Long-term 2-D Shoreline Change Analysis Using Non-Traditional Methods

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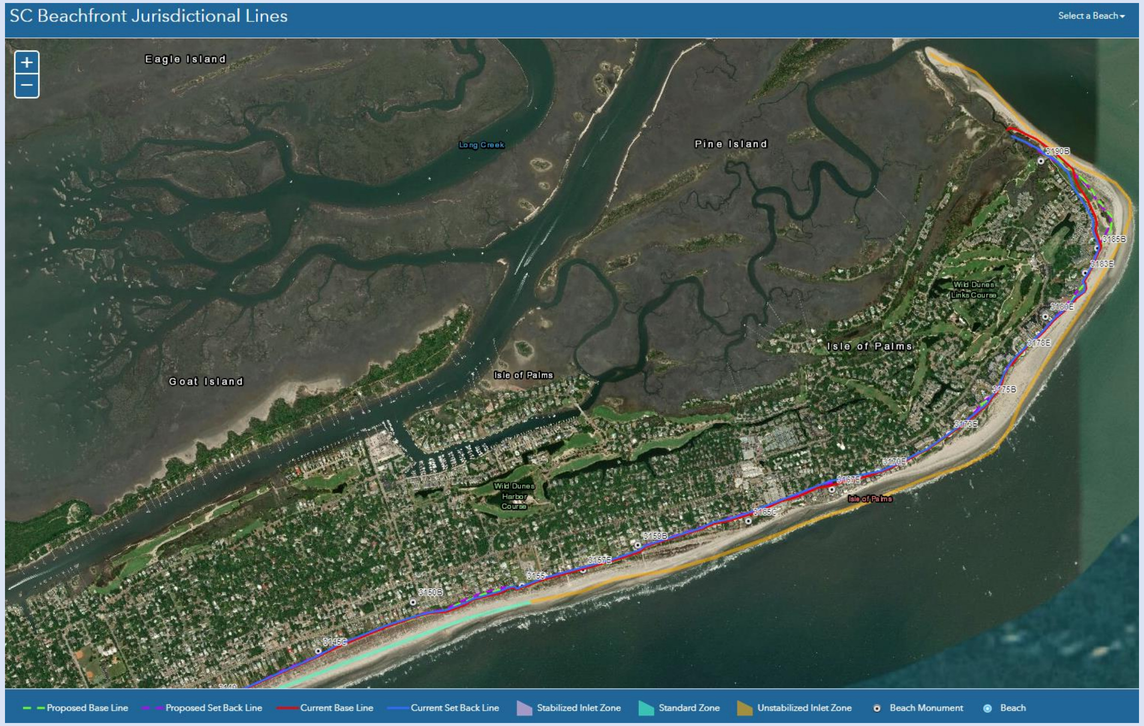
Overview

- Not a successful problem-solving presentation
- Not sure this is THE correct solution – meant to raise questions – plenty of other ways to do it
- SLR considerations accounted for
- Looking at Beaches like Infrastructure – Sad but maybe true?

- Needs
- Perceived Existing Problems
- New Paradigm vs Existing Paradigm
- Data/Site
- Processes
- Assumptions
- Example Results

