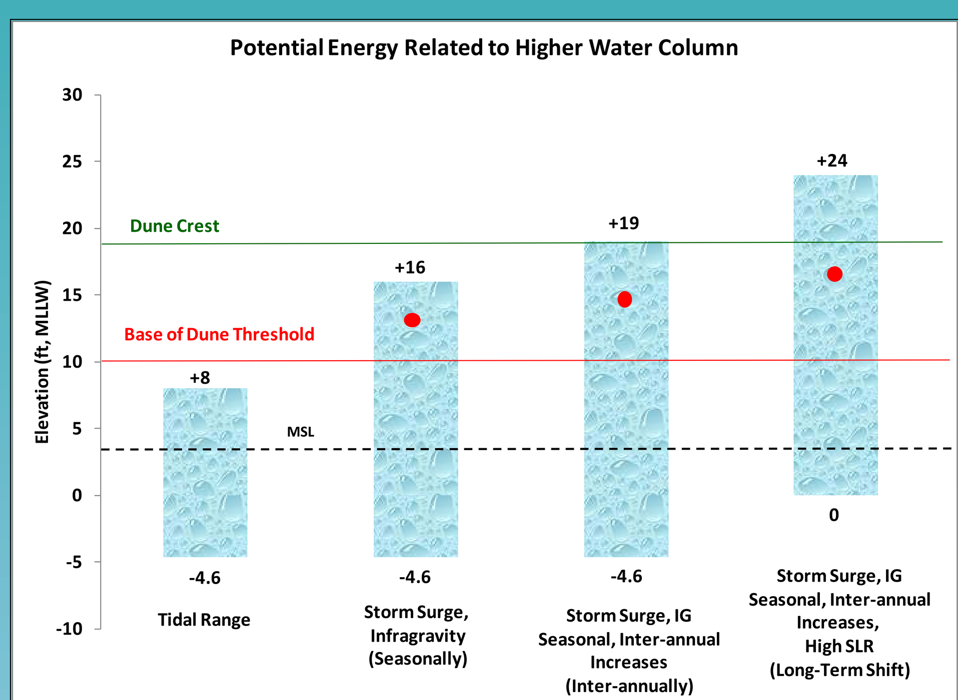
# Temporal and Spatial Impacts of Graduated Magnitudes and Frequencies of Water Level Deviations


Heidi Moritz[1], Tom Smith[2], Matt Schrader[3], Dave Kriebel[4], John Headland[5], Steve Gill[6], Rob Thieler[7], Hans Moritz[1], Kate White[8]

[1]USACE, Portland District, [2]USACE, Honolulu District, [3]USACE, Jacksonville District, [4]U.S. Naval Academy, [5]Moffatt & Nichol,
[6]NOAA, Center for Operational Oceanographic Products and Services, [7]U.S. Geological Survey, [8]USACE, Institute for Water Resources


Rising water levels establish a potential for erosion, but realization of the potential requires sediment redistribution, that is, work that depends on energy being available. (Responding to Changes In Sea Level: Engineering Implications, NRC, 1987.




Is the Bruun rule still the best representation of potential future shoreline response?

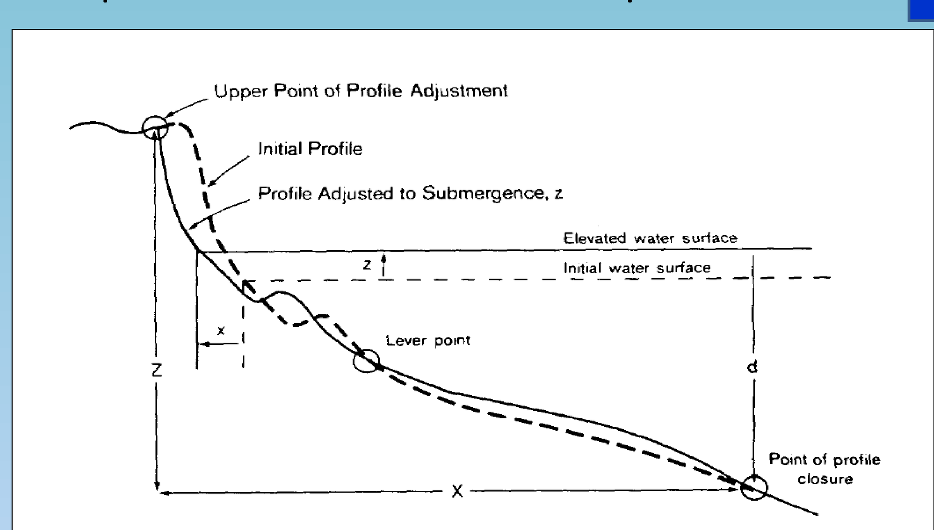



**Figure 5-3.** Shore adjustments to a change in water level elevation. (After E. Hands, 1976, *Predicting Adjustments in Shore and Offshore Sand Profile on the Great Lakes*, CERC Coastal Technical Aid 81-4, Fort Belvoir, Va.: Coastal Engineering Research Center.)

