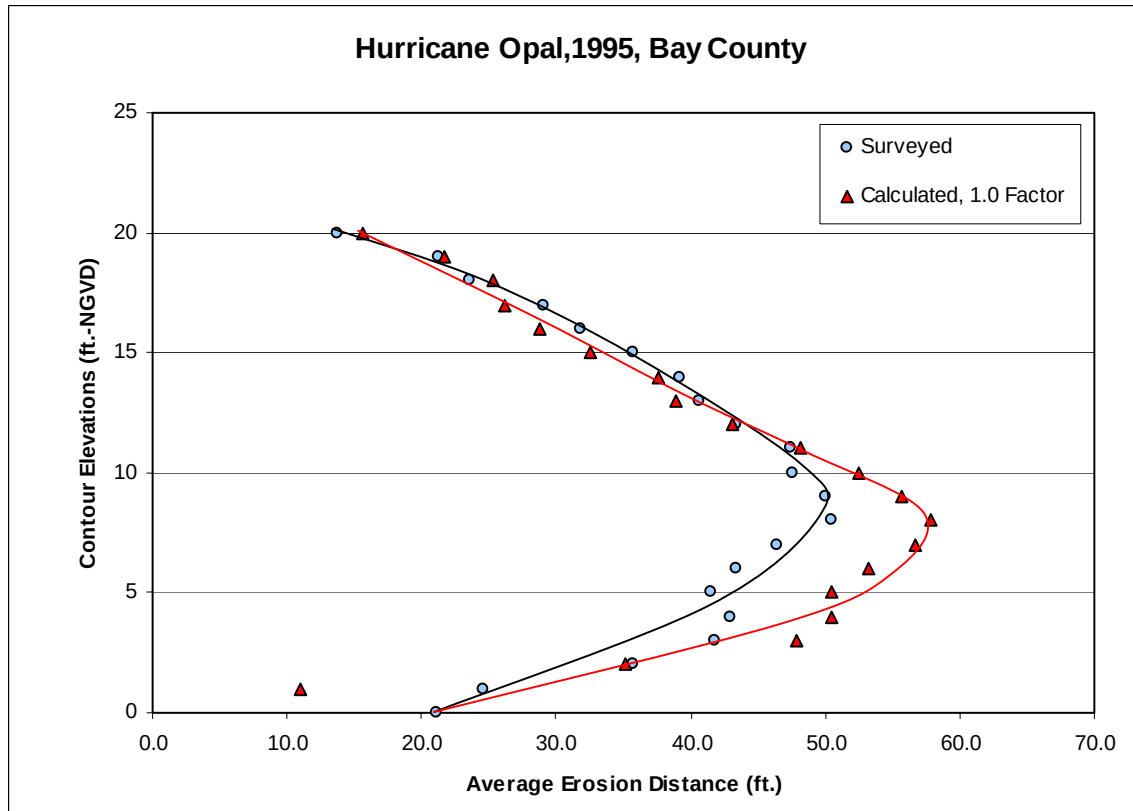


Figure 8: Comparison Between Average Measured and Calculated Erosion Distances for Bay County Due to Hurricane Opal.

Table 3: Measured compared with the CCCL model calculated erosion distances for Walton County during Hurricane Opal of 1995.

Contour	Measured Erosion (ft.)		Calculated (ft.) A= 0.1466 1.0 Factor	Factor = 2SD/Calculated
	Mean	With 2SD		
0	-20.4	-65.9	31.1	-2.1
1	-26.8	-67.5	-8.5	8.0
2	-38.8	-75.8	-39.3	1.9
3	-44.7	-81.5	-57.6	1.4
4	-51.7	-84.5	-63.6	1.3
5	-46.2	-80.5	-60.0	1.3
6	-38.3	-70.6	-53.9	1.3
7	-38.8	-80.7	-54.1	1.5
8	-41.1	-77.8	-56.3	1.4
9	-40.2	-77.2	-53.0	1.5
10	-39.0	-76.8	-50.7	1.5
11	-39.1	-79.5	-45.8	1.7
12	-37.9	-77.2	-40.3	1.9
13	-33.6	-65.4	-35.3	1.8
14	-30.2	-60.4	-32.4	1.9
15	-27.1	-55.4	-28.3	2.0
16	-24.2	-48.8	-26.0	1.9
17	-21.1	-42.7	-24.7	1.7
18	-18.7	-39.6	-23.0	1.7
19	-16.1	-33.8	-21.2	1.6
20	-14.7	-33.5	-19.4	1.7
21	-12.9	-24.0	-16.9	1.4
22	-12.1	-21.6	-15.0	1.4
23	-12.3	-21.8	-14.4	1.5
24	-11.1	-19.2	-13.0	1.5
25	-10.2	-17.8	-14.0	1.3

Table 4: Measured compared with the CCCL model calculated erosion distances for Bay County during Hurricane Opal of 1995.

Contour	Measured Erosion (ft.)		Calculated (ft.) A= 0.1494 1.0 Factor	Factor = 2SD/Calculated
	Mean	With 2SD		
0	-21.1	-68.6	19.0	-3.6
1	-24.6	-70.9	-11.0	6.4
2	-35.7	-76.3	-35.2	2.2
3	-41.8	-78.2	-47.9	1.6
4	-43.0	-78.8	-50.5	1.6
5	-41.5	-81.2	-50.5	1.6
6	-43.4	-85.6	-53.2	1.6
7	-46.5	-89.5	-56.7	1.6
8	-50.5	-100.0	-57.9	1.7
9	-50.0	-101.7	-55.7	1.8
10	-47.5	-96.0	-52.5	1.8
11	-47.5	-91.8	-48.2	1.9
12	-43.4	-88.6	-43.1	2.1
13	-40.7	-87.3	-38.9	2.2
14	-39.2	-80.2	-37.7	2.1
15	-35.8	-76.7	-32.5	2.4
16	-31.8	-70.8	-28.8	2.5
17	-29.1	-62.8	-26.2	2.4
18	-23.5	-49.1	-25.3	1.9
19	-21.2	-42.1	-21.6	1.9
20	-13.7	-23.2	-15.6	1.5

V. Discussion and Recommendation

The factor for each contour generated and shown in Tables 3 and 4 represent a calibration ratio to be applied in the RDEM2 in order to reproduce the most severe beach and dune erosion for Walton and west Bay County areas during Hurricane Opal. These factor distributions show some differences between Walton and west Bay counties as seen in Figures 9 and 10. The storm surge level was estimated at an average of 13 ft. in Walton County and reduced to an average of 12.3 ft. in west Bay County. This storm surge variation and a higher dune system in Walton County than in west Bay County might contribute to the factor difference for this case.

To neutralize the factor difference in the two counties, a regression curve shown as a solid black line was generated in the combined factors distribution as depicted in Figure 11. The maximum factor, 2, is found in the range from 12 to 15 foot contours, which corresponds to the CCCL's 100-year storm surge levels in most counties. Table 5 lists the factors for various contours to be applied in the RDEM2 following Hurricane Opal calibrations in Walton and west Bay counties. Sample plots of some ranges for the model predictions and surveyed profiles are shown in the Appendix.

