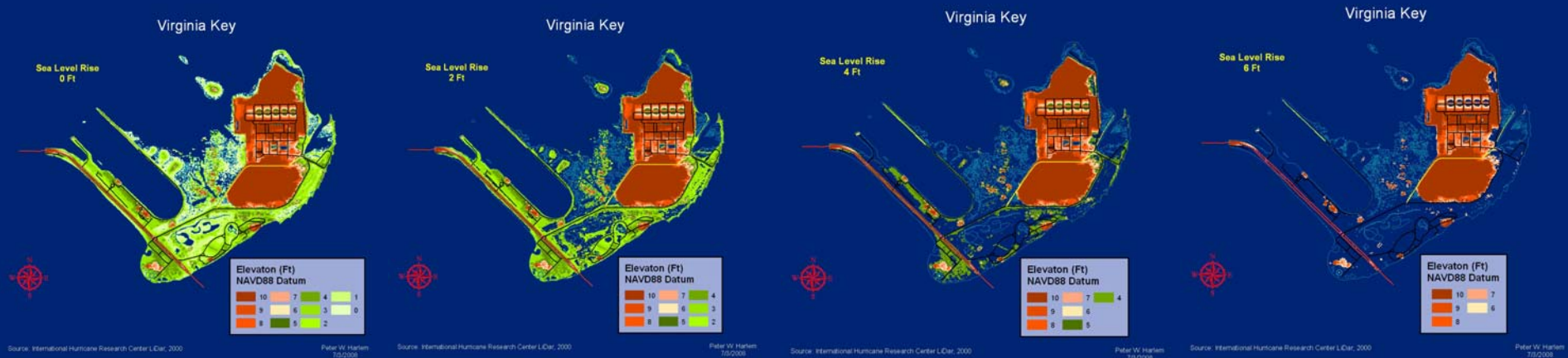


Sea Level Rise in Miami-Dade County Florida

Implications for Management of Coastal Wetlands and the Everglades



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Florida International University
Southeast Environmental Research Center

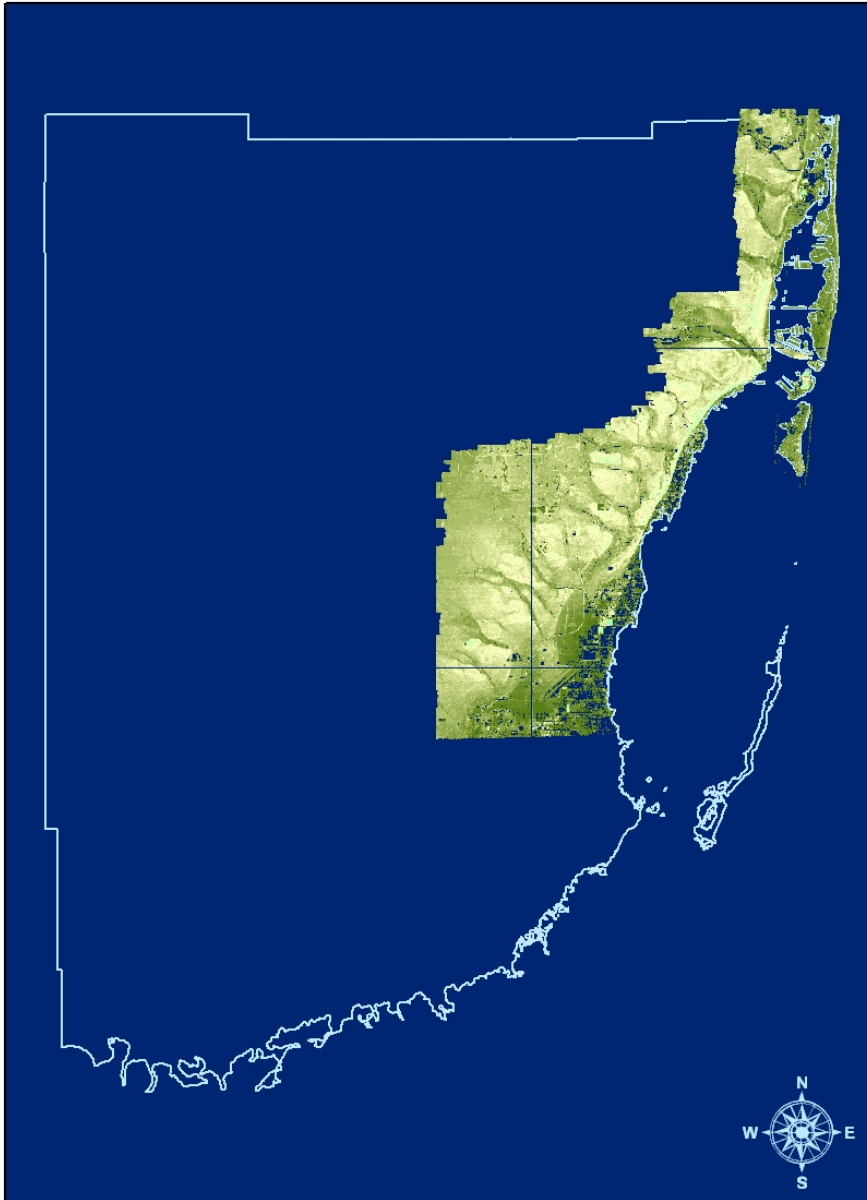
The Problem

By 2100 sea level will:

1. Inundate much of coastal and interior Miami-Dade County.
2. Seriously degrade freshwater availability county wide.
3. Change the climate from a terrestrial to an oceanic process dominated system.
4. Result in unique ecological problems as anthropogenic altered areas are inundated.

The IPCC (2007) made global sea level rise projections to provide guidance for the next 100yrs but does not provide detailed local information. What will happen here?

LIDAR Coverage - IHRC (5ft -cell)



Source: IHRC-FIU

PWH 2008

0 5 10 20 30 40
Kilometers

IHRC LiDAR*

- Where: Eastern Miami-Dade.
- Acreage: 500+ sq miles in 1 mile raster grids.
- Cell size: 5 Ft.
- Vertical Datum: NAVD88.
- Top layers show trees and buildings (not used).
- Bottom layers filtered to show ground surface (used here).