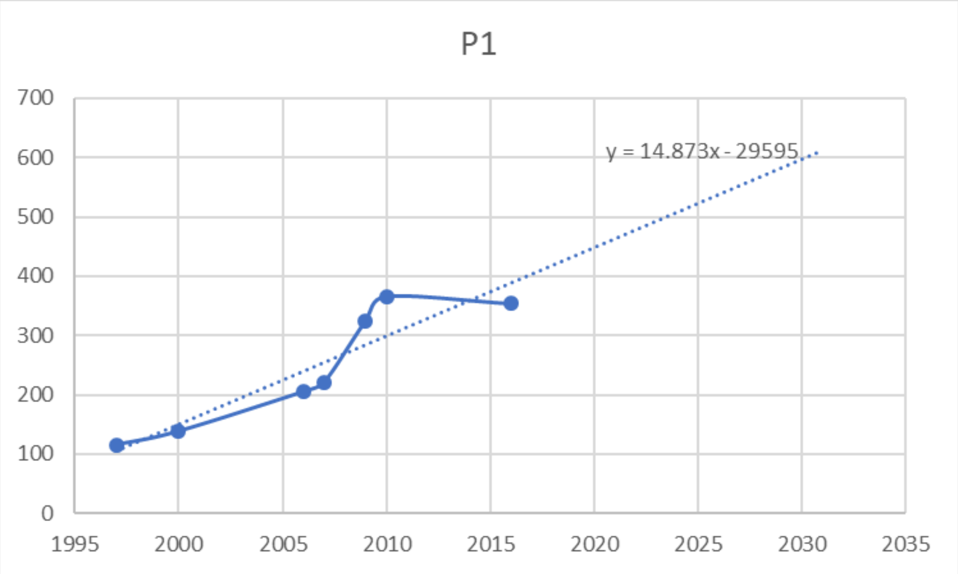
Needs and Uses

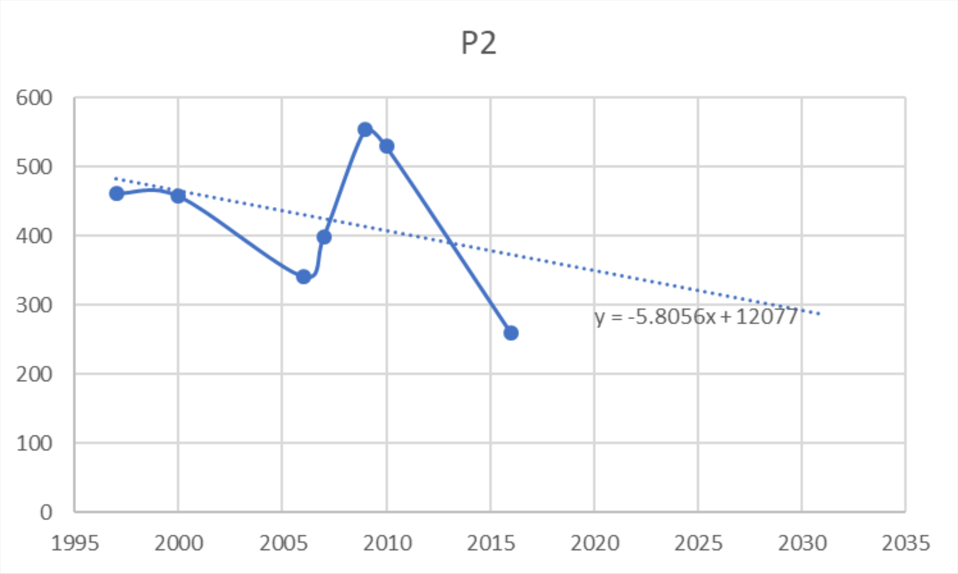
- Lots of $$ spent on coastal resilience here!!
- Existing Regulations
- Future under SLR
    - Future Regulations
    - Future Needs for Sediment
- Artificial Sediment
    - How to deal with renourishment in long term analysis?



Perceived Existing Problems

- Non Linear Shoreline Trends
- Non-natural Sediment Sources
- Timing of Surveys (start – end)
- Trend based – Cyclical conditions can not be forecasted