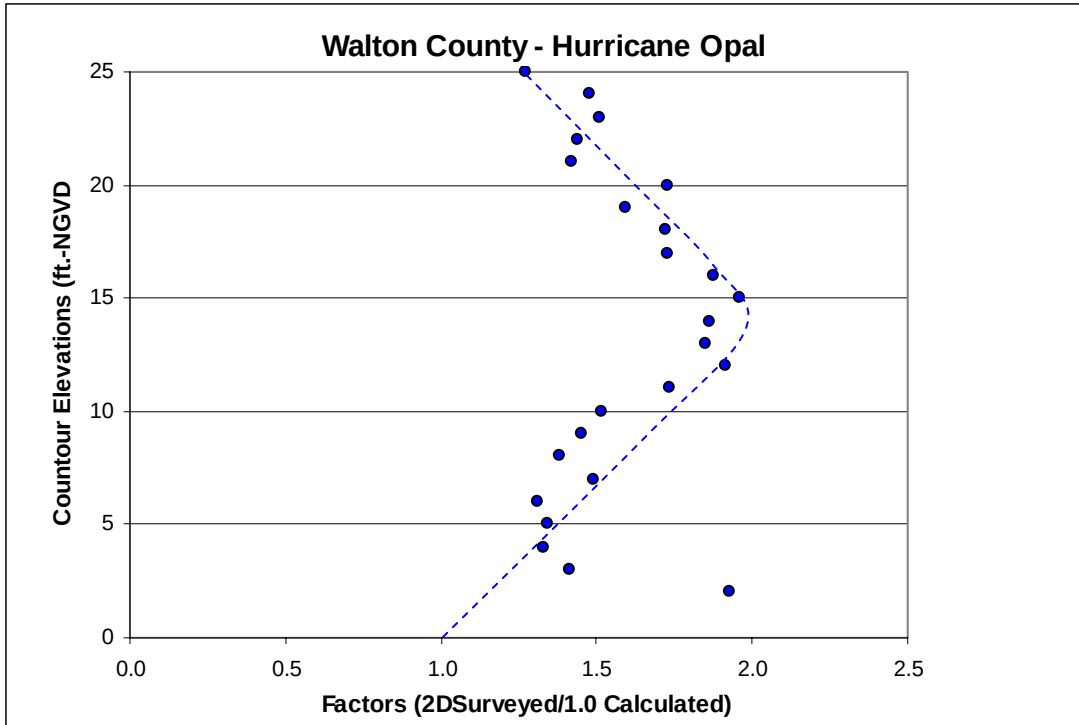


Figure 9: Factor Distribution in Walton County during Hurricane Opal.

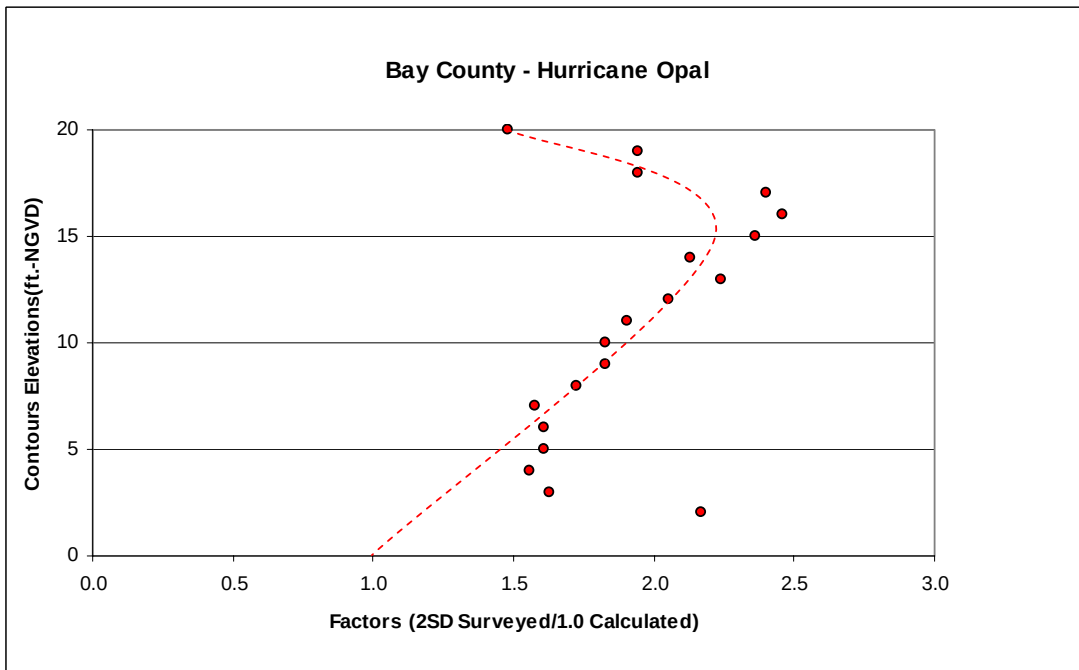


Figure 10: Factor Distribution in West Bay County during Hurricane Opal.

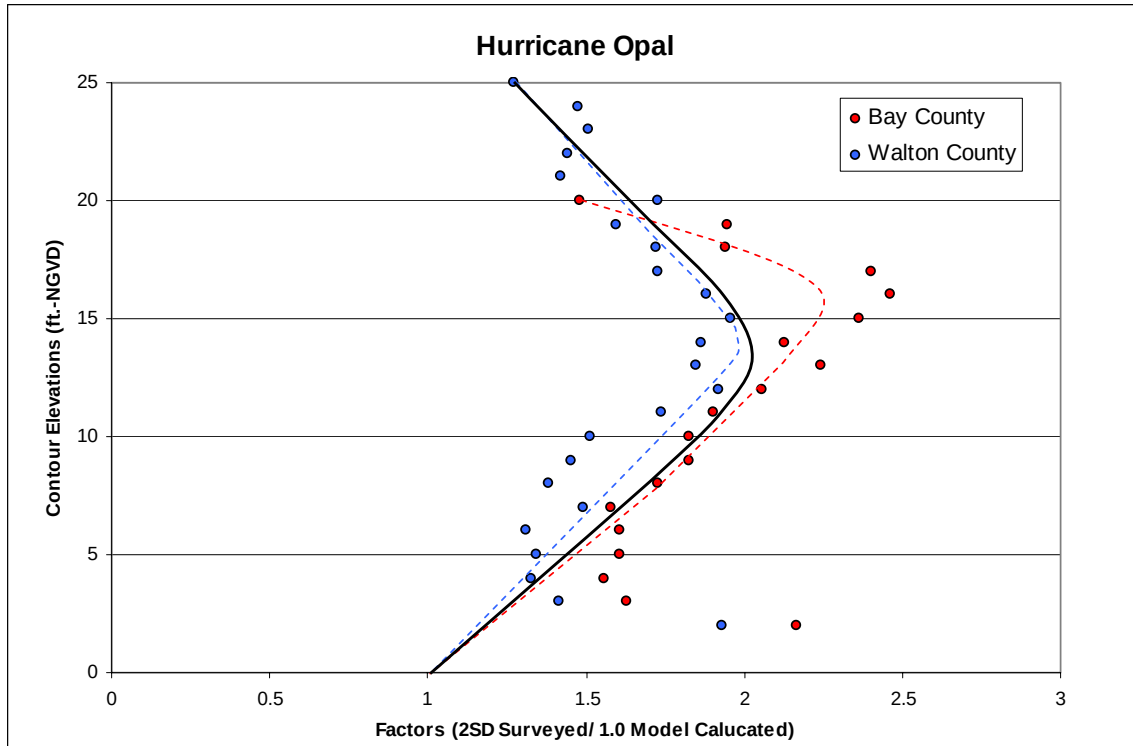


Figure 11: Combined Factors Distributions and Regression Line for Walton and West Bay Counties during Hurricane Opal.