*Light Detection and Ranging

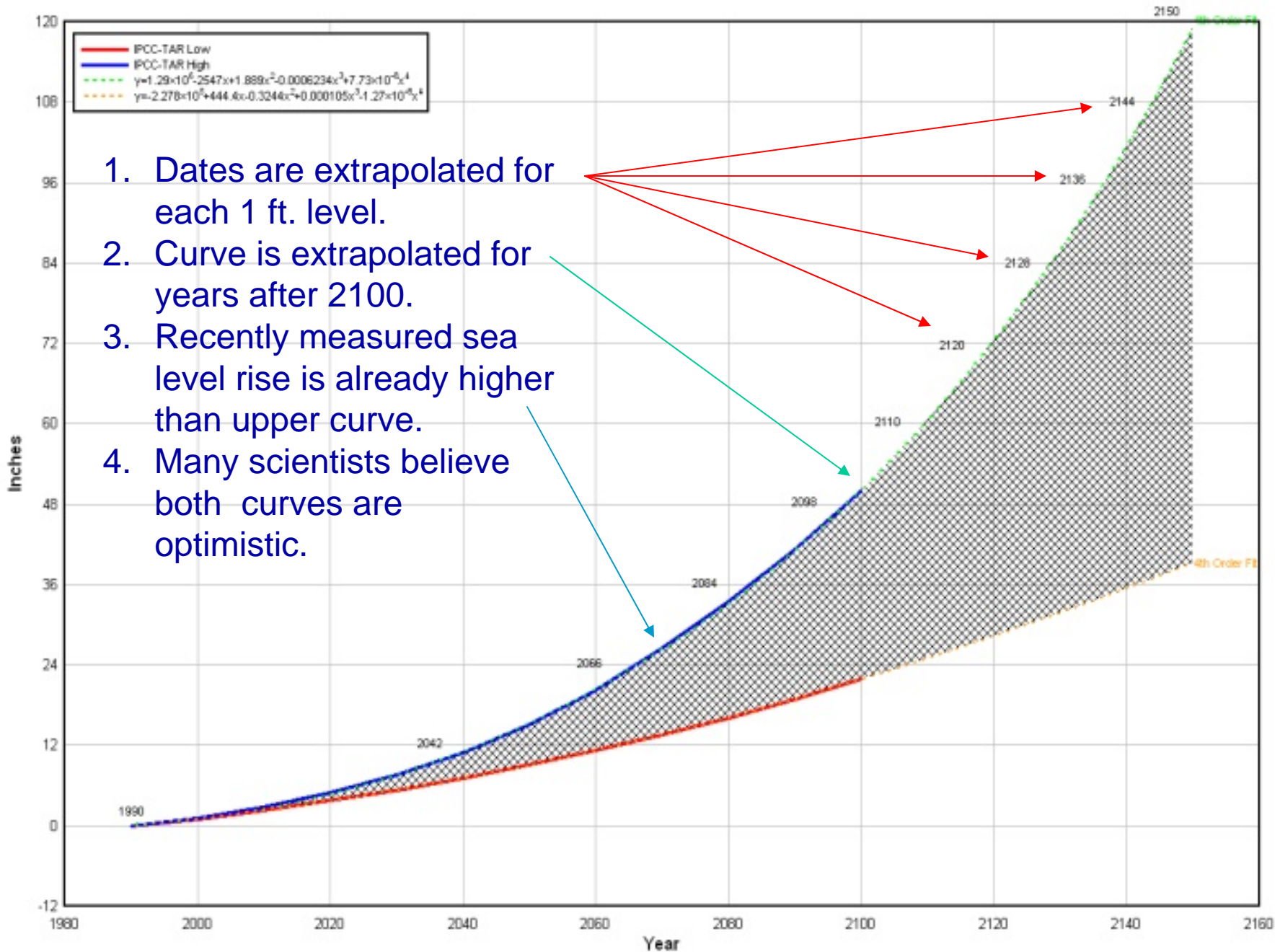
LiDAR Considerations

- Data overlaps eastern Everglades and Southeast Saline Everglades (SESE) providing insight there.
- Data shows morphology of transverse glades and how they will facilitate change from freshwater domination to marine conditions.
- Static maps produced do not show effect of ocean on coastal structures/sediments.
- Erosion \longleftrightarrow Deposition + human and biological response not shown.

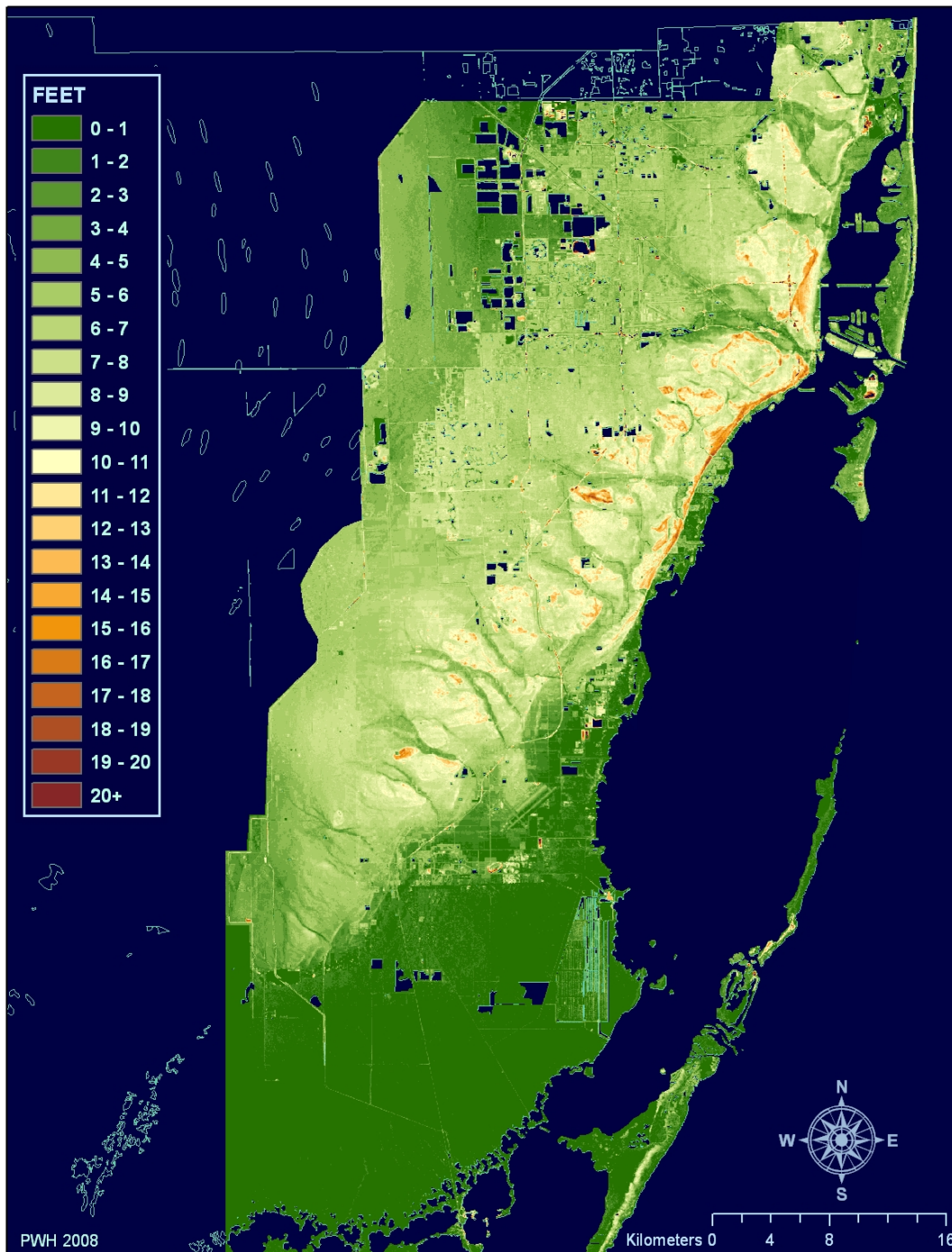
Methods

- LiDAR “bottom layer” tiles imported to ArcGIS 9.2. and a single raster elevation file extracted.
- Minor data anomalies cleaned up.
- Maps supplemented with USACE-CSOP LiDAR data. This has 25 ft. cells but covers larger area.
- 1 ft. (0.3 meter) map layers extracted up to 12 ft. (4m).
- Acreages calculated and tabulated.
- Hypsographic sea level rise curves calculated for entire data set and subsets.

IPCC TAR Sea Level Curves



1. Dates are extrapolated for each 1 ft. level.
2. Curve is extrapolated for years after 2100.
3. Recently measured sea level rise is already higher than upper curve.
4. Many scientists believe both curves are optimistic.