## Netherlands approach, Mulder, et al.

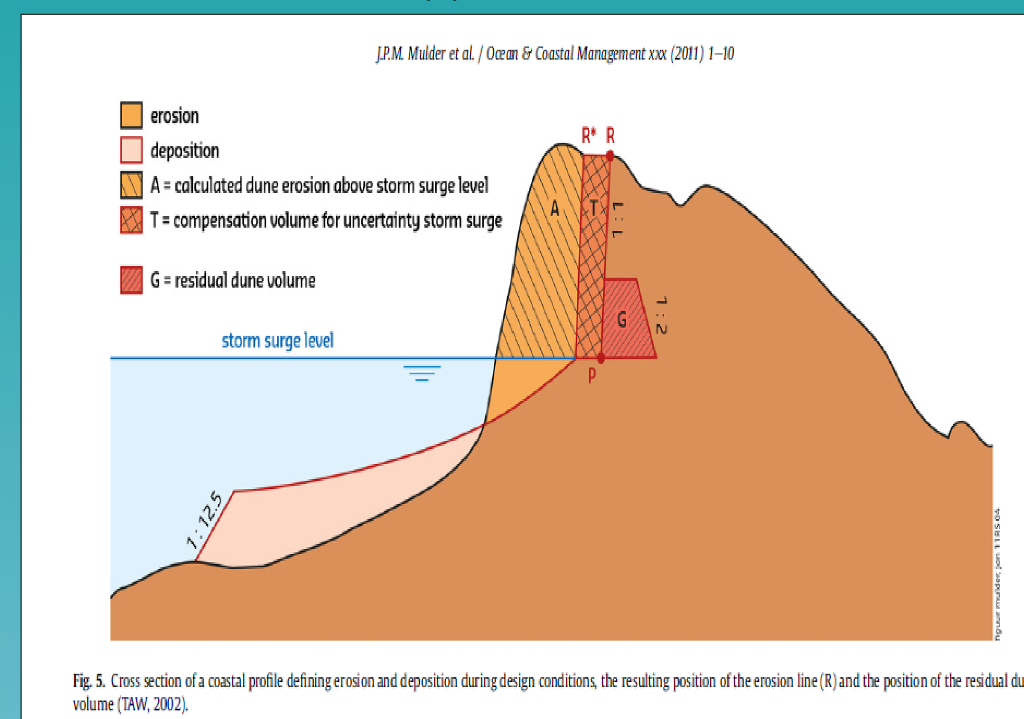



Fig. 5. Cross section of a coastal profile defining erosion and deposition during design conditions, the resulting position of the erosion line (R) and the position of the residual dune volume (TAW, 2002).