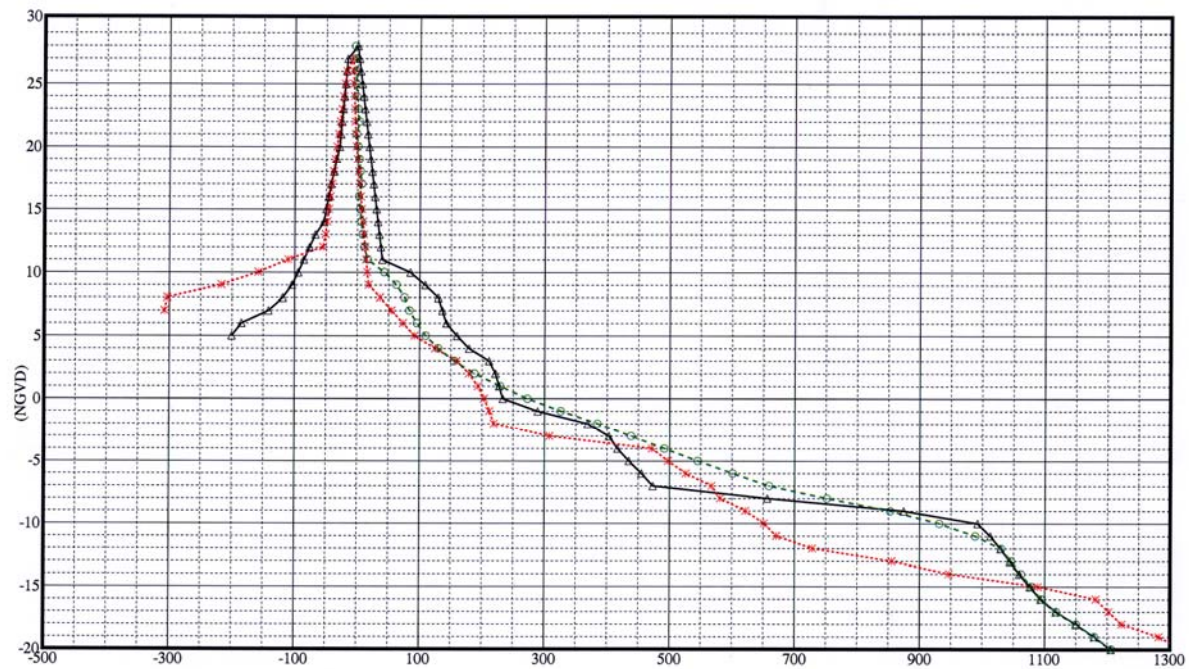
Table 5: Factors Distribution for the RDEM2.

Contour (ft. – NGVD)	Factor	Contour (ft. – NGVD)	Factor	Contour (ft. – NGVD)	Factor
0	1.00	9	1.75	18	1.80
1	1.10	10	1.85	19	1.70
2	1.20	11	1.90	20	1.65
3	1.25	12	2.00	21	1.55
4	1.35	13	2.00	22	1.50
5	1.45	14	2.00	23	1.40
6	1.50	15	2.00	24	1.35
7	1.60	16	1.95	25	1.30
8	1.70	17	1.85		

VI. References

1. Chiu, T. Y. "Beach and Dune Response to Hurricane Eloise of September 1975", *Coastal Sediments '77*, ASCE, 1977.
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8. Leadon, M. E., Nguyen, N. T. and Clark, R. R., "Hurricane Opal, Beach and Dune Erosion and Structure Damage Along the Panhandle Coast of Florida", Beau of Beaches and Coastal Systems, Florida Dept. of Environmental Protection, January 1998.

VII. Appendix



OFFSHORE PROFILE

— Survey May-95 Pre-Opal
..... Survey Oct-95 Post-Opal
- - - Dean Model Erosion Calc.

WALTON - OPAL

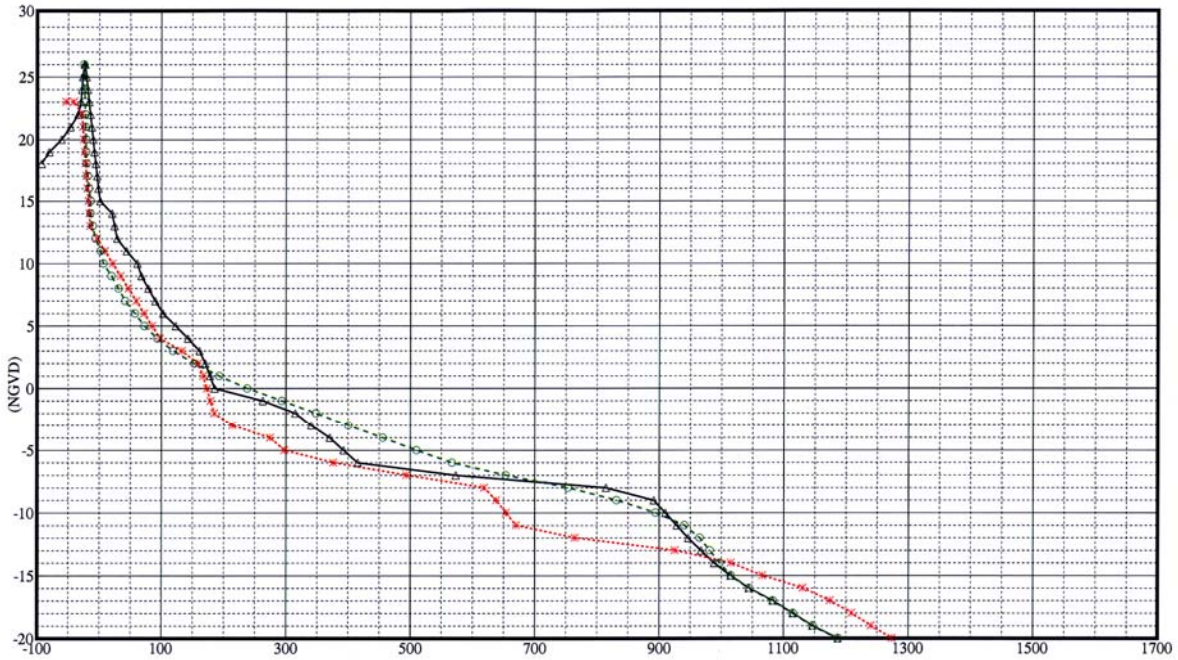
A = 0.1466, 1.0 factor
BEACHES & SHORES RESOURCE CENTER
FLORIDA STATE UNIVERSITY

Range: R-23

1/2

DOT DATA: 08OCT80
BEACH DATA: 25MAY95
OFFSHORE DATA: MAY1995

05-24-06



OFFSHORE PROFILE

—▲— Survey May-95 Pre-Opal
 Survey Oct-95 Post-Opal
 ---◇--- Dean Model Erosion Calc.