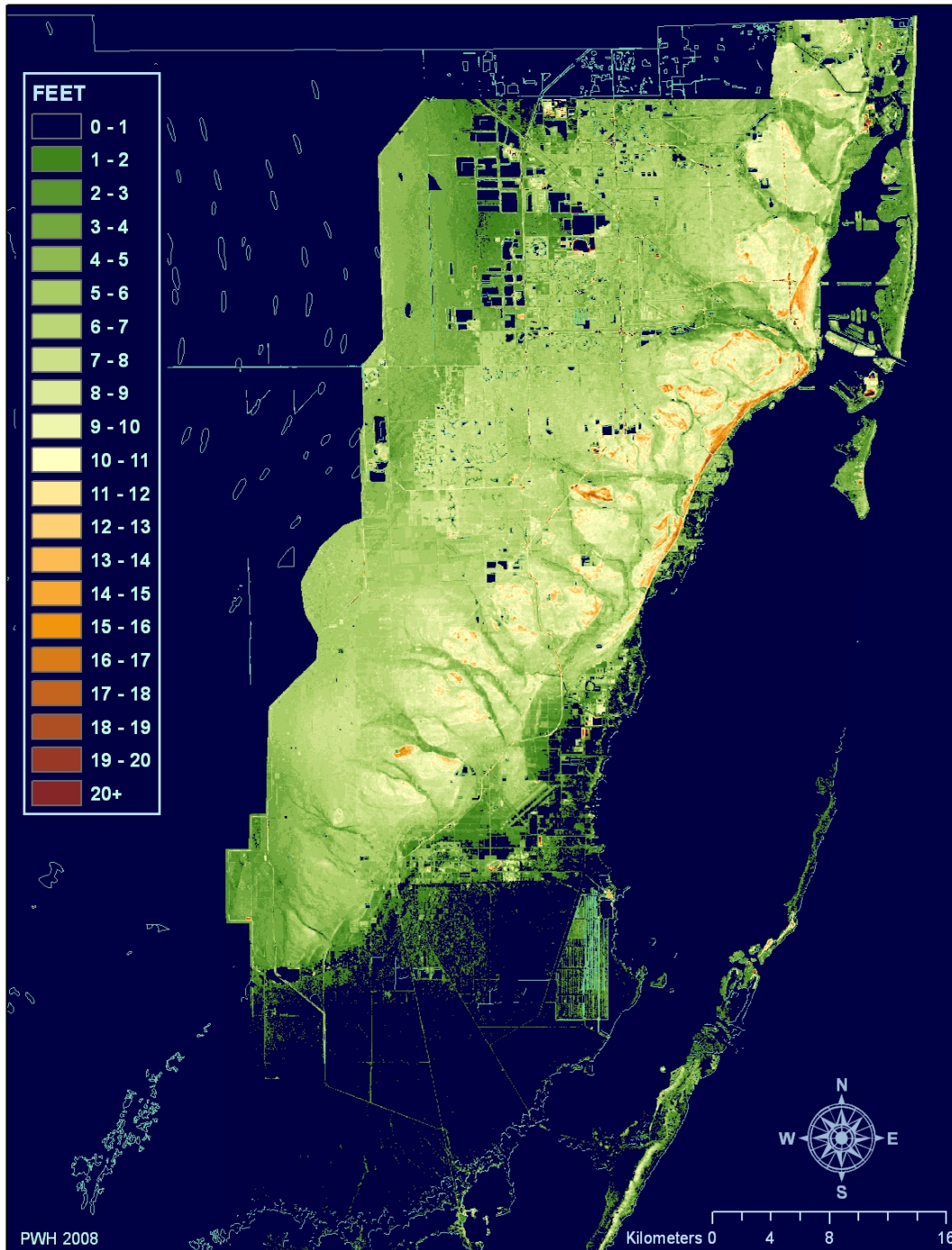


SLR = 0 Ft.

DATE = 2004

Current Conditions

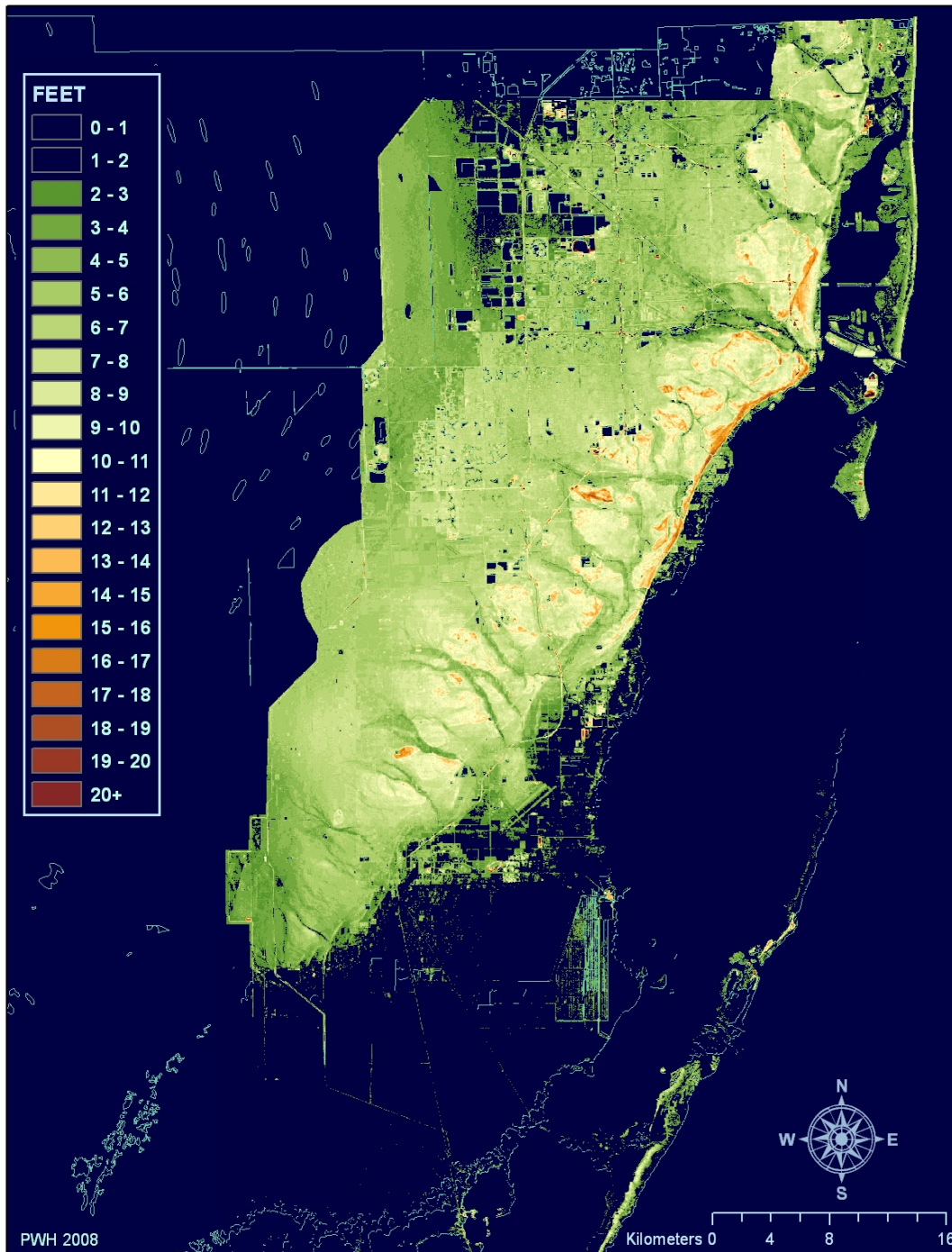
- Raster elevation map of area covered by combined LiDAR data sets.
- Brown areas are high ground, dark green are near sea level.
- Main limestone ridge, barrier islands are IHRC data.
- Area from Turkey Point south and NW lake region from USACE-CSOP data.



SLR = 1 Ft.