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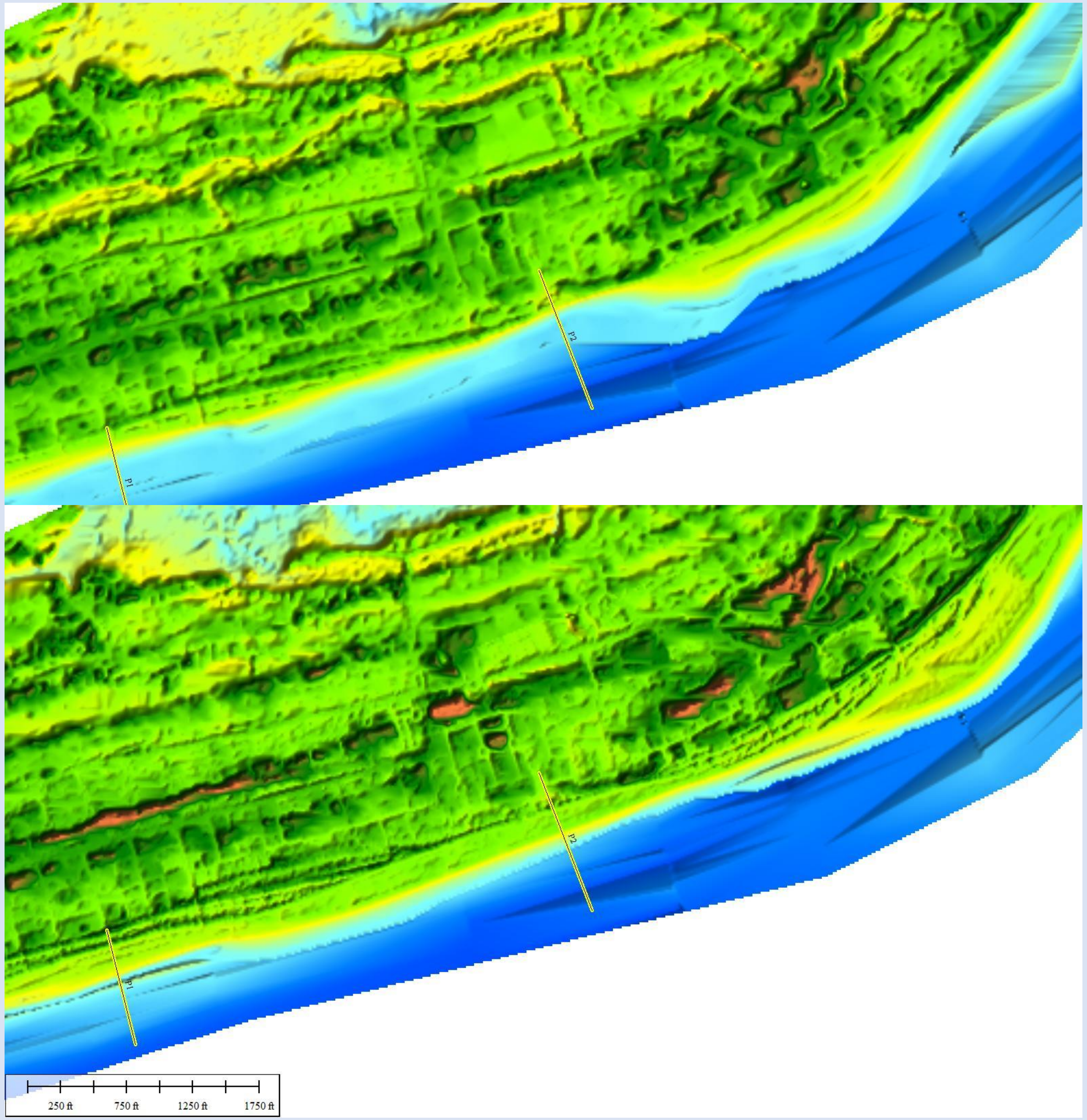
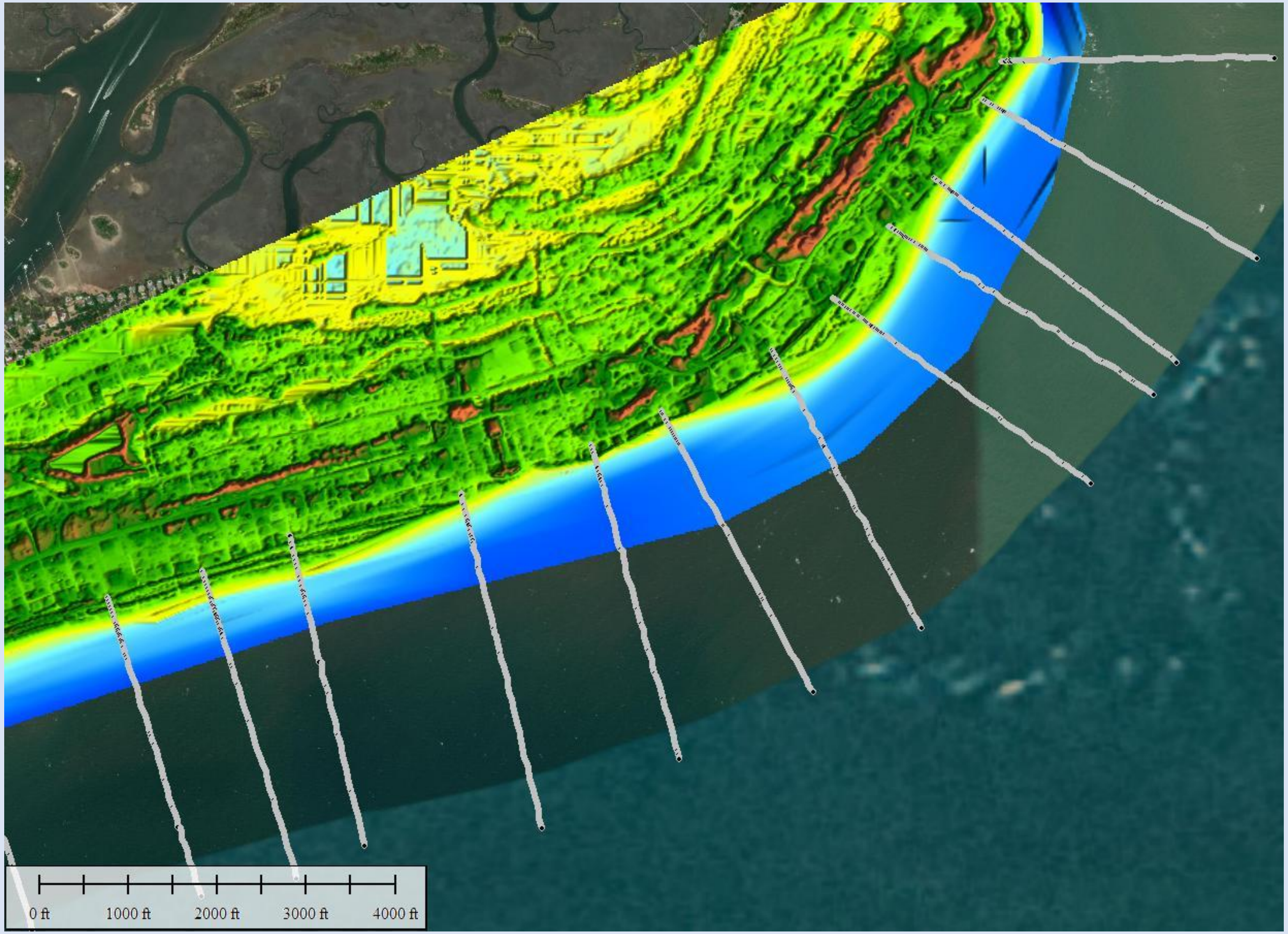
“Infrastructure” view vs. Existing “Trend”

- Timing of survey not that important
  - Sampling population of potential beach morphologies
- Natural and “Artificial” Sedimentation OK
- Morphologic Variability is Driver
- Trends are de-emphasized
  - Used for future calculations – not in projection form though
- SLR and its uncertainty is included