WALTON - OPAL

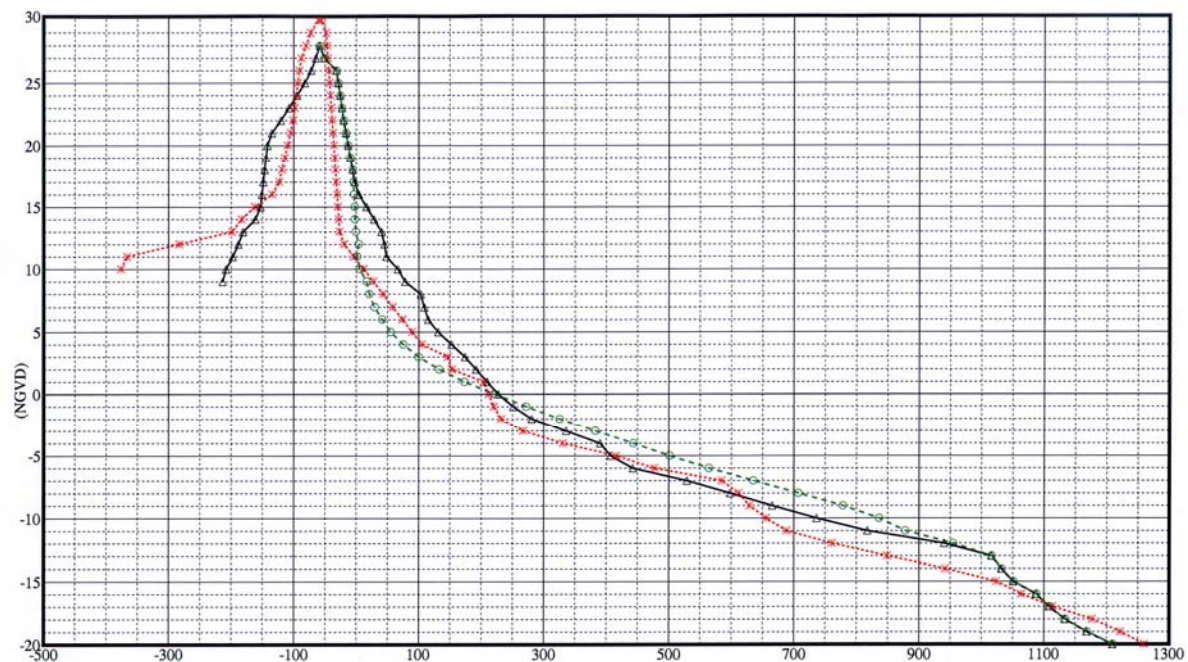
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 BEACHES & SHORES RESOURCE CENTER
 FLORIDA STATE UNIVERSITY

Range: R-33

1/1

DOT DATA: 08OCT80
 BEACH DATA: 06JUN95
 OFFSHORE DATA: MAY1995

05-24-06



OFFSHORE PROFILE

— Survey May-95 Pre-Opal
 Survey Oct-95 Post-Opal
 --- Dean Model Erosion Calc.

WALTON - OPAL

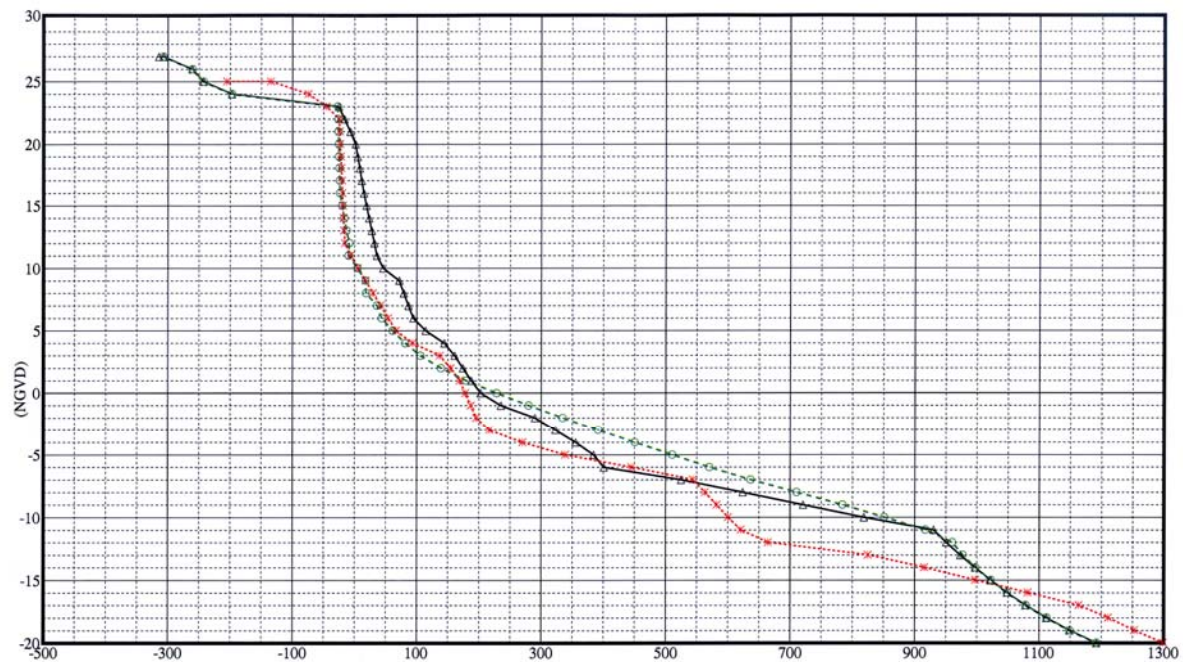
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 BEACHES & SHORES RESOURCE CENTER
 FLORIDA STATE UNIVERSITY

Range: R-34

1/2

DOT DATA: 08OCT80
 BEACH DATA: 06JUN95
 OFFSHORE DATA: MAY1995

05-24-06



OFFSHORE PROFILE

—▲— Survey May-95 Pre-Opal
●..... Survey Oct-95 Post-Opal
 - - -◇- - - Dean Model Erosion Calc.

WALTON - OPAL

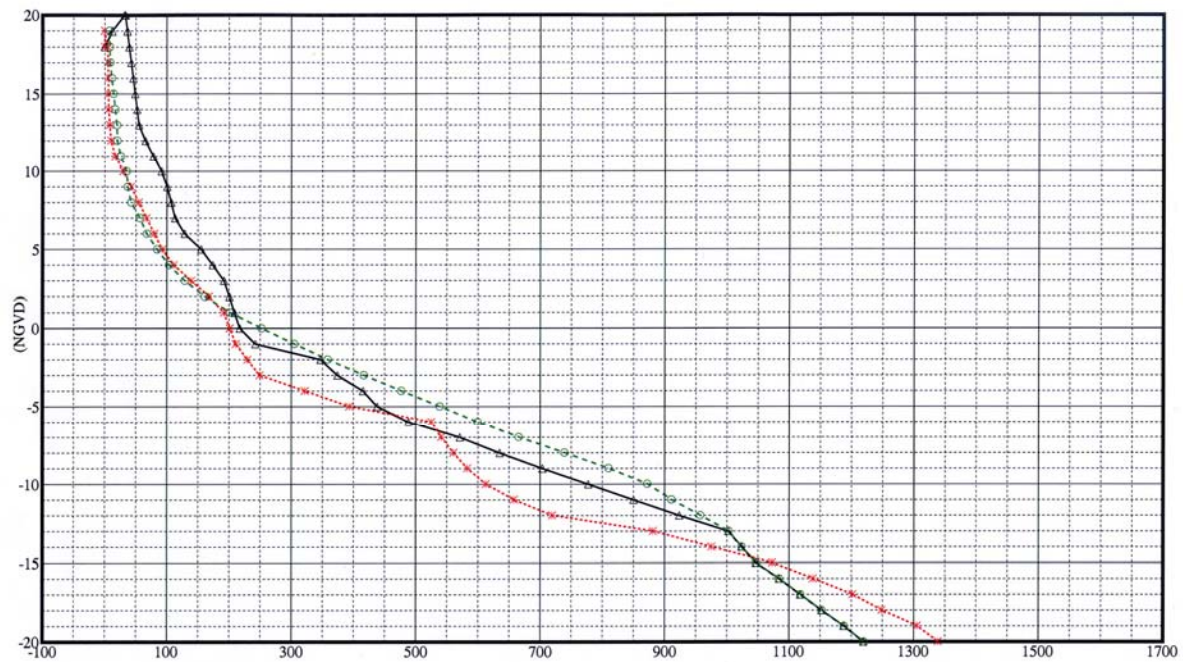
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 BEACHES & SHORES RESOURCE CENTER
 FLORIDA STATE UNIVERSITY