DATE = 2042

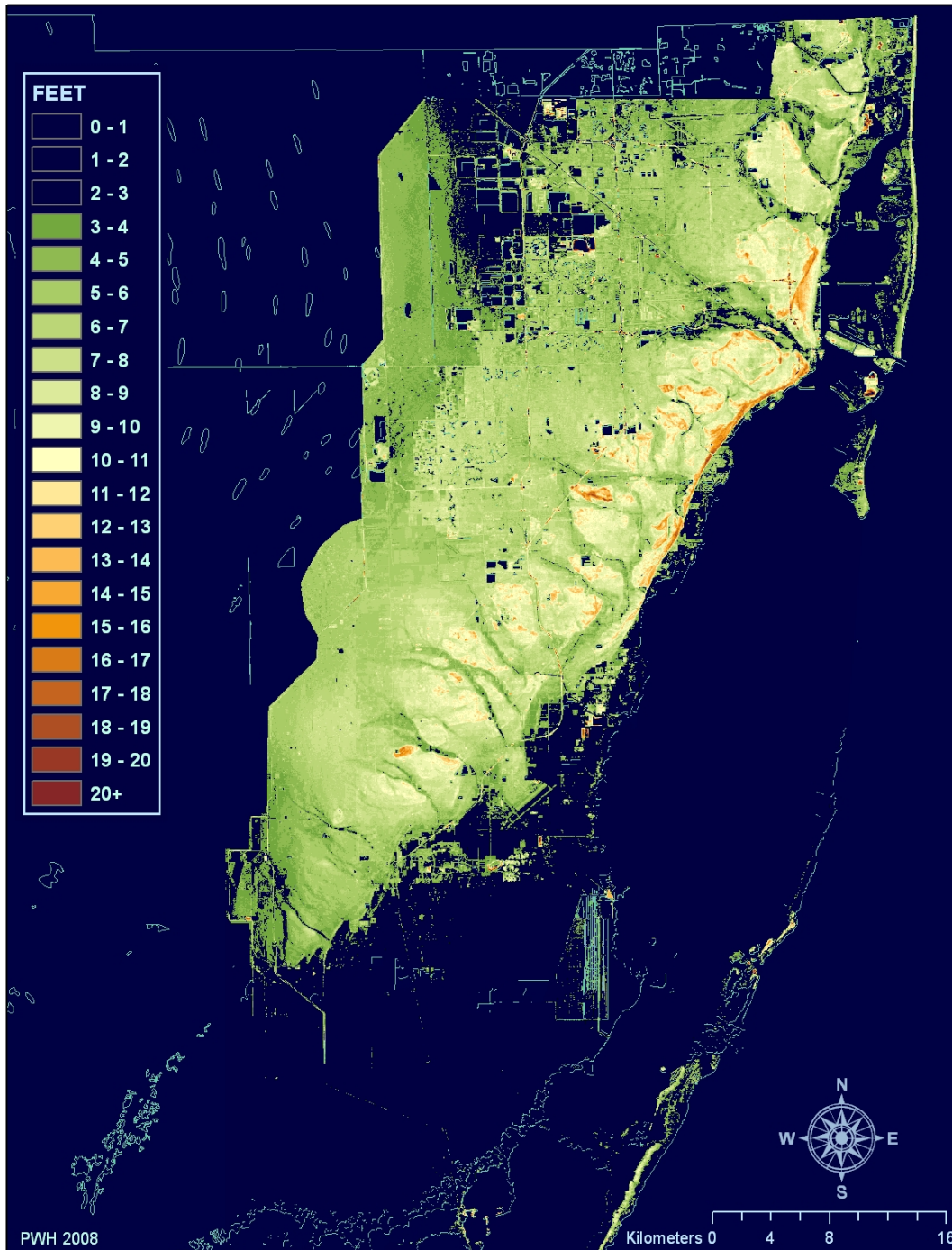
- 83% of land surface remains above mean high tide.
- Coastal plain and marshes inundated at high tides.
- Mangrove swamps deepen, coastal vegetation migrates upslope.
- Erosion increases.
- Levees like the L-31E expected to restrict encroachment - delaying salt water intrusion in south Miami-Dade.
- Southern Everglades not protected by equivalent structure.



SLR = 2 Ft.

DATE = 2066

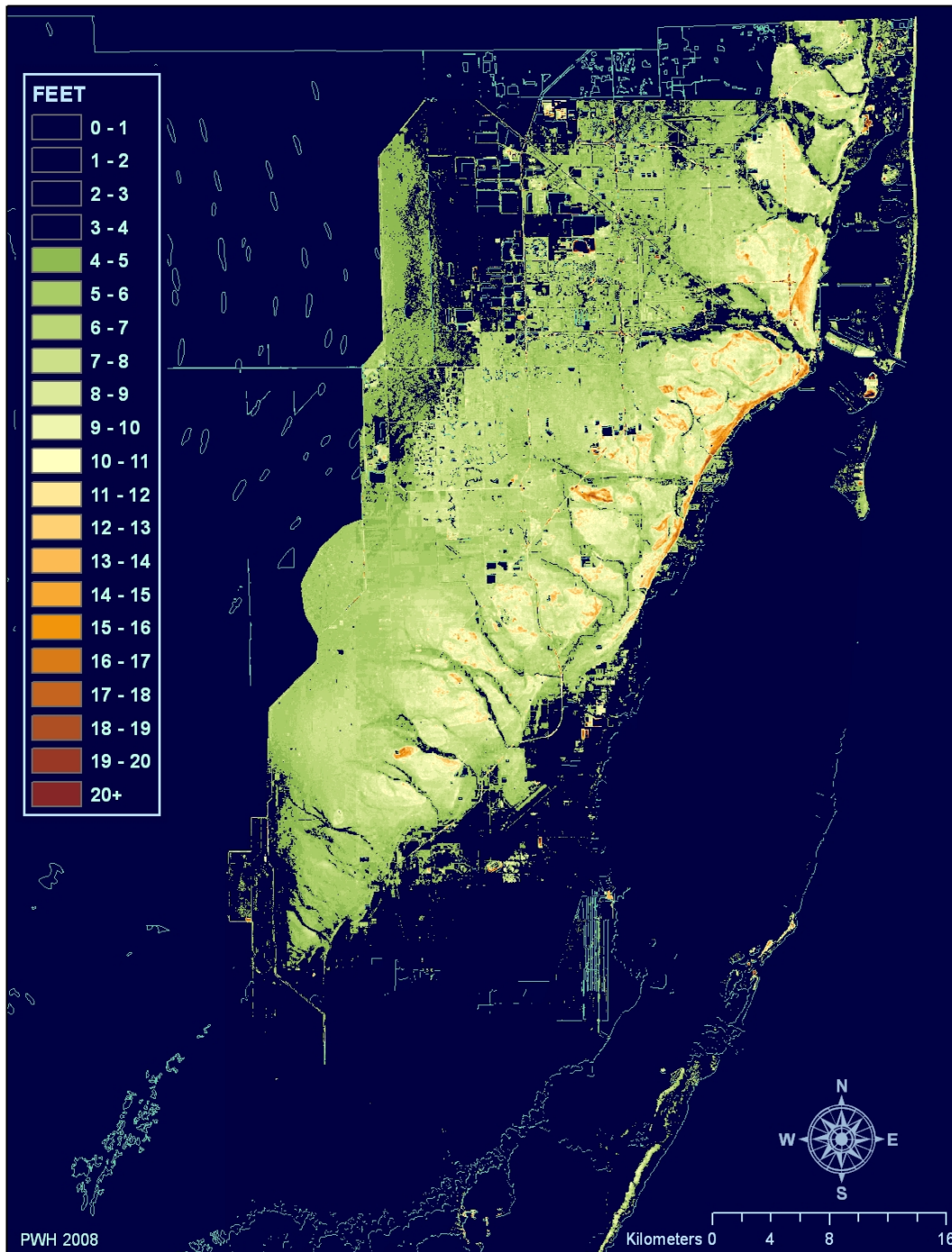
- 72% of land surface remains.
- Oldest areas on Miami Beach inundated.
- Mangrove swamps east of steep central ridge collapse.
- Much of upper Keys inundated.
- Coastal levees under wave attack.
- Access to barrier islands and public works becomes difficult – Turkey Point, South Dade landfill.



SLR = 3 Ft.