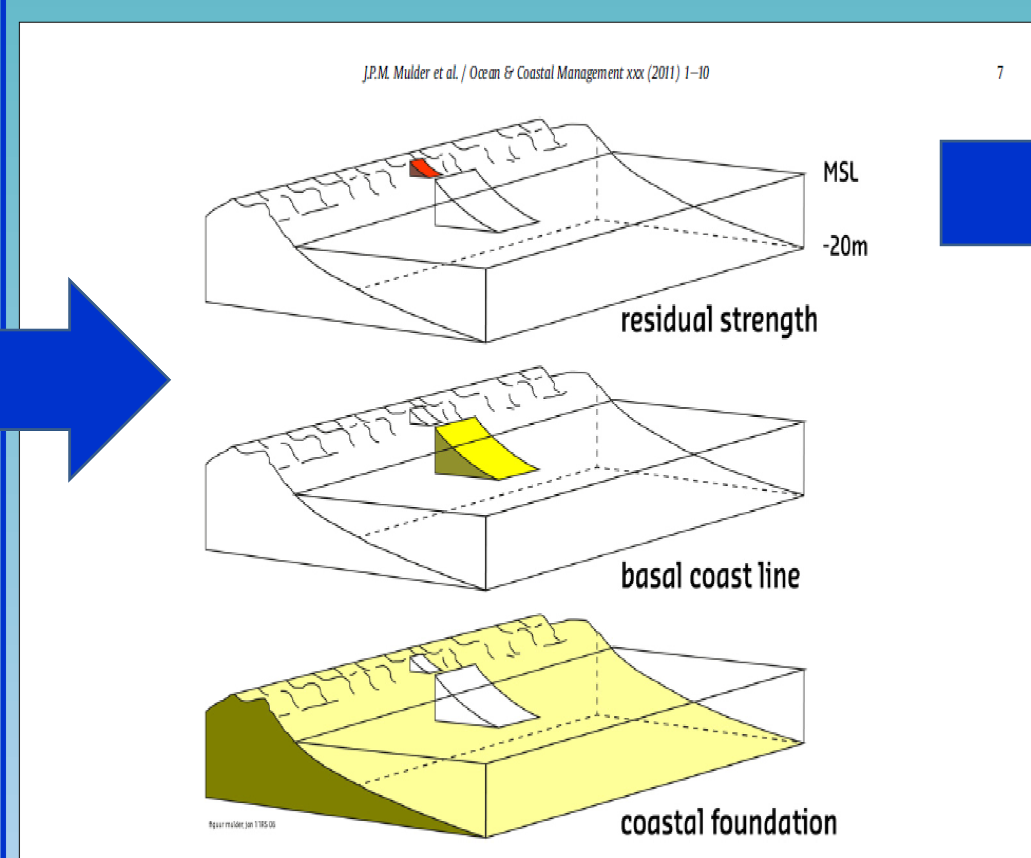


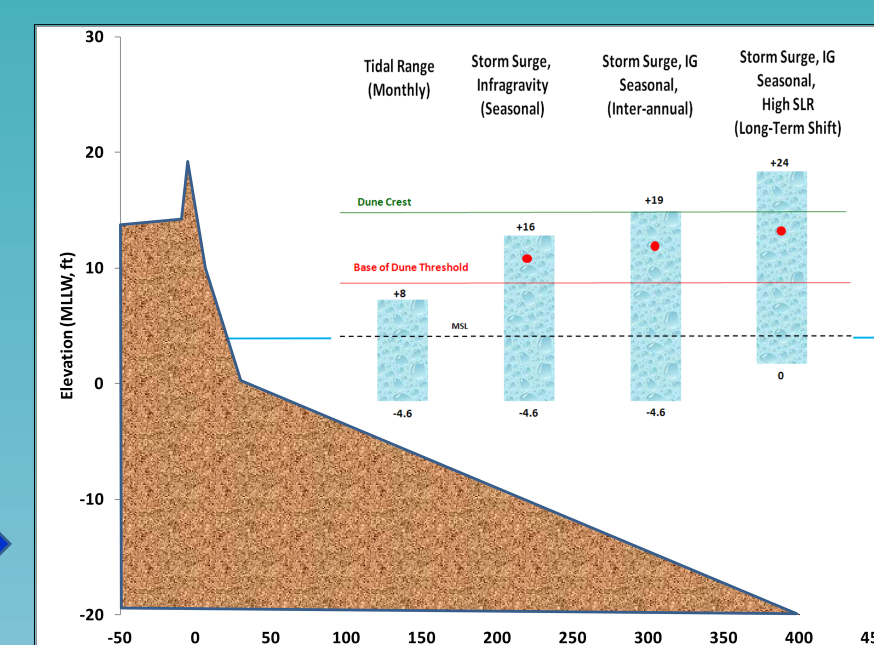

Fig. 6. Definition sketch of three different scales in coastal management (after Mulder et al., 2006). Each scale is associated with a specific coastal cell; each cell enables benchmarking of a specific tactical objective:

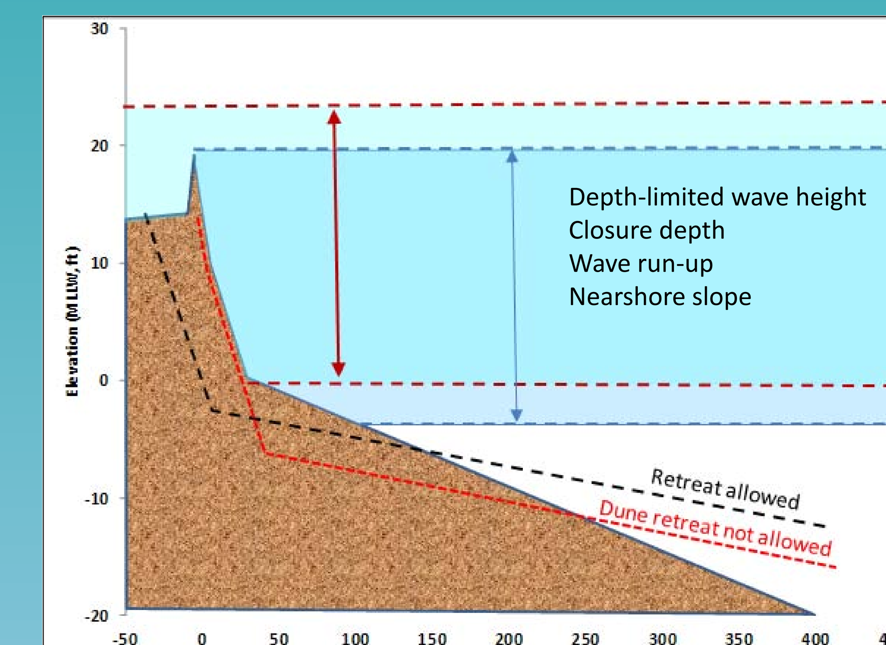
| | Temporal scale: | Spatial scale: |
|---|---|---|
| - Residual strength | days | meters |
| - Basal Coast Line (BCL) | years | kilometers |
| - Coastal foundation | decades/centuries | 10's/100's kilometers |

Mulder, J.P.M., et al., Implementation of coastal erosion management in the Netherlands, Ocean & Coastal Management (2011), doi:10.1016/j.ocecoman.2011.06.009

Coastal hazards vary in definition depending on the magnitude and frequency of loading contrasted to the relative capacity or vulnerability of the receiving shoreline. The vulnerability of the receiving shoreline can include such factors as geomorphology of the shoreline, mean tide range, mean wave height, nearshore coastal slope, and available sediment supply.