Range: R-43

1/2

DOT DATA: 08OCT80
 BEACH DATA: 07JUN95
 OFFSHORE DATA: MAY1995

05-24-06



OFFSHORE PROFILE

—▲— Survey May-95 Pre-Opal
×..... Survey Oct-95 Post-Opal
 - - - - -◇- - - - - Dean Model Erosion Calc.

WALTON - OPAL

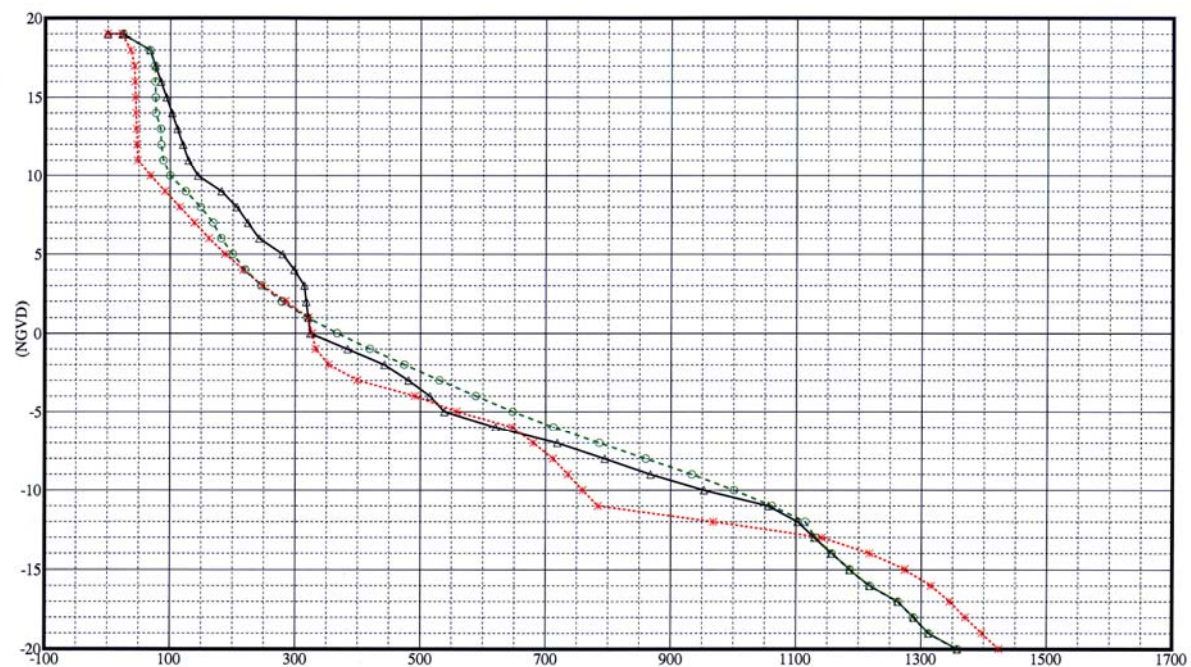
A = 0.1466, 1.0 factor
 BEACHES & SHORES RESOURCE CENTER
 FLORIDA STATE UNIVERSITY

Range: R-47

1/1

DOT DATA:
 BEACH DATA: 07JUN95
 OFFSHORE DATA: MAY1995

05-24-06



OFFSHORE PROFILE

—△—△— Survey May-95 Pre-Opal
 - - - × - - - Survey Oct-95 Post-Opal
 - - - ○ - - - Dean Model Erosion Calc.

WALTON - OPAL

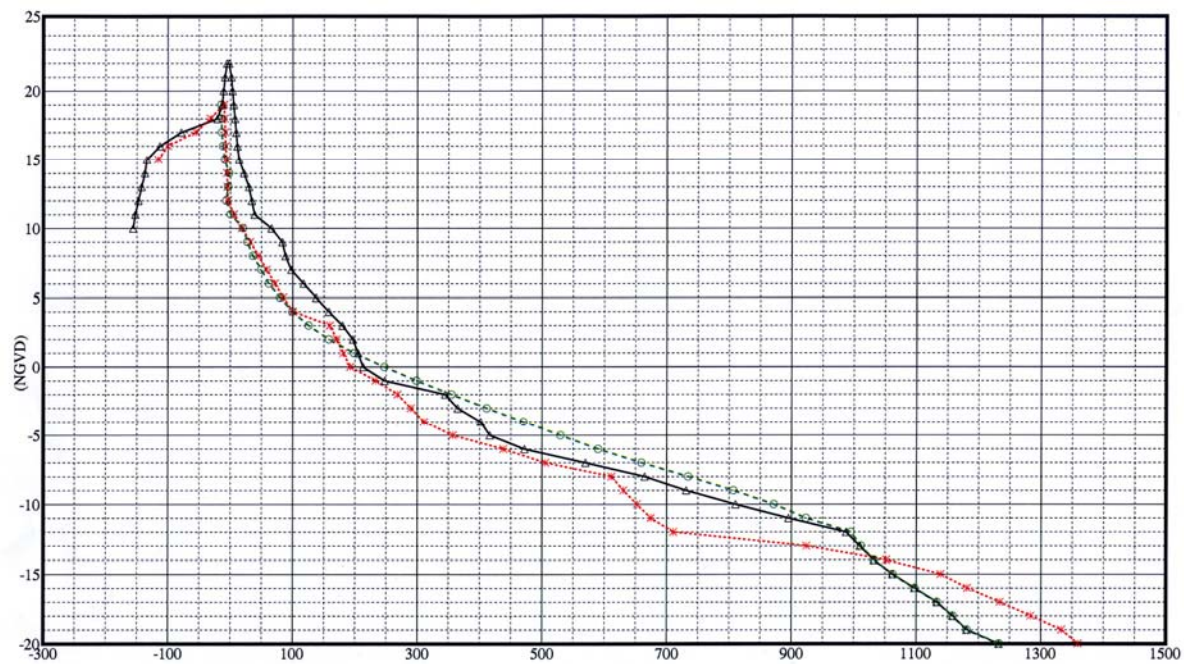
A = 0.1466, 1.0 factor
 BEACHES & SHORES RESOURCE CENTER
 FLORIDA STATE UNIVERSITY

Range: R-55

1/1

DOT DATA:
 BEACH DATA: 09JUN95
 OFFSHORE DATA: MAY1995

05-24-06



OFFSHORE PROFILE

—▲— Survey May-95 Pre-Opal
*..... Survey Oct-95 Post-Opal
 ---◇--- Dean Model Erosion Calc.