DATE = 2084

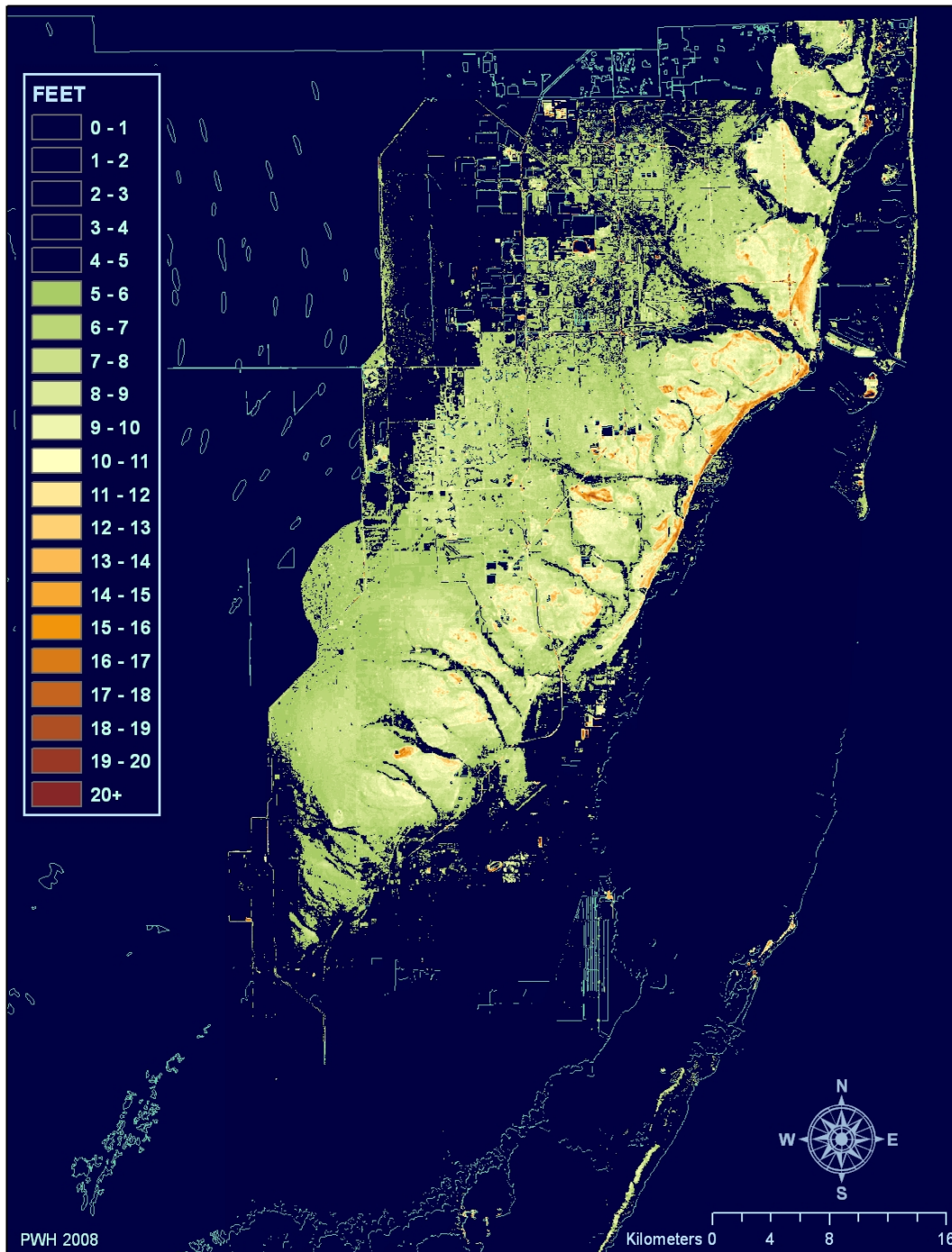
- 67% of land surface remains.
- Increasing coastal erosion expected to export carbon and nutrients south and west to Florida Bay.
- Potable water supply threatened by salt water encroachment.
- Northern river basins begin to flood – threat to major economic engine and county water quality.
- Causeways and low areas of barrier islands inundated.



SLR = 4 Ft.

DATE = 2098

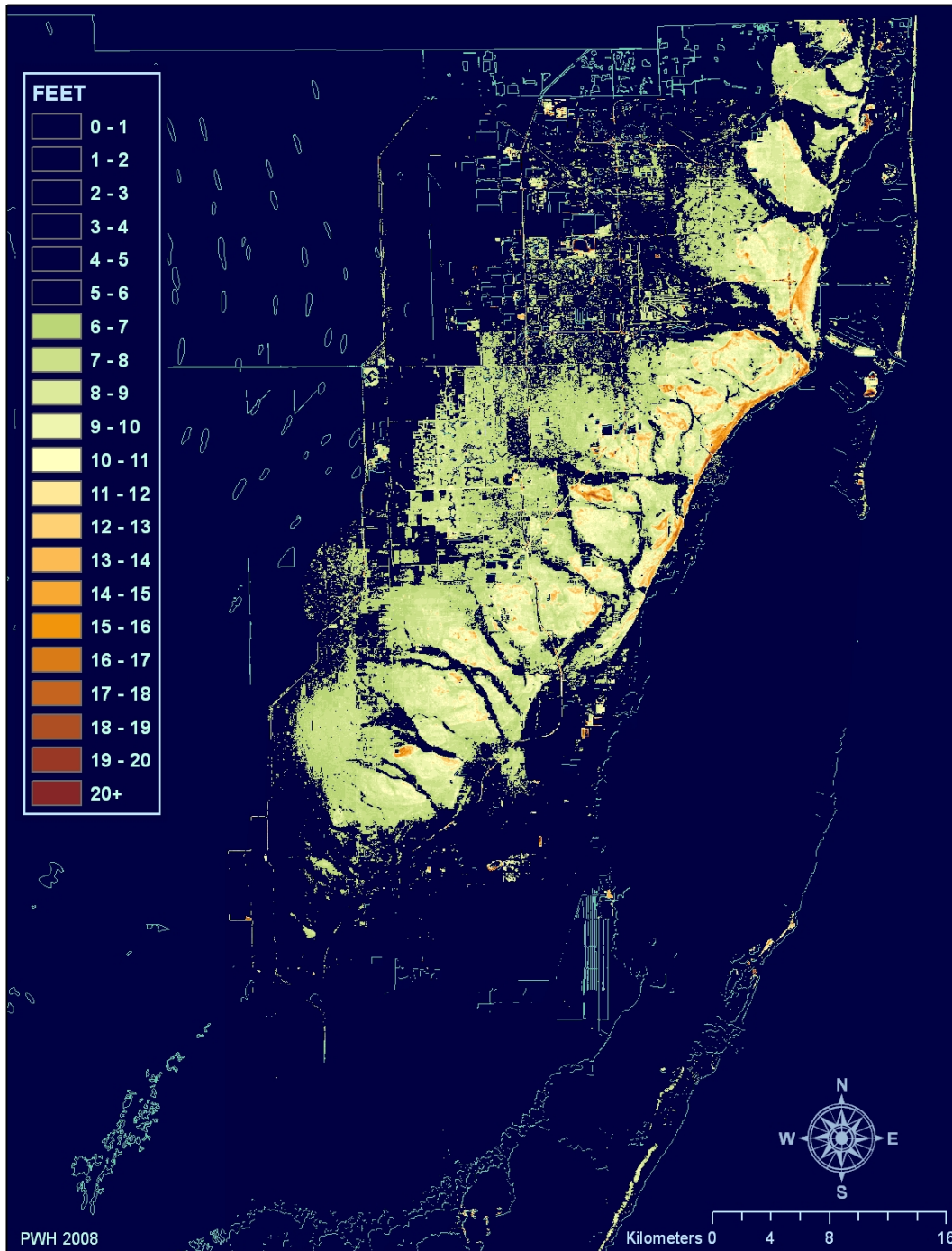
- 62% of land surface remains.
- Northern rivers tidal dominated producing interior flooding.
- Only highest portions of barrier and man made islands remain above tide.
- Increased coastal wave energy.
- Groundwater flow to bays ends causing total collapse of estuaries.
- Southernmost transverse glades inundated.



SLR = 5 Ft.