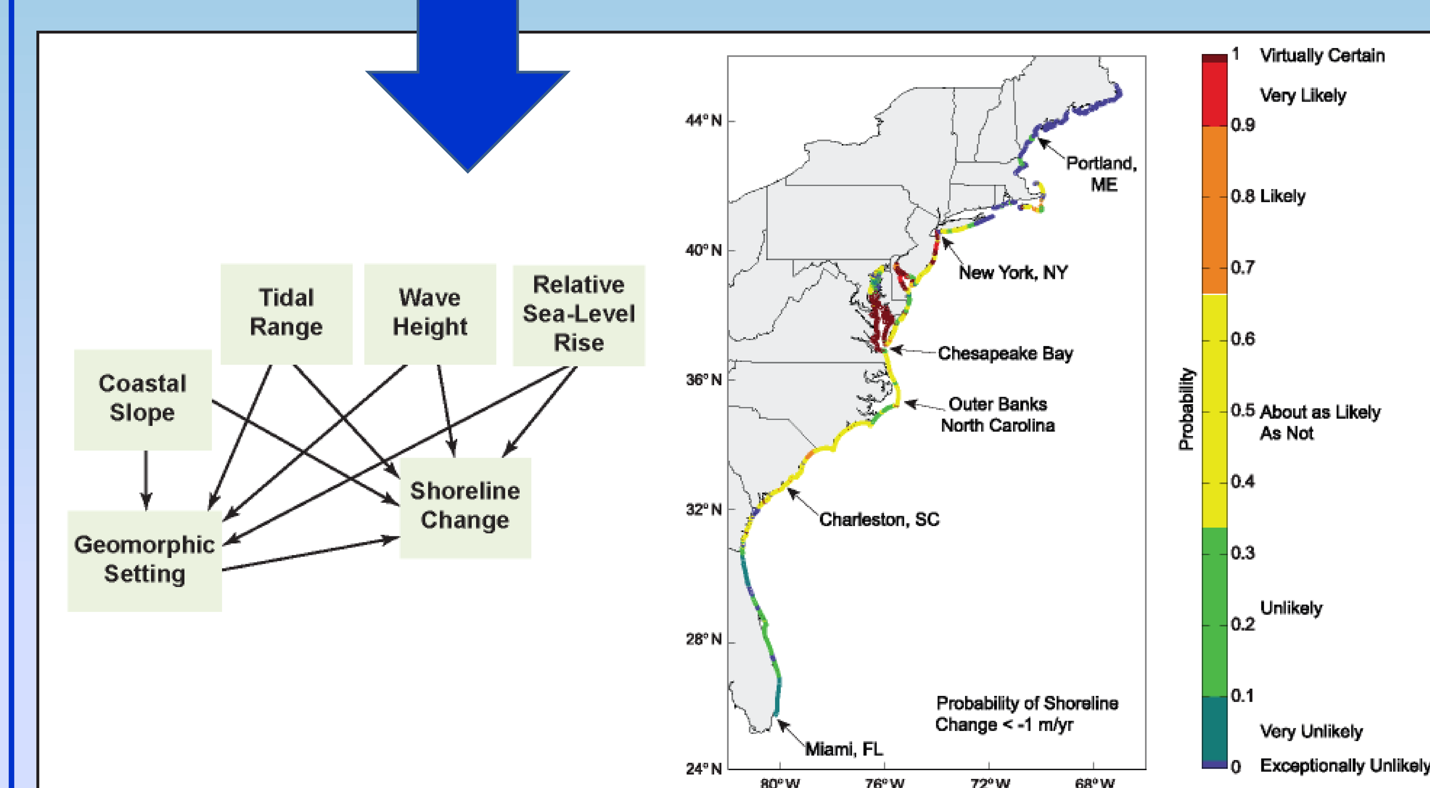
Analysis and design related to graduated water levels must accurately portray the potential response of the structure and surrounding morphology.