WALTON - OPAL

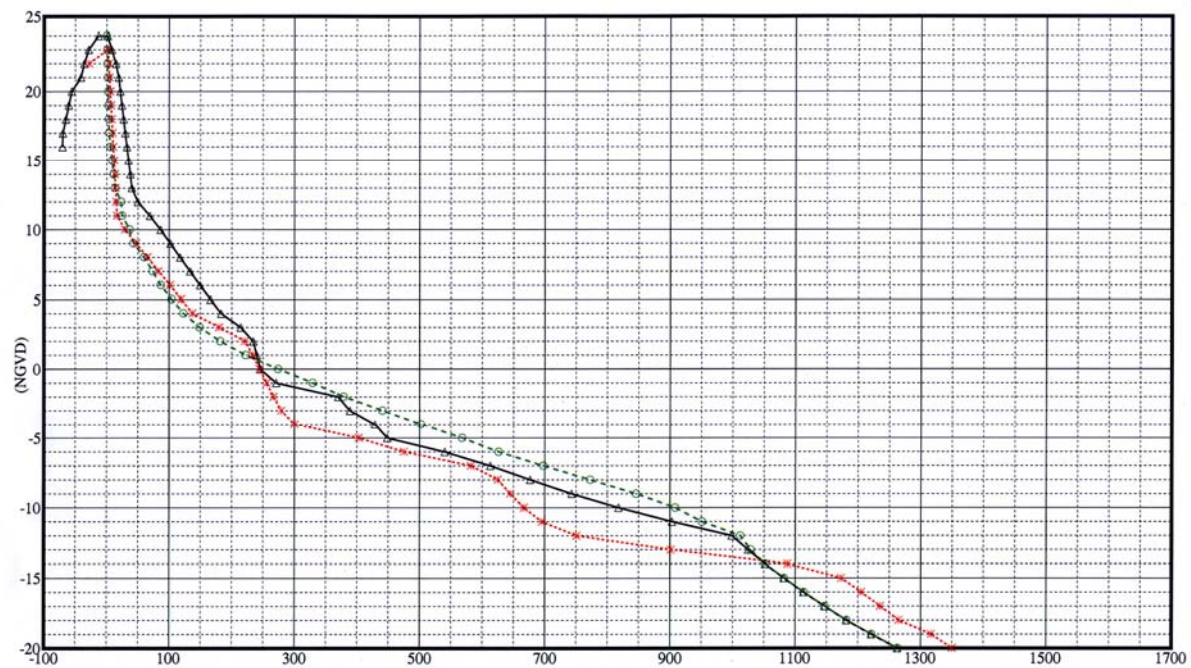
A = 0.1466, 1.0 factor
 BEACHES & SHORES RESOURCE CENTER
 FLORIDA STATE UNIVERSITY

Range: R-78

1/1

DOT DATA: 08OCT80
 BEACH DATA: 20JUN95
 OFFSHORE DATA: MAY1995

05-24-06



OFFSHORE PROFILE

—△— Survey May-95 Pre-Opal
×..... Survey Oct-95 Post-Opal
 ---○--- Dean Model Erosion Calc.

WALTON - OPAL

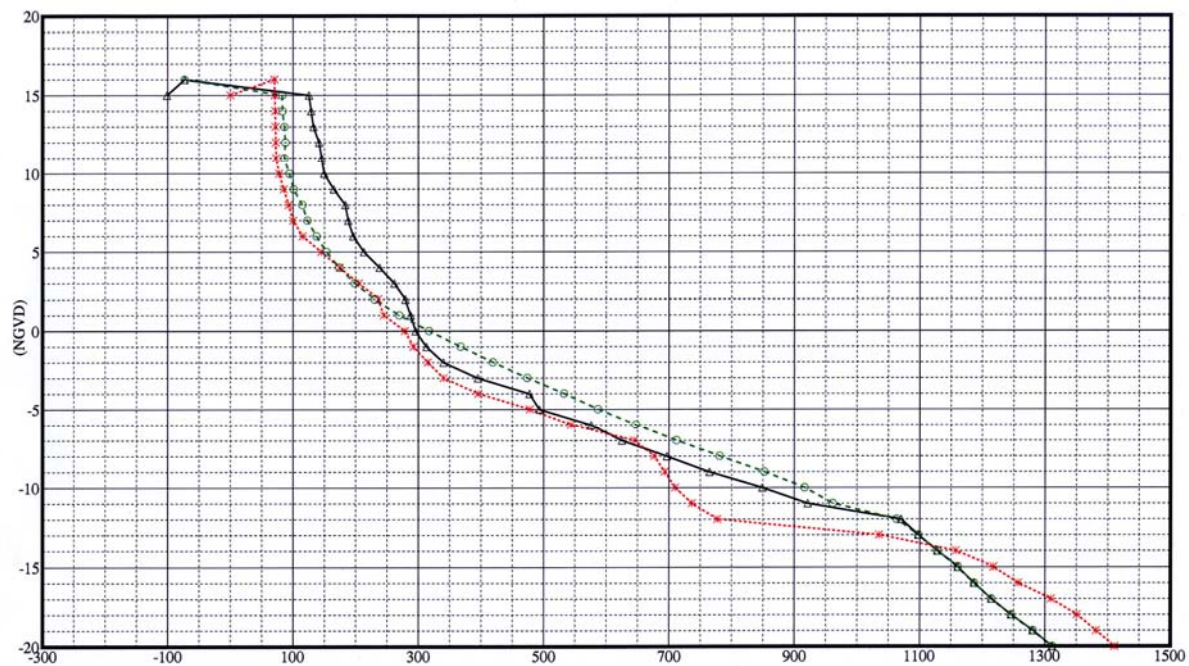
A = 0.1466, 1.0 factor
 BEACHES & SHORES RESOURCE CENTER
 FLORIDA STATE UNIVERSITY

Range: R-79

1/1

DOT DATA: 08OCT80
 BEACH DATA: 20JUN95
 OFFSHORE DATA: MAY1995

05-24-06



OFFSHORE PROFILE

—▲— Survey Apr-95 Pre-Opal
×..... Survey Oct-95 Post-Opal
 ----○---- Dean Model Erosion Calc.