DATE = 2110

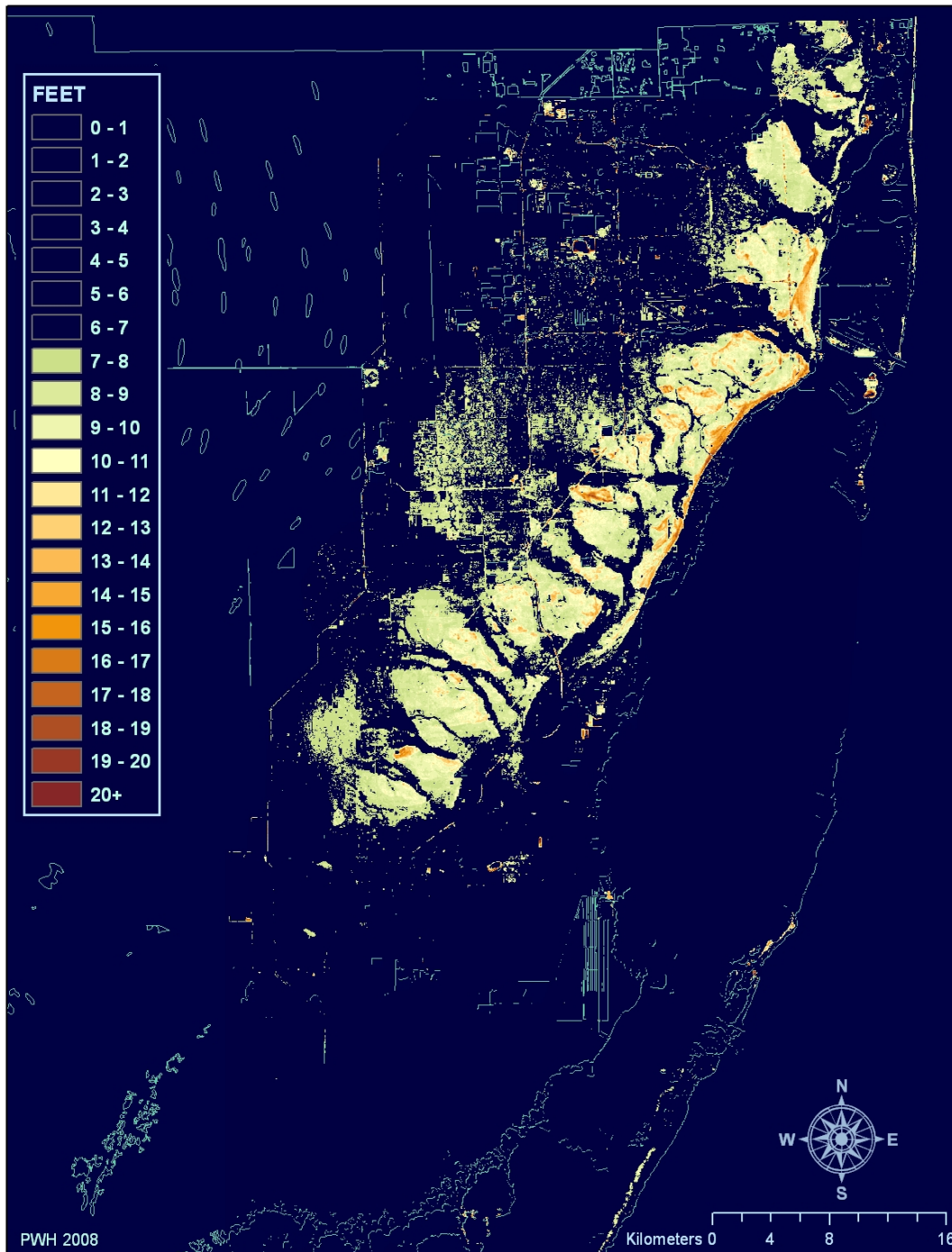
- 54% of land surface remains.
- Most transverse glades flooded at high tide.
- Northern rivers now tidal passes into flooded Everglades form independent islands.
- Continued saltwater encroachment and coastal erosion.



SLR = 6 Ft.

DATE = 2120

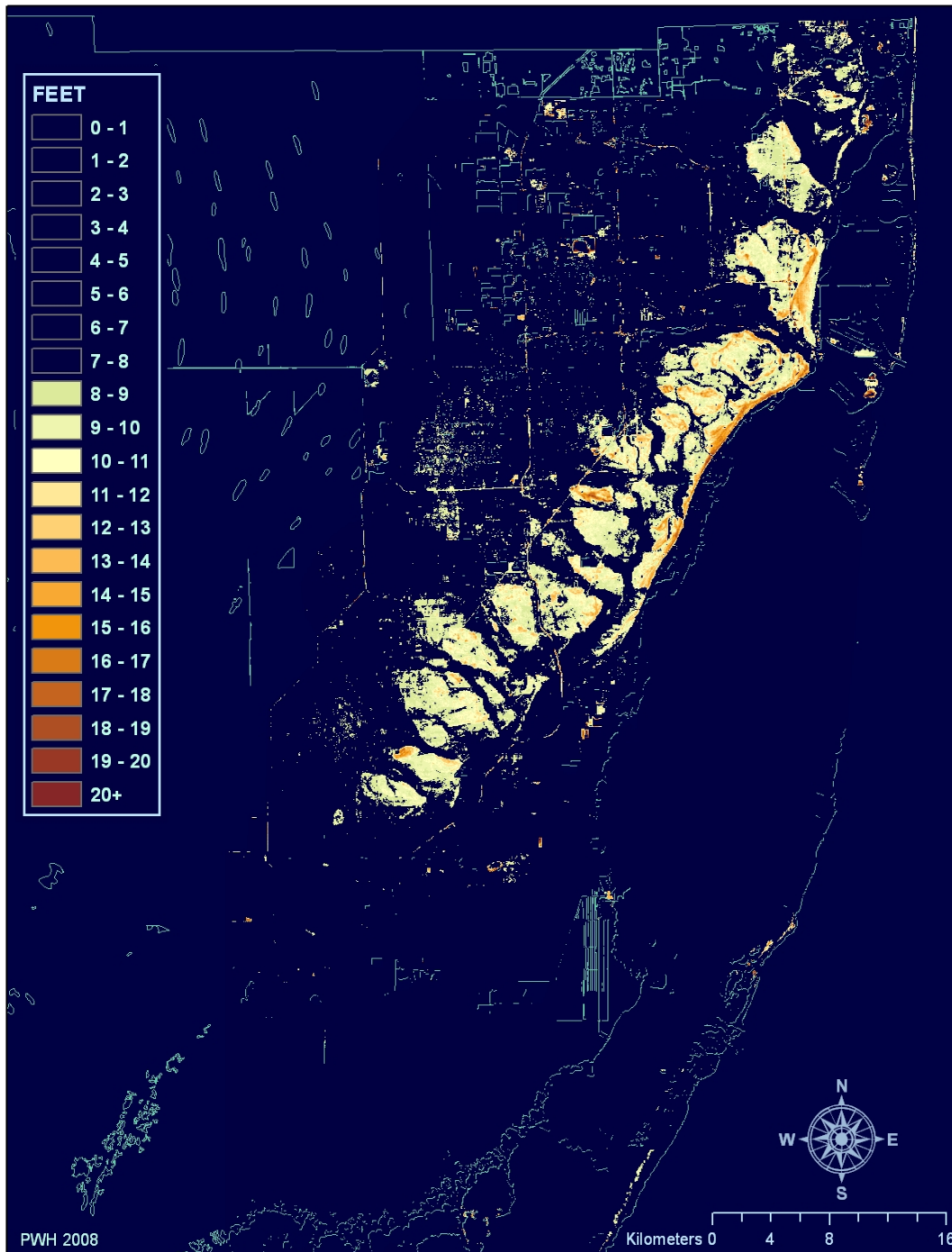
- 44% of land surface remains.
- Transverse glades south of Miami River become large tidal passes.
- SW portion of ridge inundated.
- Outer-most coastal ridge dissected by tidal passes.
- Only anthropogenic structures remain on barrier islands.
- Florida Bay expands north of Tamiami Trail.
- Decrease rainfall begins – onset of Florida Keys-like environment.



SLR = 7 Ft.