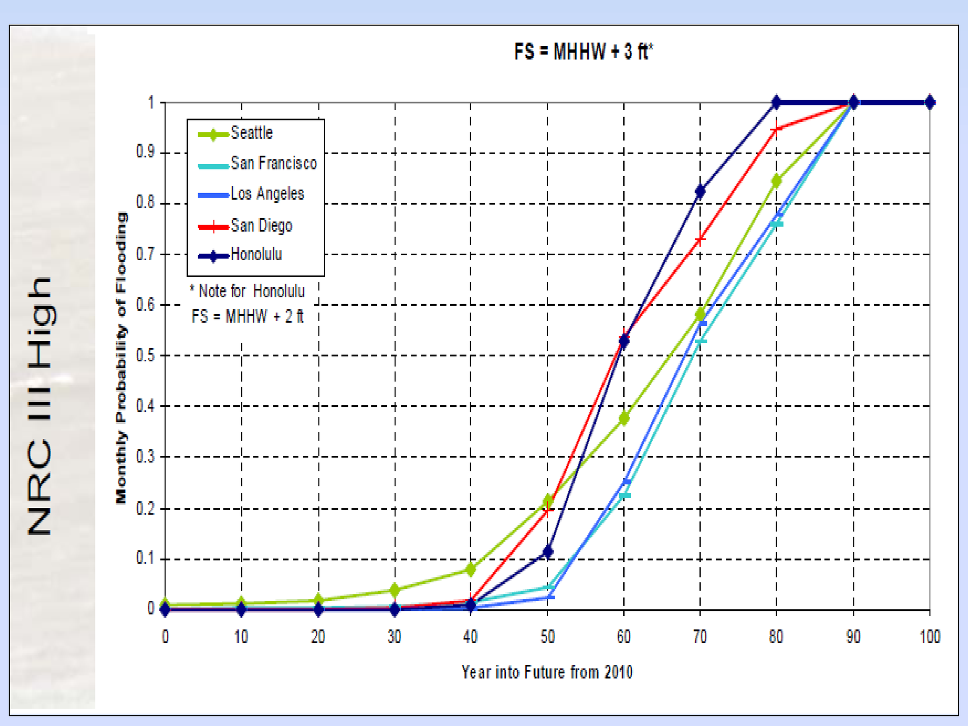

Key Questions:

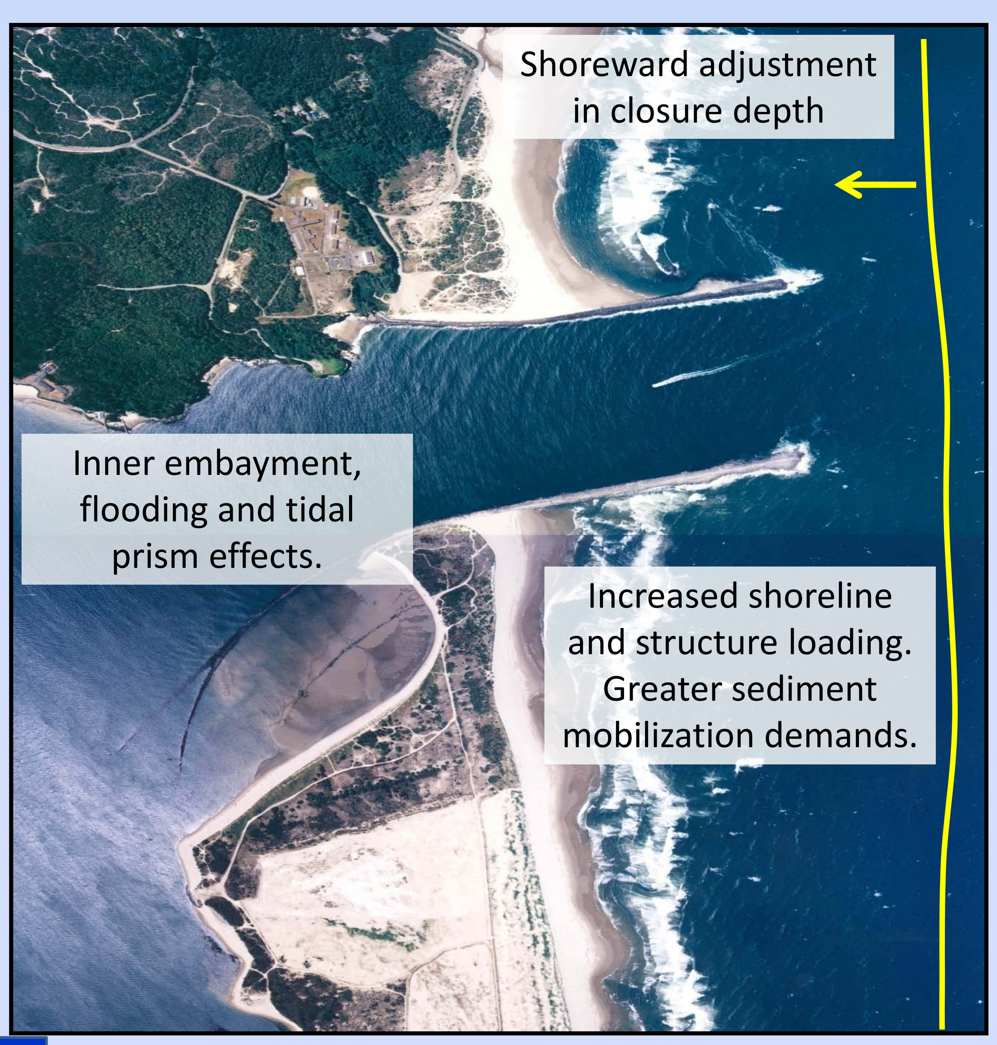
- If the Bruun rule is not always applicable, what method should we be using?
- How well does the Bruun rule (or other method) work if the sediment supply is limited?
- If the approach is to hold the shoreline in place, how does the profile adjust?
- Do we have a good perception of the frequency/volume of nourishment required to hold the line?
- Looking at the Netherlands approach, are we considering the basal coast line and the coastal foundation?