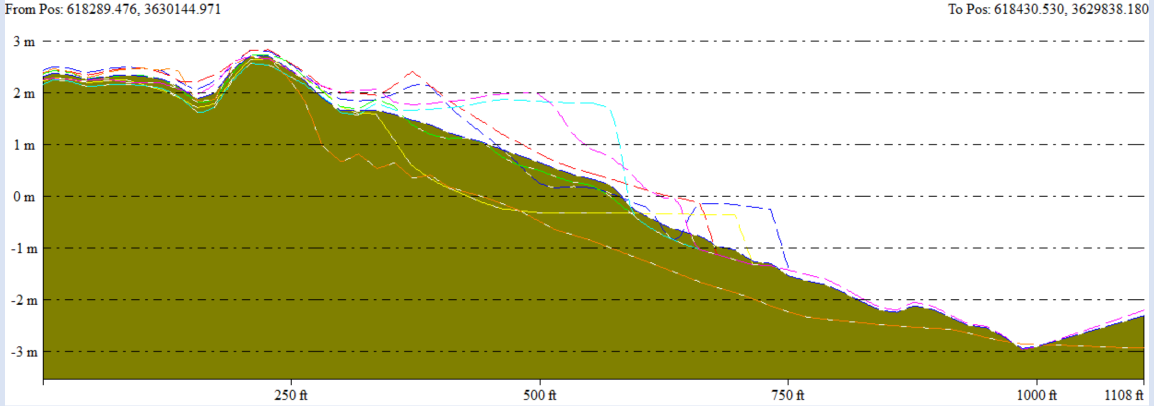
Data/Site

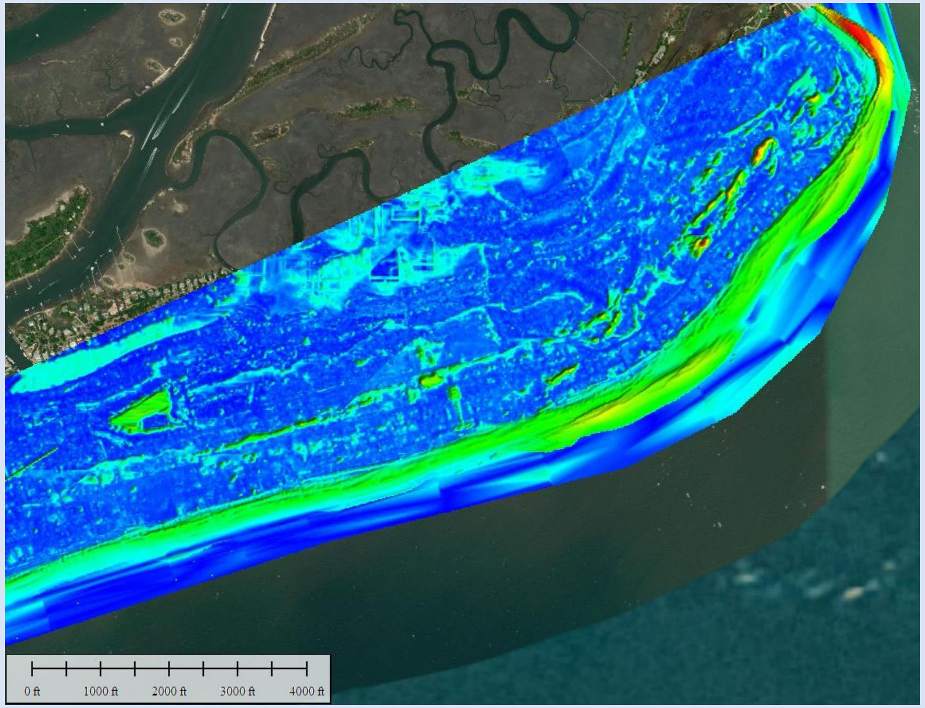
- Lidar Data
  - Aerial (~20 years worth)
  - 1997, 2000, 2006, 2007, 2009, 2010, 2016
  - Drone/Mobile (future)
- Profile Data



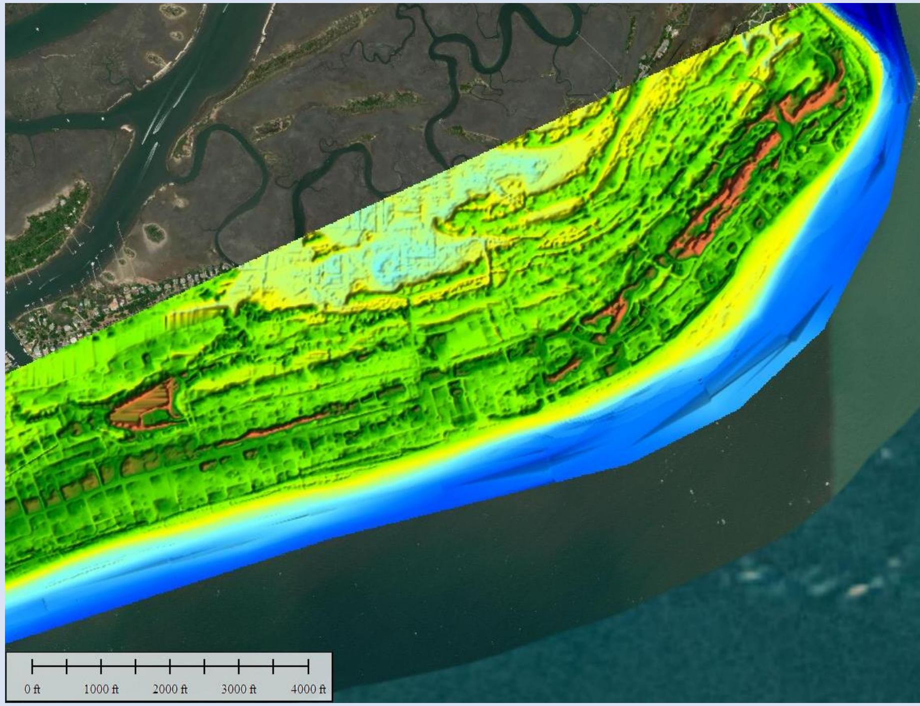
Process - Technique

- Based on ‘Uncertainty Technique’ developed for SLR Viewer
- Stochastic vs. Deterministic
- Standard Deviation used to define Z scores from which risk %’s are determined.