BAY - OPAL

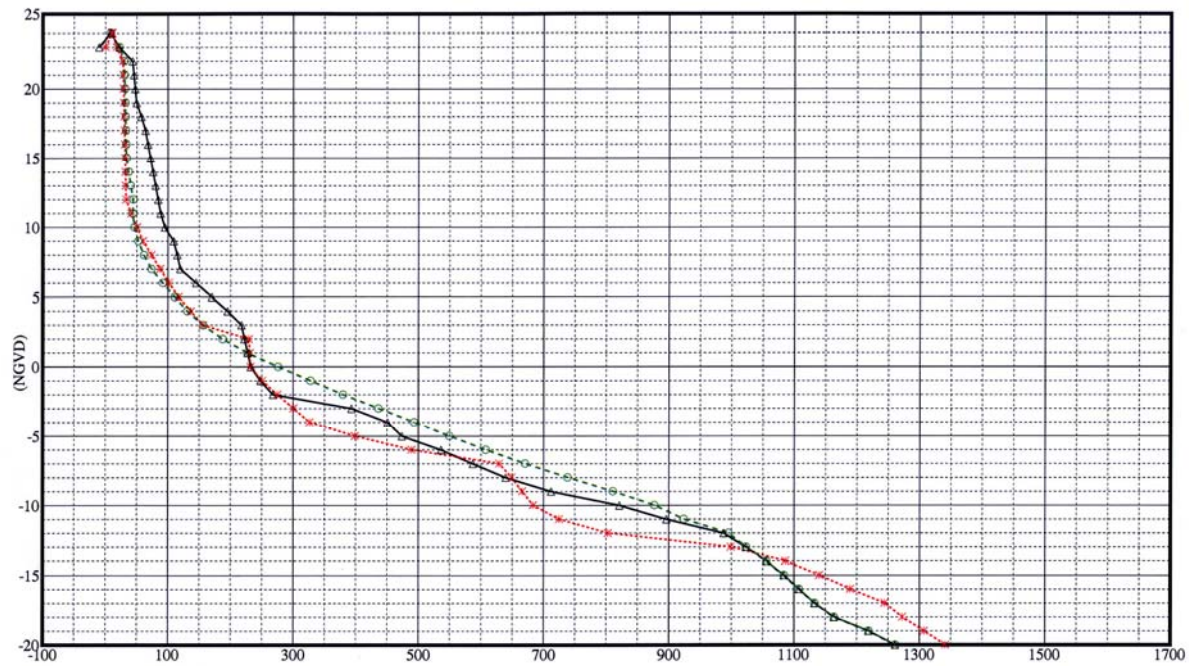
A = 0.1494, 1.0 factor
 BEACHES & SHORES RESOURCE CENTER
 FLORIDA STATE UNIVERSITY

Range: R-13-T

1/2

DOT DATA:
 BEACH DATA: 30MAR95
 OFFSHORE DATA: 04APR95

05-24-06



OFFSHORE PROFILE

—▲— Survey Apr-95 Pre-Opal
×..... Survey Oct-95 Post-Opal
 - - - - -○- - - - - Dean Model Erosion Calc.

BAY - OPAL

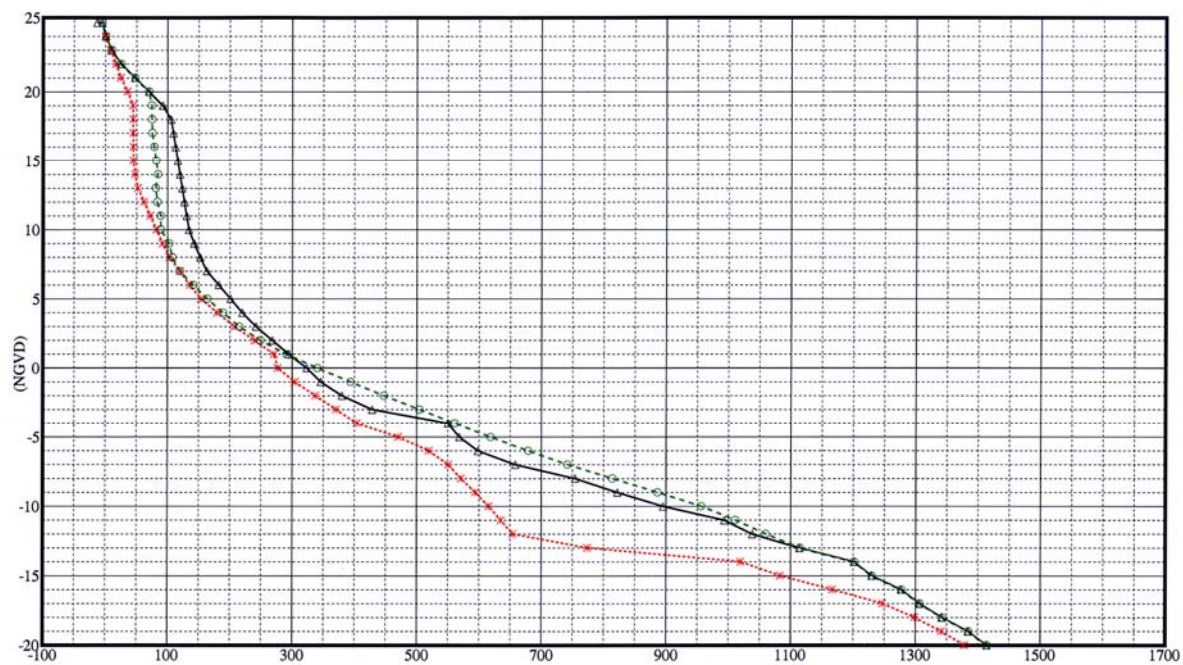
A = 0.1494, 1.0 factor
 BEACHES & SHORES RESOURCE CENTER
 FLORIDA STATE UNIVERSITY

Range: R-14

1/1

DOT DATA:
 BEACH DATA: 30MAR95
 OFFSHORE DATA: 04APR95

05-24-06



OFFSHORE PROFILE

—▲— Survey Apr-95 Pre-Opal
●..... Survey Oct-95 Post-Opal
 - - - - -◇- - - - - Dean Model Erosion Calc.

BAY - OPAL

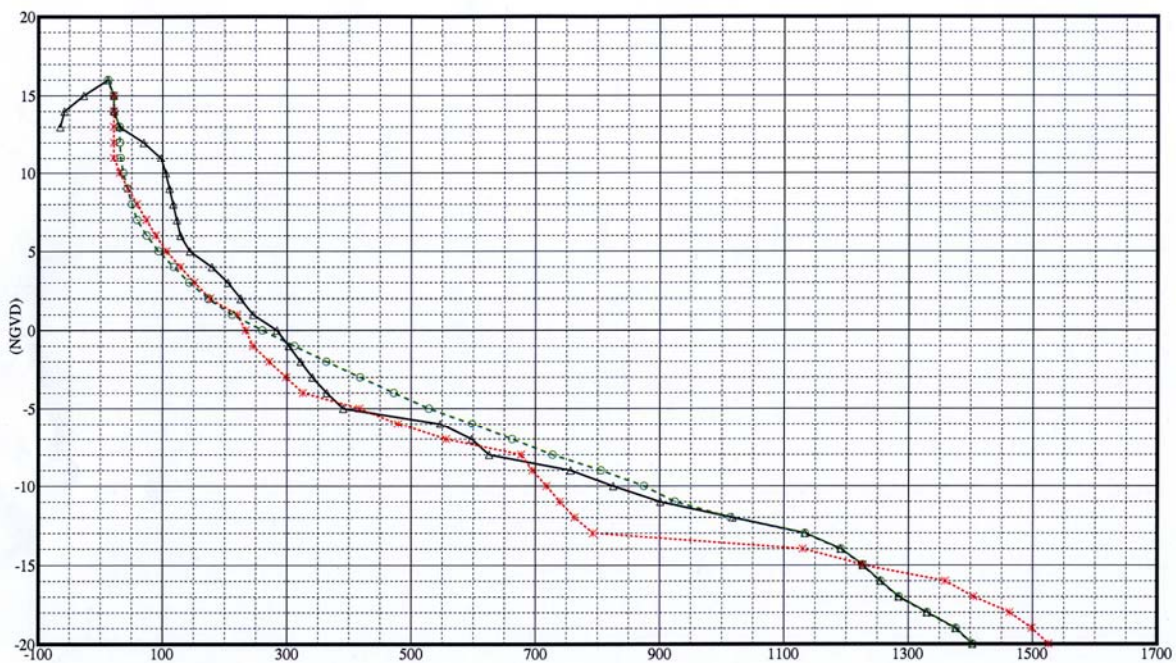
A = 0.1494, 1.0 factor
 BEACHES & SHORES RESOURCE CENTER
 FLORIDA STATE UNIVERSITY

Range: R-51

1/1

DOT DATA:
 BEACH DATA: 04MAR95
 OFFSHORE DATA: 04APR95

05-24-06



OFFSHORE PROFILE

—△—△— Survey Apr-95 Pre-Opal
 Survey Oct-95 Post-Opal
 - - - - - Dean Model Erosion Calc.