http://www.agu.org/pubs/crossref/2011/2010JF001891.shtml >

The U.S. Geological Survey is further developing a method to assess coastal vulnerability based on the six parameters noted at the left. This approach provides probabilistic estimates of shoreline vulnerability. The multi-colored ribbon around the map of the U.S. to the left and below indicates coastal vulnerability developed using this method from green (low) to red (high.)(Gutierrez, Plant, Thieler, 2011. A Bayesian network to predict coastal vulnerability to sea level rise. Journal of Geophysical Research, Vol. 116)



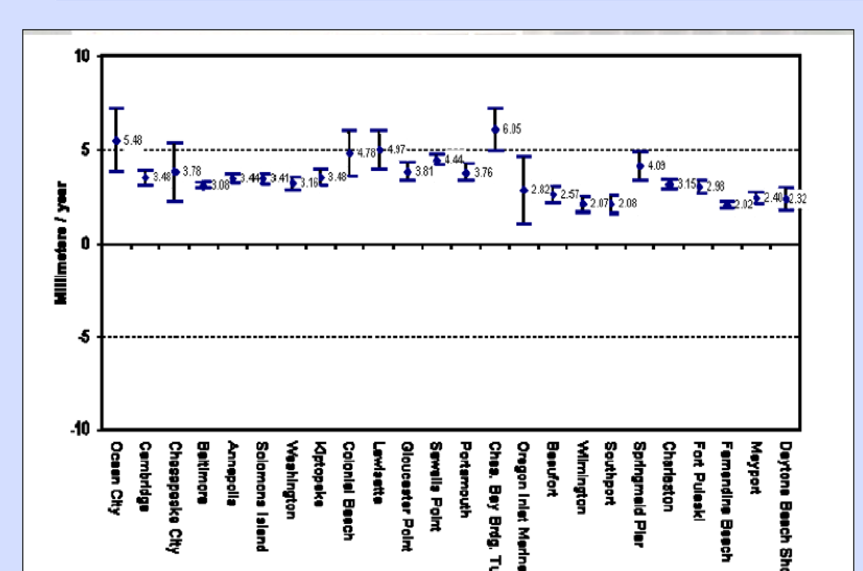
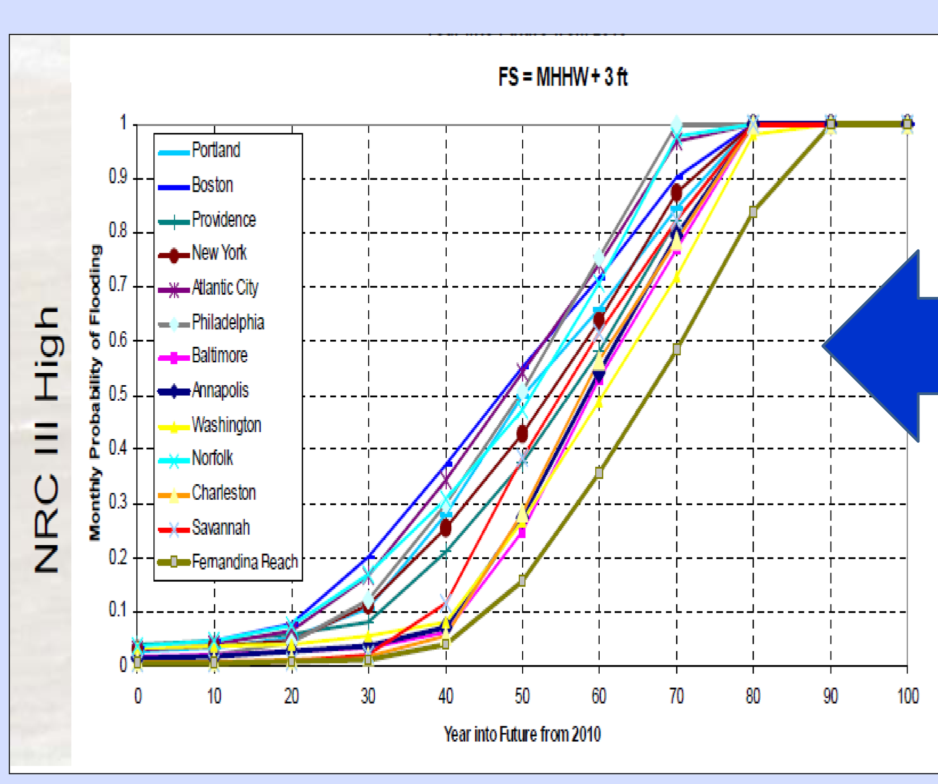
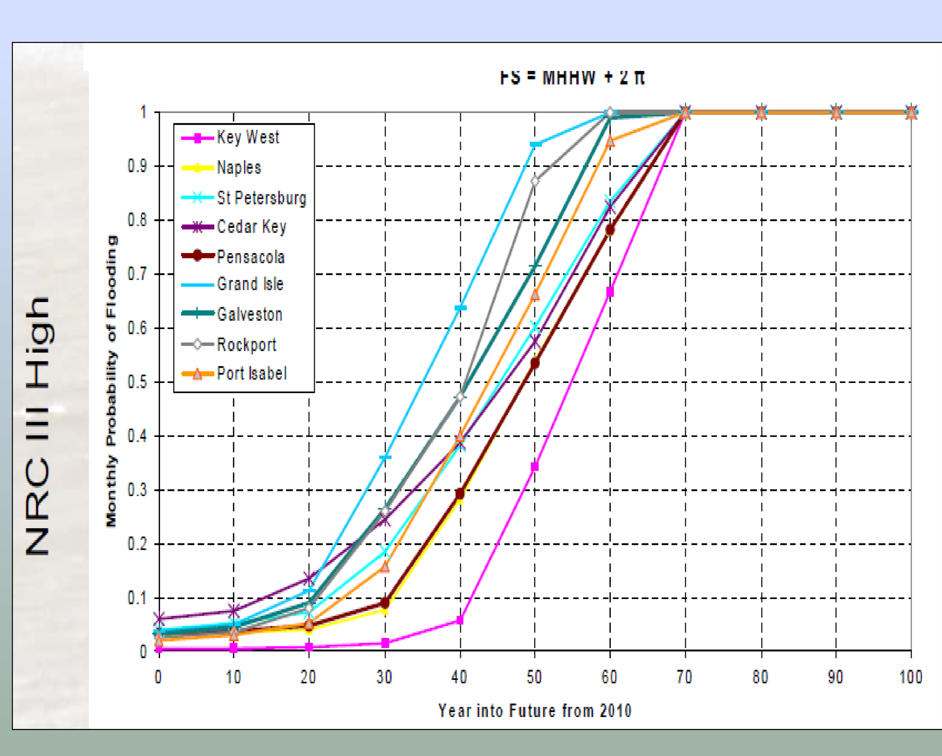
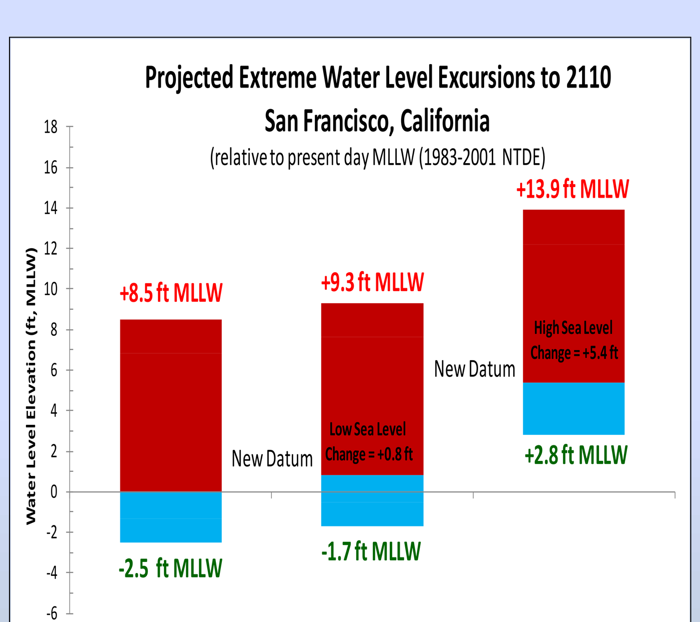