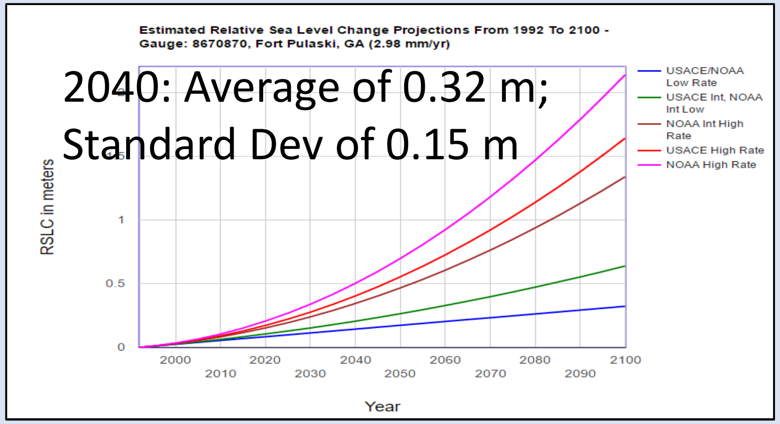
Std dev surface



Average 20 year ‘shoreline epoch’ surface

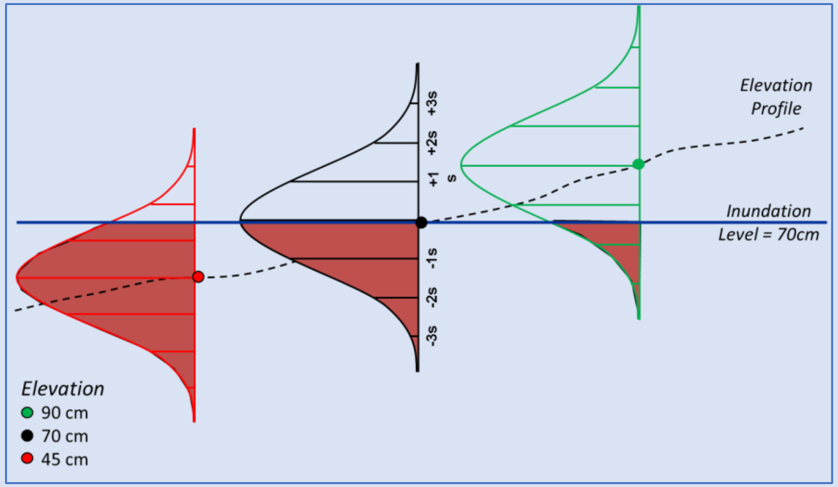
Process – Calculations (per pixel)

- Simple – No Trends
- Compound – Includes Trends (adding curves)



$$f(elev\ risk) = \ Elev + Elev\ Variability\ (Morphology) + Water\ Level + Varibility\ (SLR)$$

$$\text{Zscore} = \frac{Elev^{ave} - Water\ Level^{ave}}{\sqrt{Morphology^2 + SLR^2}}$$



$$f(elev\ risk) = \ Elev + Elev\ Variability\ (Morphology) + Trends + Water\ Level + Varibility\ (SLR)$$

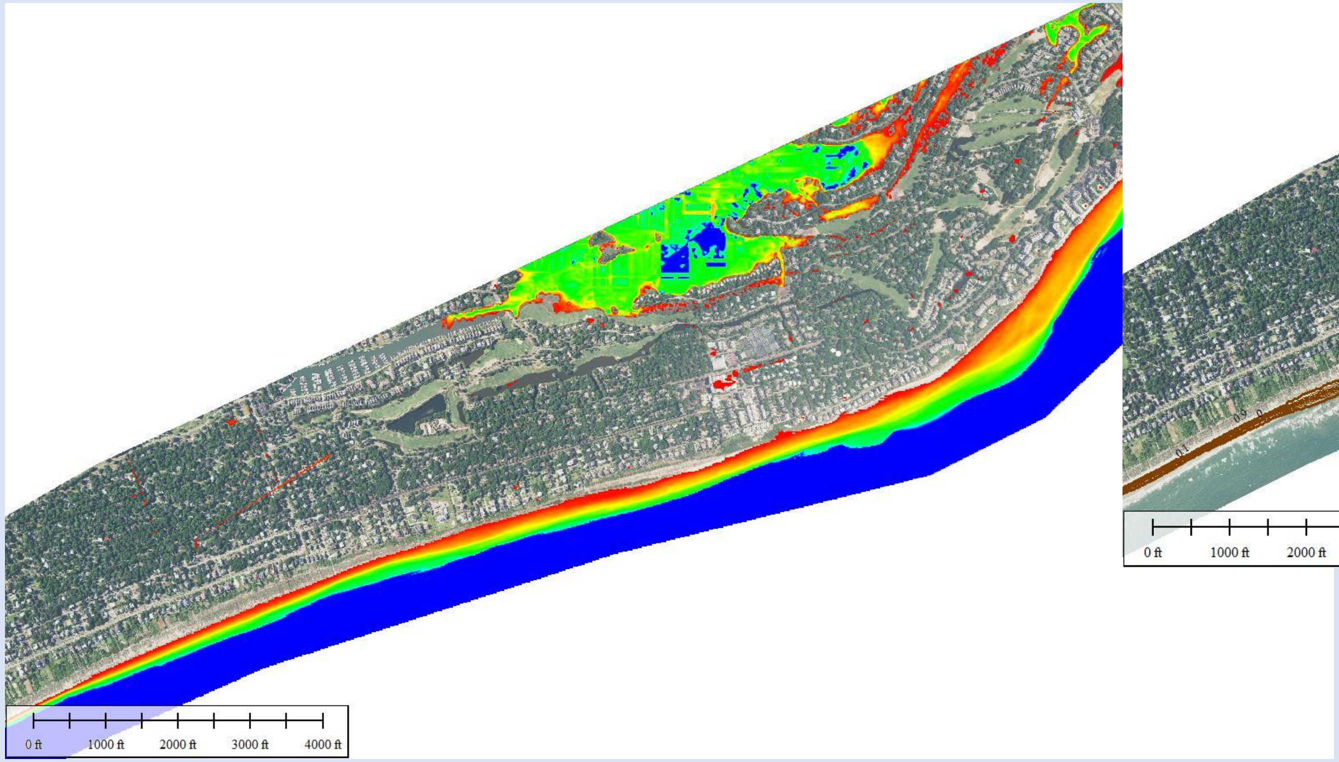
$$\text{Zscore} = \frac{Elev^{ave} - Water\ Level^{ave}}{\sqrt{Morphology^2 + SLR^2}} + \frac{Trends^{ave} - 0}{Trends\ Stdev}$$