BAY - OPAL

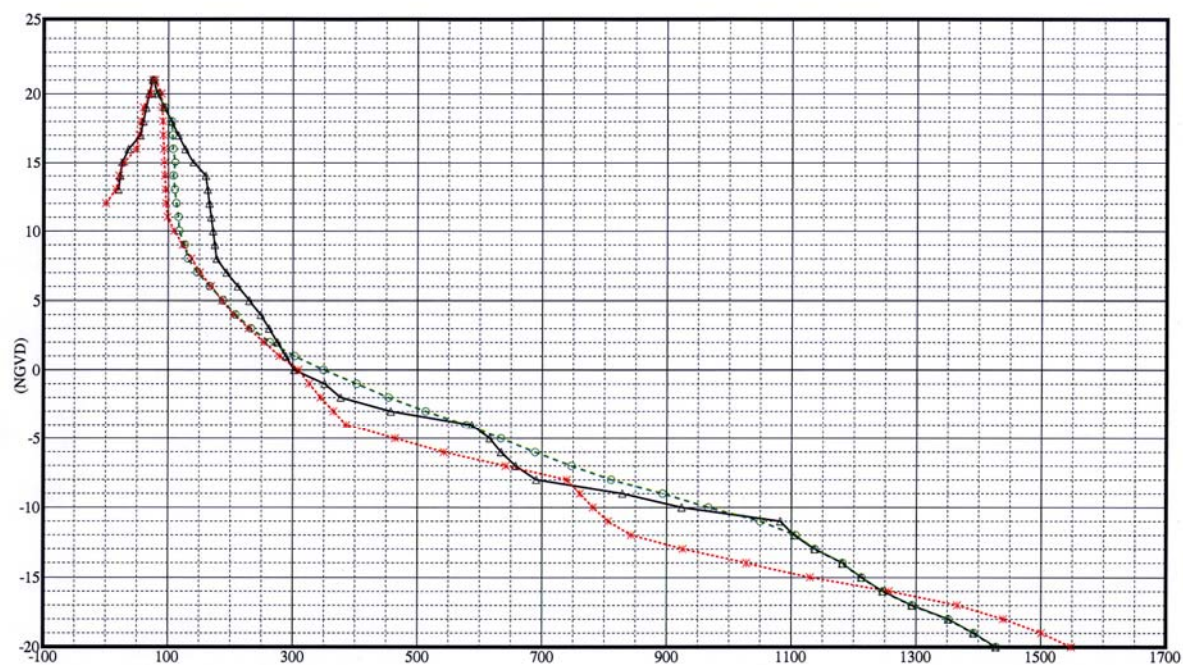
A = 0.1494, 1.0 factor
 BEACHES & SHORES RESOURCE CENTER
 FLORIDA STATE UNIVERSITY

Range: R-67

1/1

DOT DATA:
 BEACH DATA: 03MAR95
 OFFSHORE DATA: 04APR95

05-24-06



OFFSHORE PROFILE

—▲— Survey Apr-95 Pre-Opal
○..... Survey Oct-95 Post-Opal
 - - -◇- - - Dean Model Erosion Calc.

BAY - OPAL

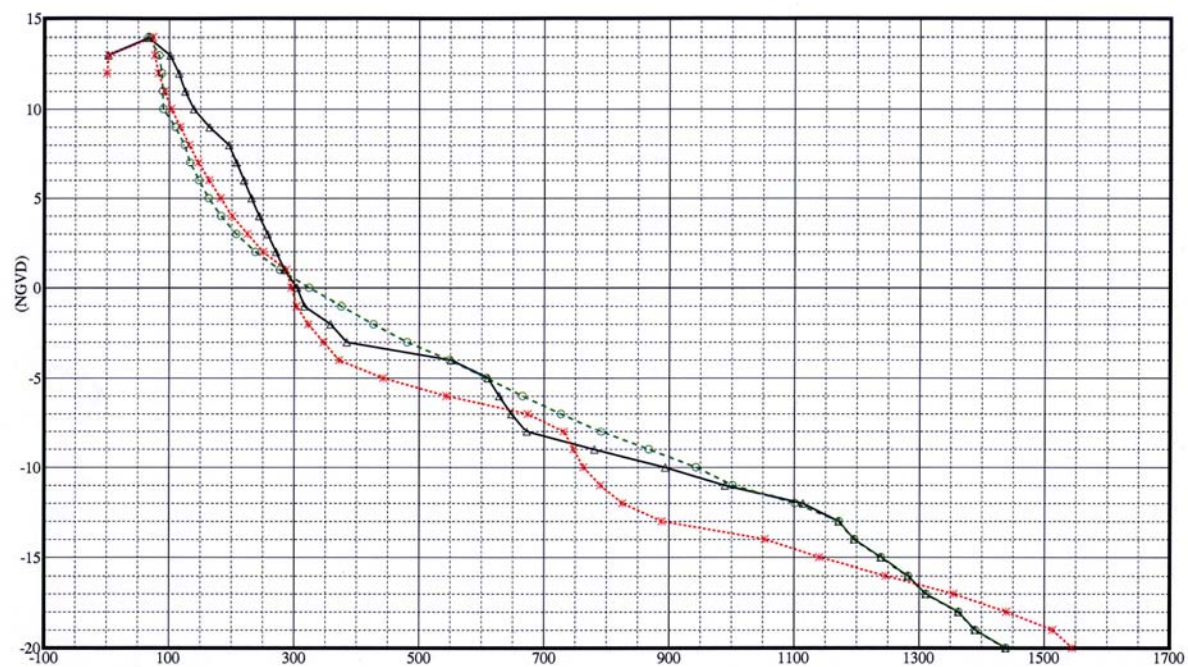
A = 0.1494, 1.0 factor
 BEACHES & SHORES RESOURCE CENTER
 FLORIDA STATE UNIVERSITY

Range: R-78-T

1/1

DOT DATA:
 BEACH DATA: 02MAR95
 OFFSHORE DATA: 07APR95

05-24-06



OFFSHORE PROFILE

—○— Survey Apr-95 Pre-Opal
 - - - - - Survey Oct-95 Post-Opal
 - - - - - Dean Model Erosion Calc.

BAY - OPAL

A = 0.1494, 1.0 factor
 BEACHES & SHORES RESOURCE CENTER
 FLORIDA STATE UNIVERSITY

Range: R-83-T

1/1

DOT DATA:
 BEACH DATA: 02MAR95
 OFFSHORE DATA: 07APR95

05-24-06