Figure B-4. Magnitude and confidence limits of trends for Southern Atlantic coast NOS tide stations. (NOS 2009, http://tidesandcurrents.noaa.gov/sltrends/index.shtml).

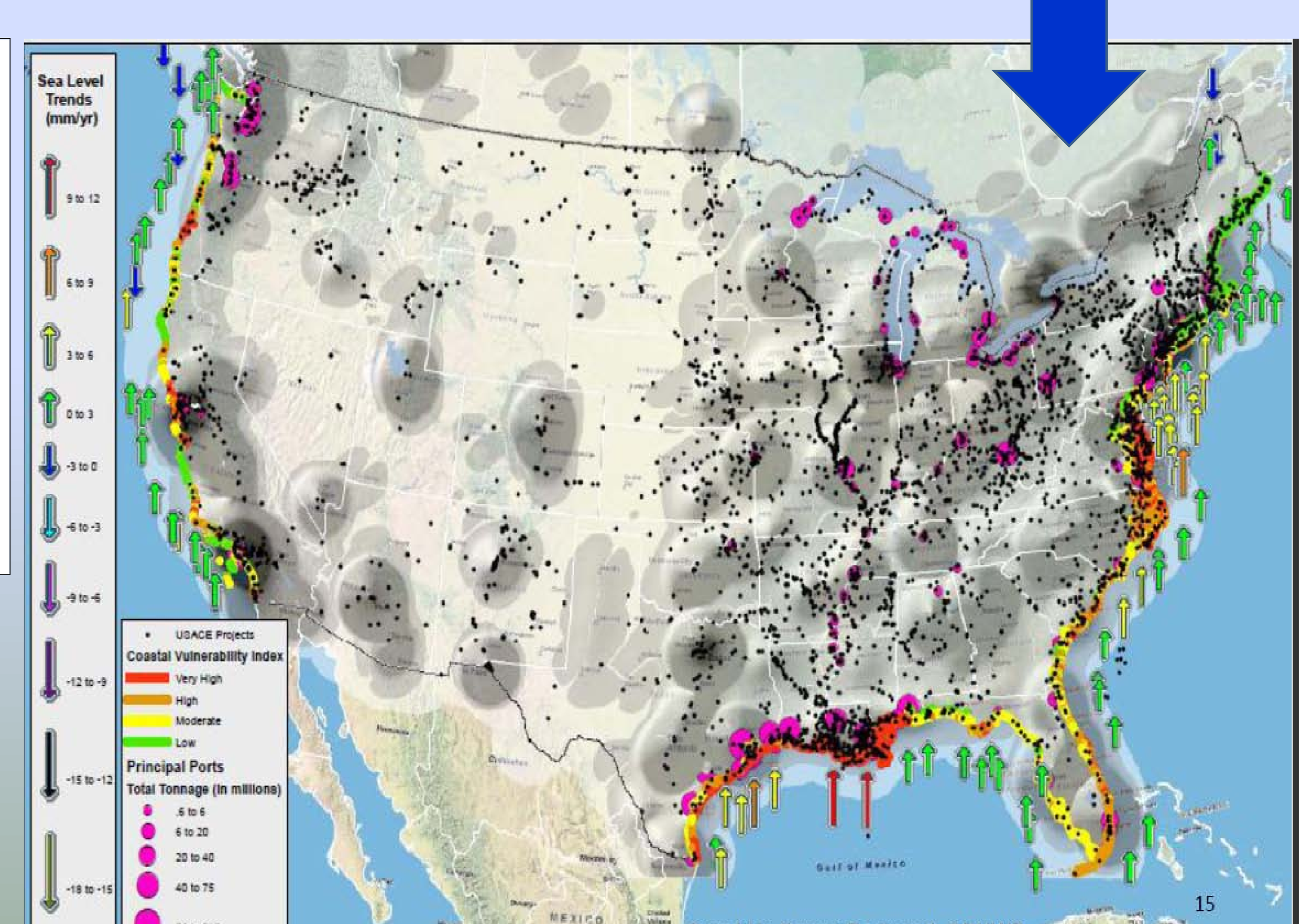
Sea level rise trends given in millimeters per year do not convey a "threat" from sea level rise. Dr. Dave Kriebel (USNA) has conducted an analysis using historical storm tides around the U.S. coastline to help with visualizing coastal flood hazards related to sea level increases. His work was patterned after the work done by Dr. Chip Fletcher at the University of Hawaii. His approach illustrates that future coastal flood hazard depends on relative sea level rise, storm tide elevation and frequency, and the applicable flood threshold at which damages occur. His analysis clearly shows that rising mean sea level will allow future storm tides to reach higher elevations than past storms and will allow this exceedance more frequently. The stage curves and frequency plots shown here are from Dr. Kriebel's extensive study.

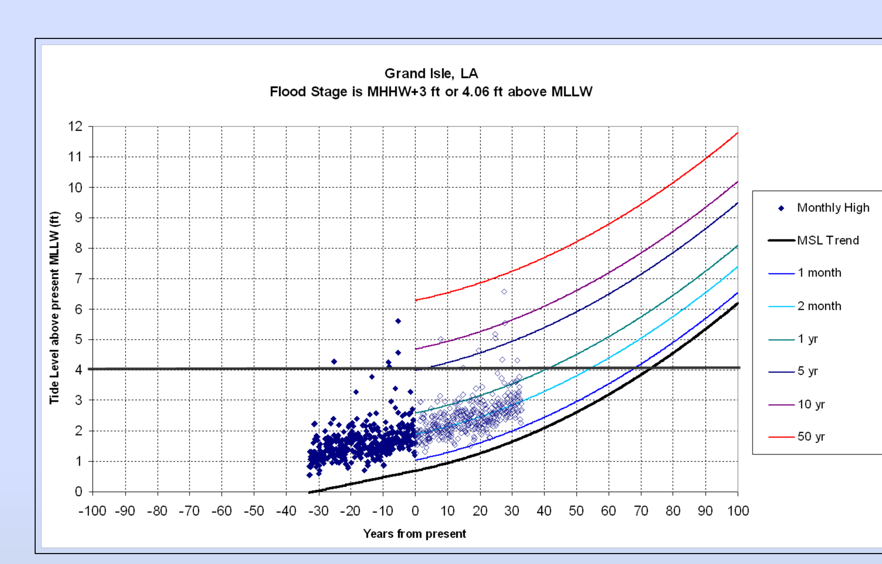



Projected extreme water level plots (low and high) include documented existing extremes from NOAA data as well as shifted extremes based on future sea level change scenarios. Open coast surges and wave run-up are not included.




Extremal Probability Grand Isle Curve 3