DATE = 2128

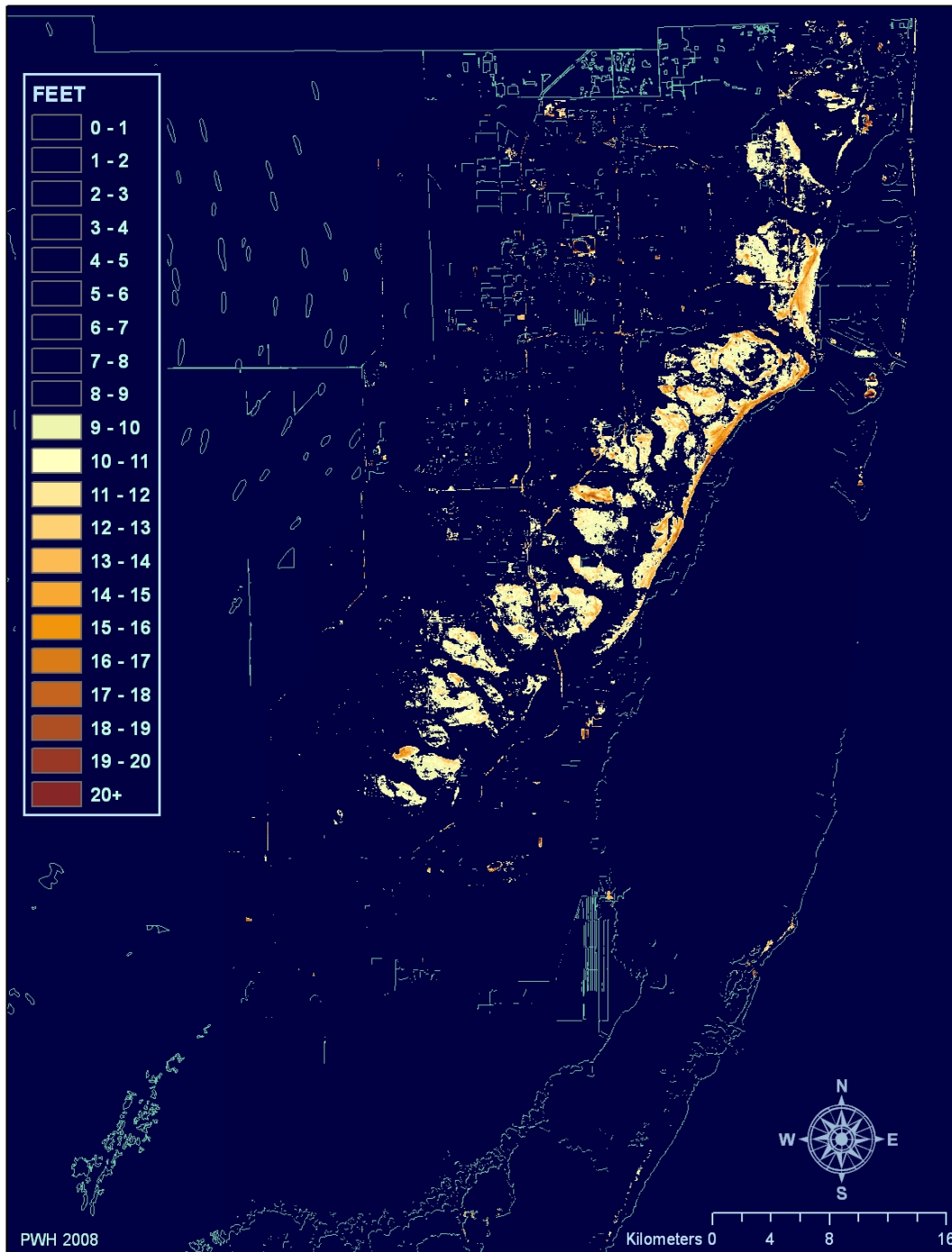
- 33% land surface remaining.
- Total loss of mainland climate.
- Both landfills and Turkey Point remain emergent.
- Displayed beach ridge probably eroded away leaving urban rubble substrate.



SLR = 8 Ft.

DATE = 2135

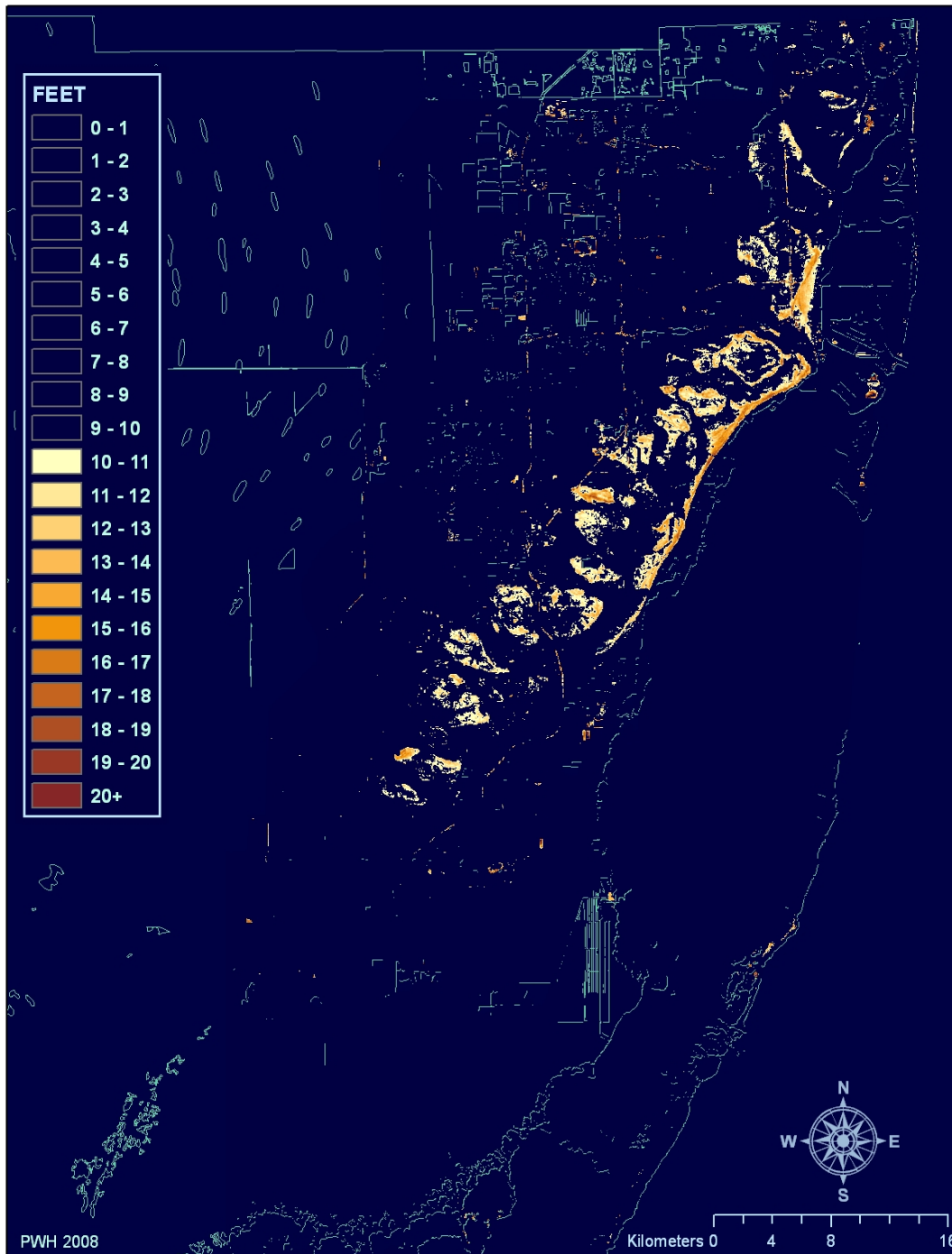
- 12% land surface remaining.
- Rate of rise accelerating - ~1 ft. every 6-7 years.
- Small ground water lenses floating on seawater.
- Everglades now extension of Florida Bay.
- Shoreline energy increased considerably – large surf common.



SLR = 9 Ft.