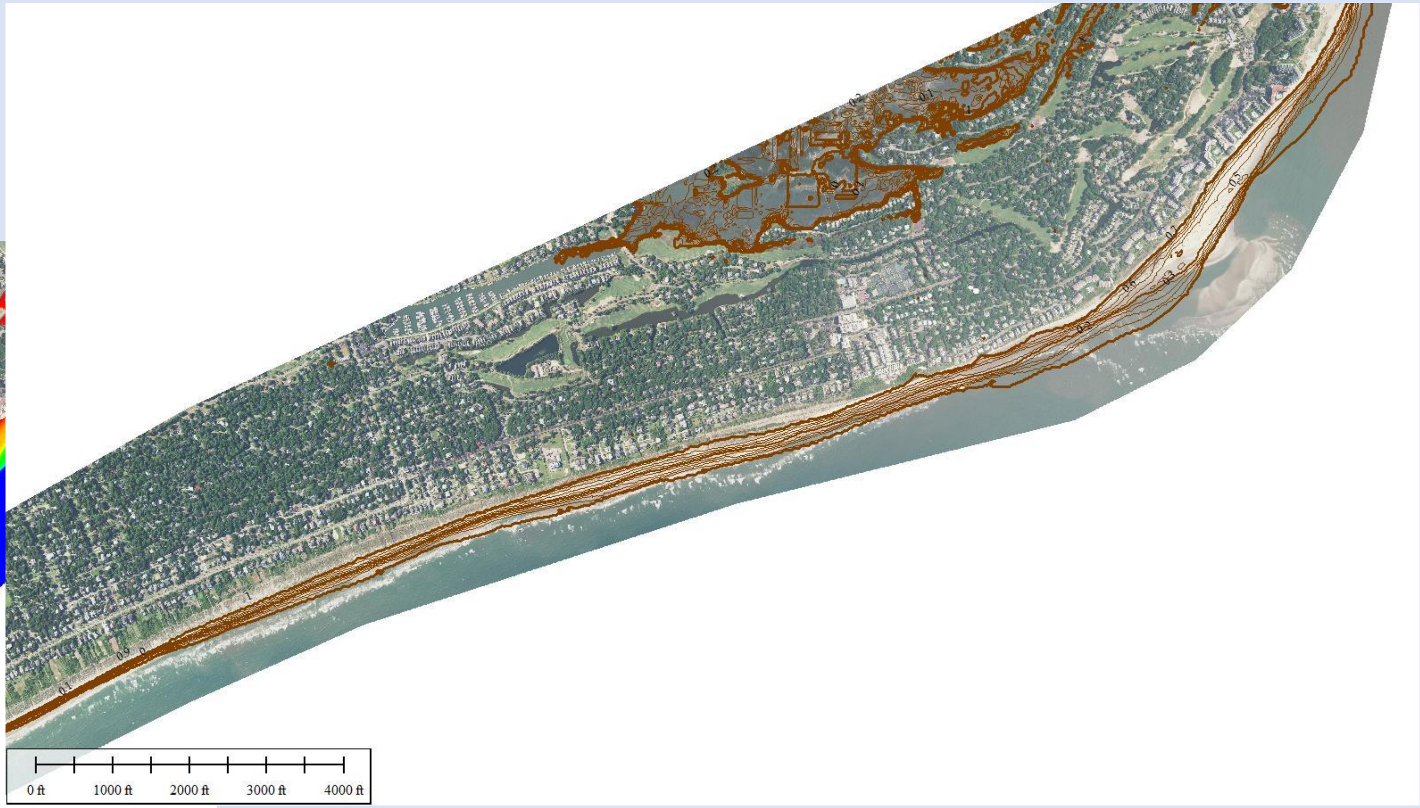
Assumptions

- Beach configuration is not solely time dependent
- Population (7 samples over 20 yrs) represents the various possible conditions (to a large degree)
- Looking at Normal (Gaussian) Distribution
- The first row of houses is going to be protected – whether we have regulations or not (wont let infrastructure fail completely)
- Humans are a geologic forcing – as important as waves, currents, longshore transport, etc.

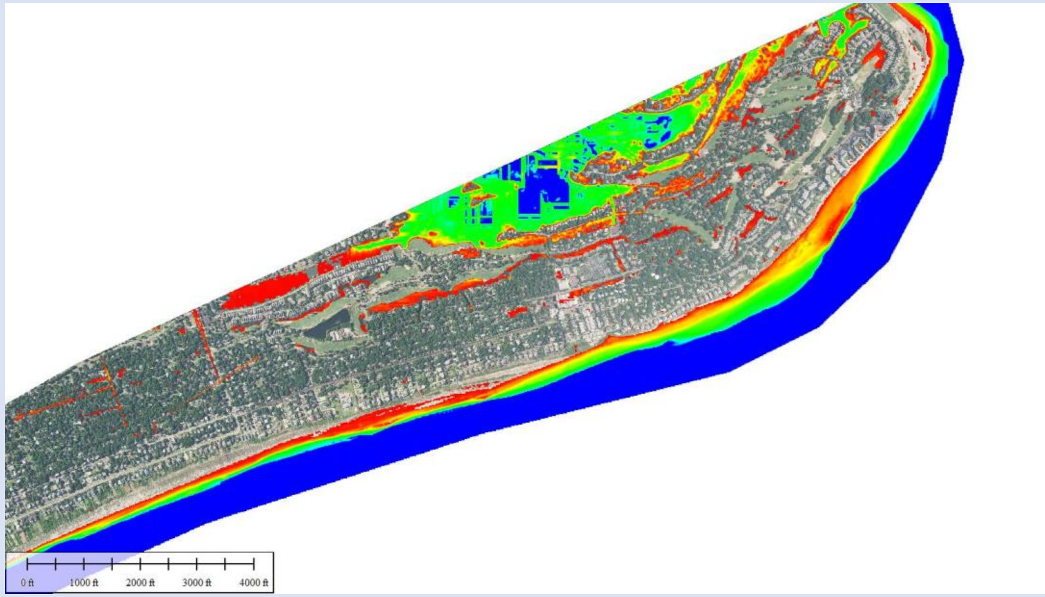
Results - Present

$$\text{Zscore} = \frac{Elev^{ave} - Water\ Level^{ave}}{\sqrt{Morphology^2 + SLR^2}}$$





Results – Future (2040)



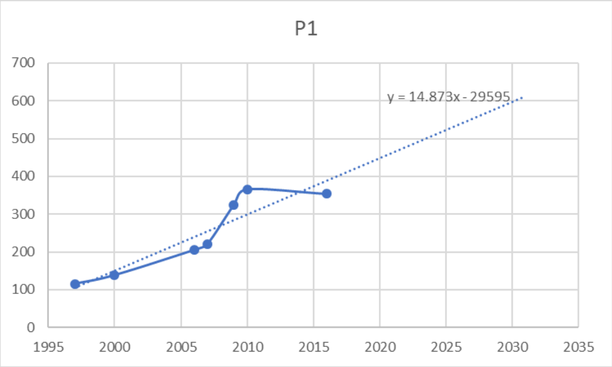
$$\text{Zscore} = \frac{Elev^{ave} - Water\ Level^{ave}}{\sqrt{Morphology^2 + SLR^2}} + \frac{Trends^{ave} - 0}{Trends\ Stdev}$$

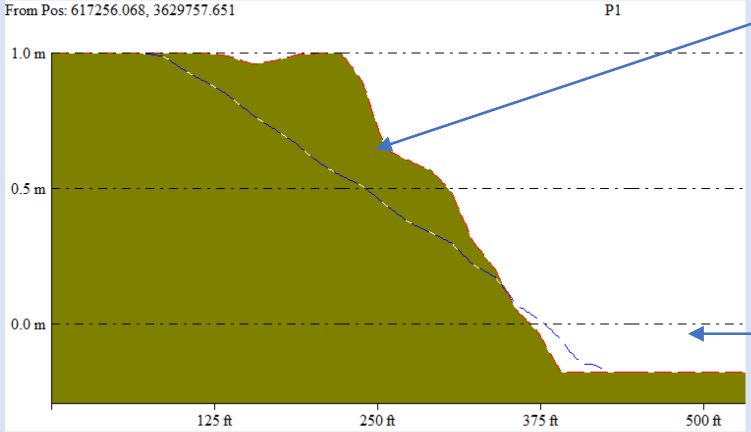
2040

2010

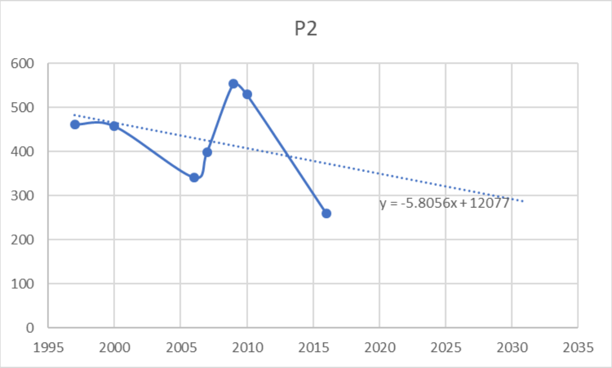
Results – Planning (Volumes)

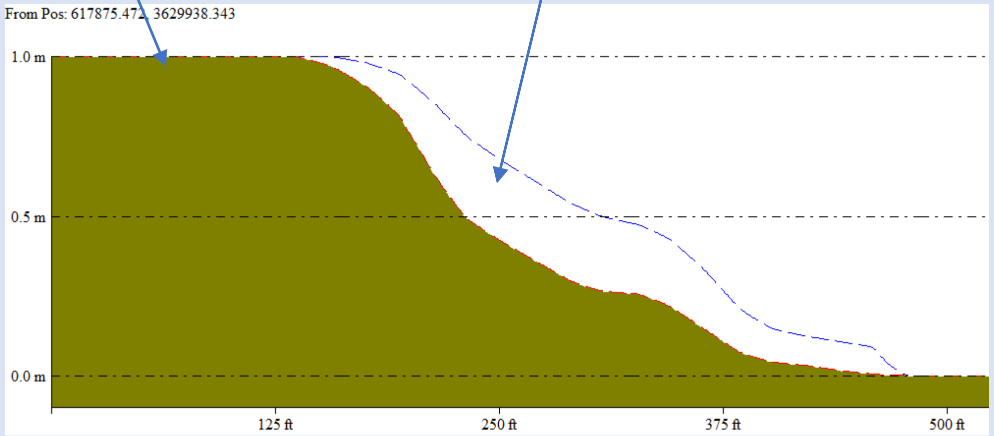
- What about getting to a better or stable future
- Example of using present risk surface compared to 2040 risk (Risk Profiles)
- A planned risk surface can be used





Shoreline Probability Profiles

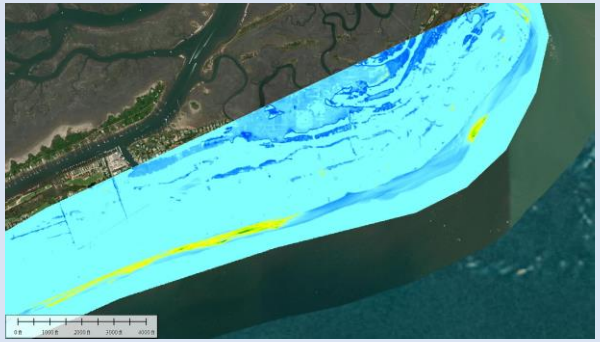




Results – Planning (Volumes)

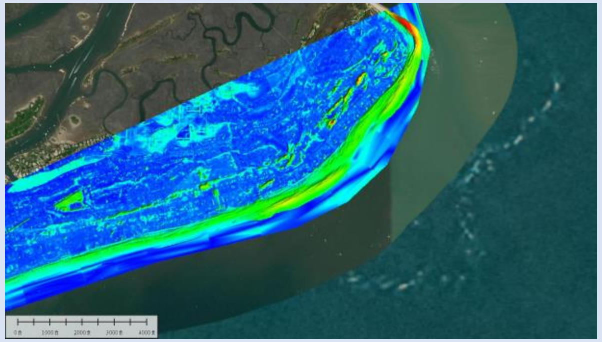
Elev (Target) = Zscore (Dif) * Standard Deviation

- Reverse equation
- Use “Risk Goal” surface (present in example)
- Calc Zscore differences
- Multiply by future Std dev



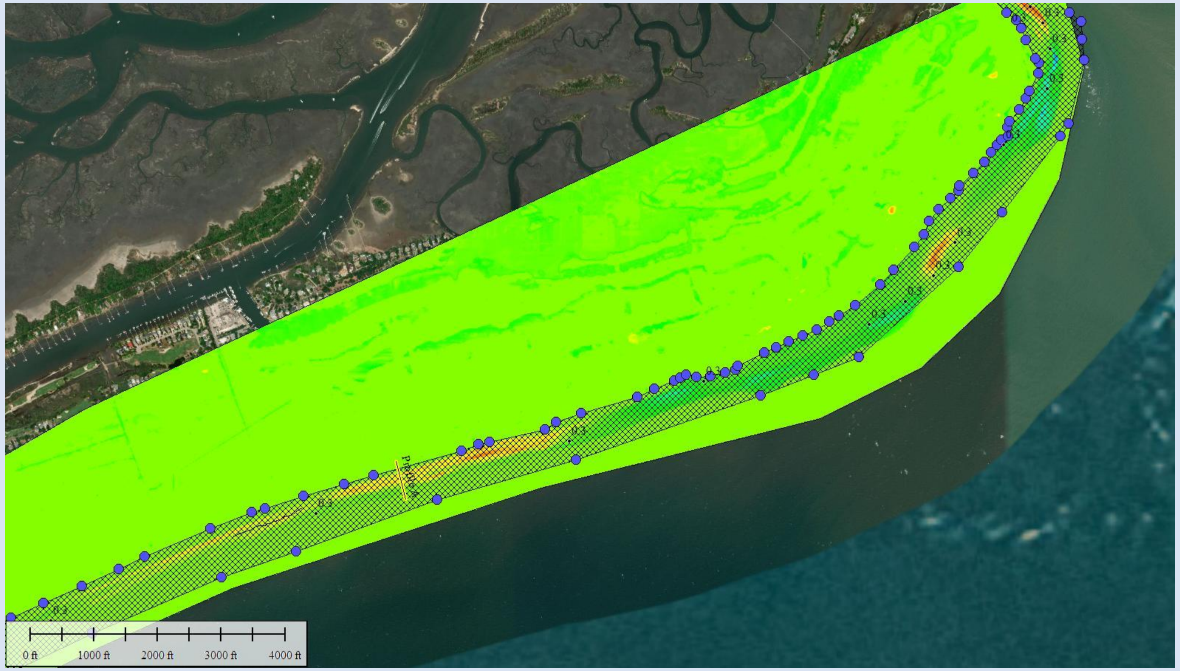
Risk Differences (zscores)

*



2040 Std Dev

=



Elevation Differences (present to 2040)

To maintain present risk surface an additional volume is needed (beyond existing nourishment volumes)

TOTAL_VOLUME	NET_VOLUME	CUT_VOLUME	CUT_AREA	CUT_AREA_3D	FILL_VOLUME
557488.78 cubic yards	-251012.99 cubic yards	153237.9 cubic yards	0.1058 sq mi	0.1059 sq mi	404250.89 cubic yards

Summary

- Hopefully raised questions
- Beach maintenance is here to stay
- Lots of Data available
- Opens up many statistical techniques
- Need to move past 1-D analysis

2018 Renourishment

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