DATE = 2144

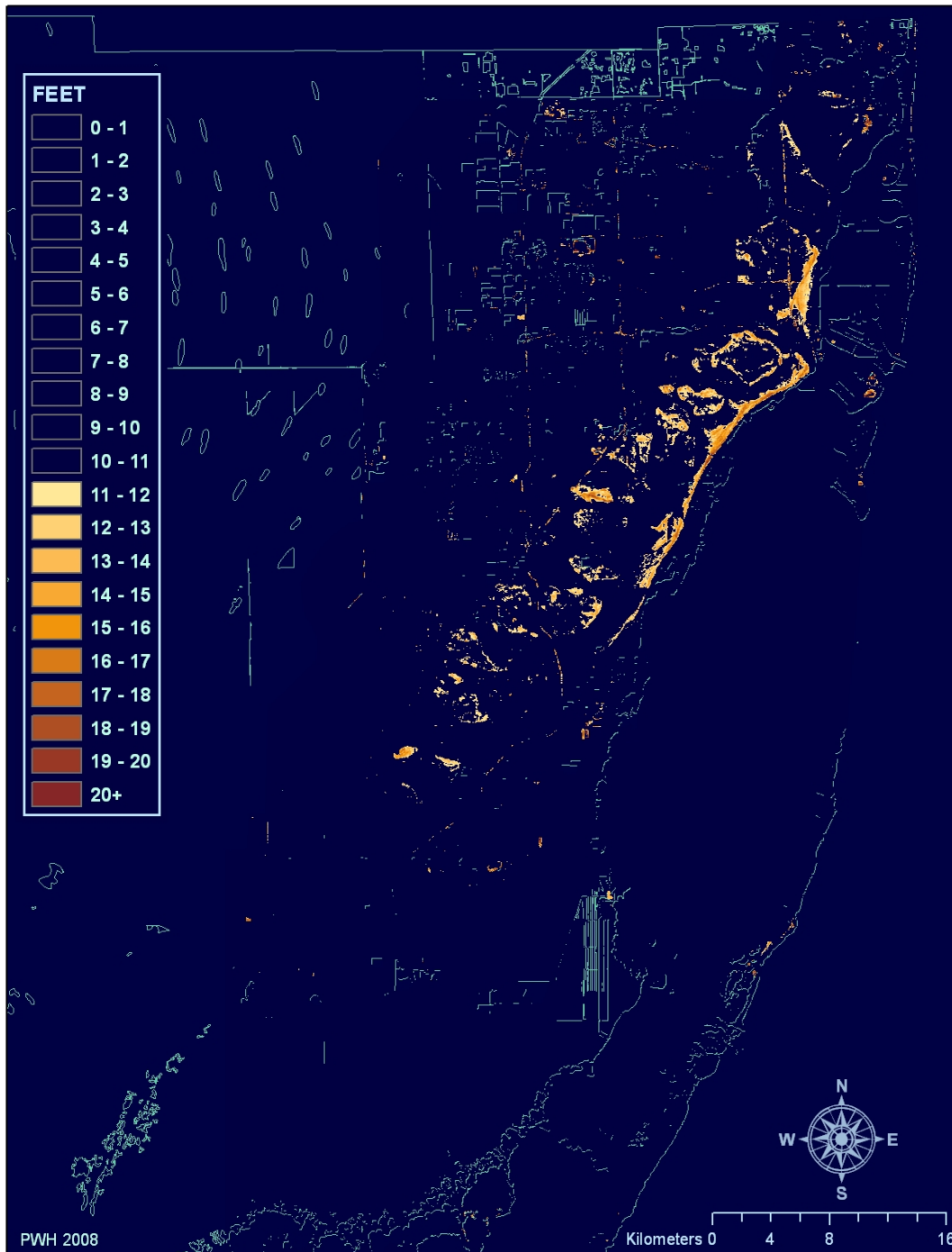
- 14% land surface remaining.
- Transverse glades now passes between many small islands.
- Creation of extensive nearshore shelf ecosystems.
- Transportation restricted to boat or helicopter.



SLR = 10 Ft.

DATE = 2150

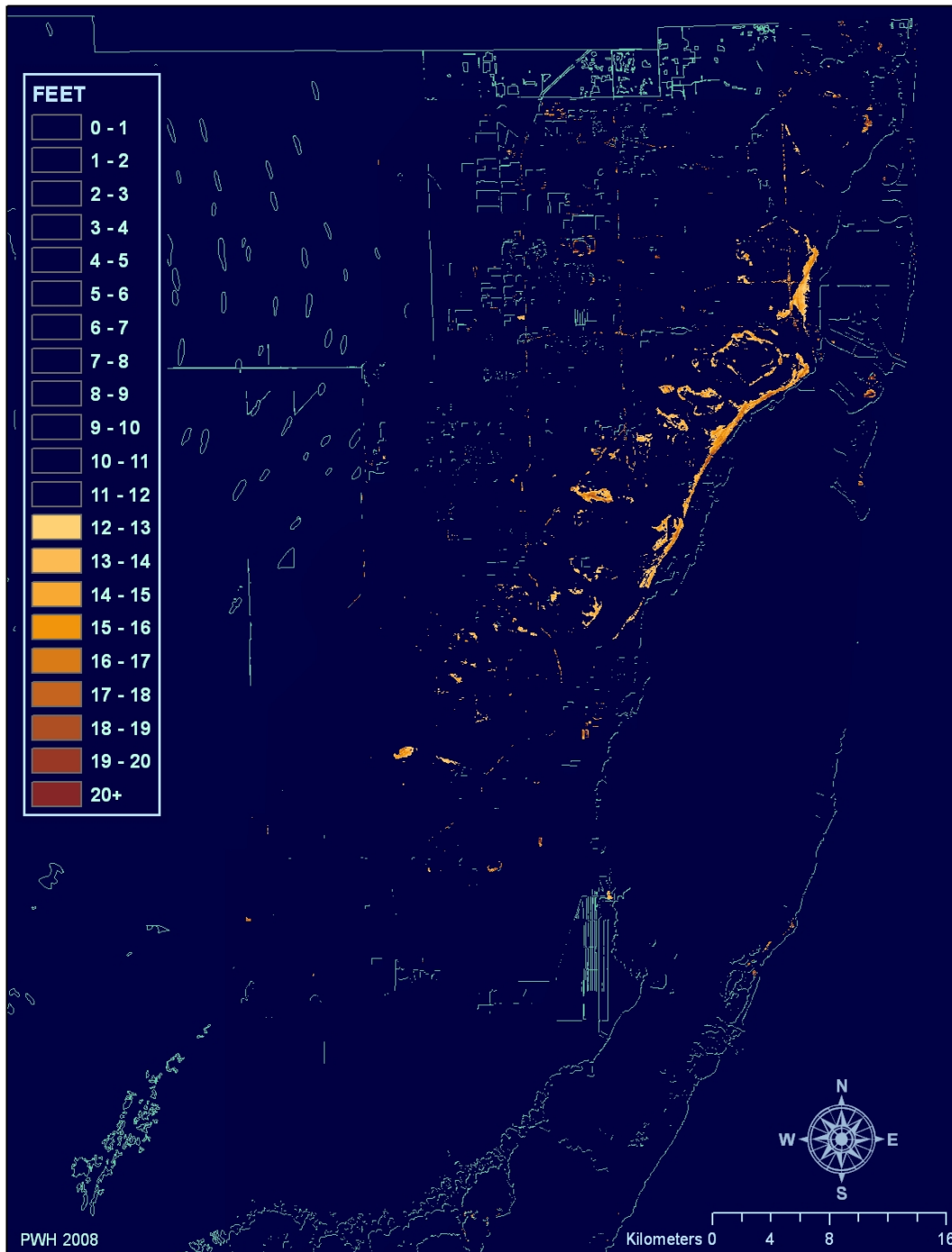
- 9% of land surface remaining.
- Extensive areas of new anthropogenic benthic habitat – i.e. roadbed hardgrounds?
- Maximum elevations ~10ft.
- Prone to storm surge and extreme high tides.



SLR = 11 Ft.

DATE = 2155

- 5% of land surface remaining.
- Virginia Key landfill overtopped.
- Unchecked sea level rise dooms remaining islands.
- Rocky islands resemble current upper Keys.

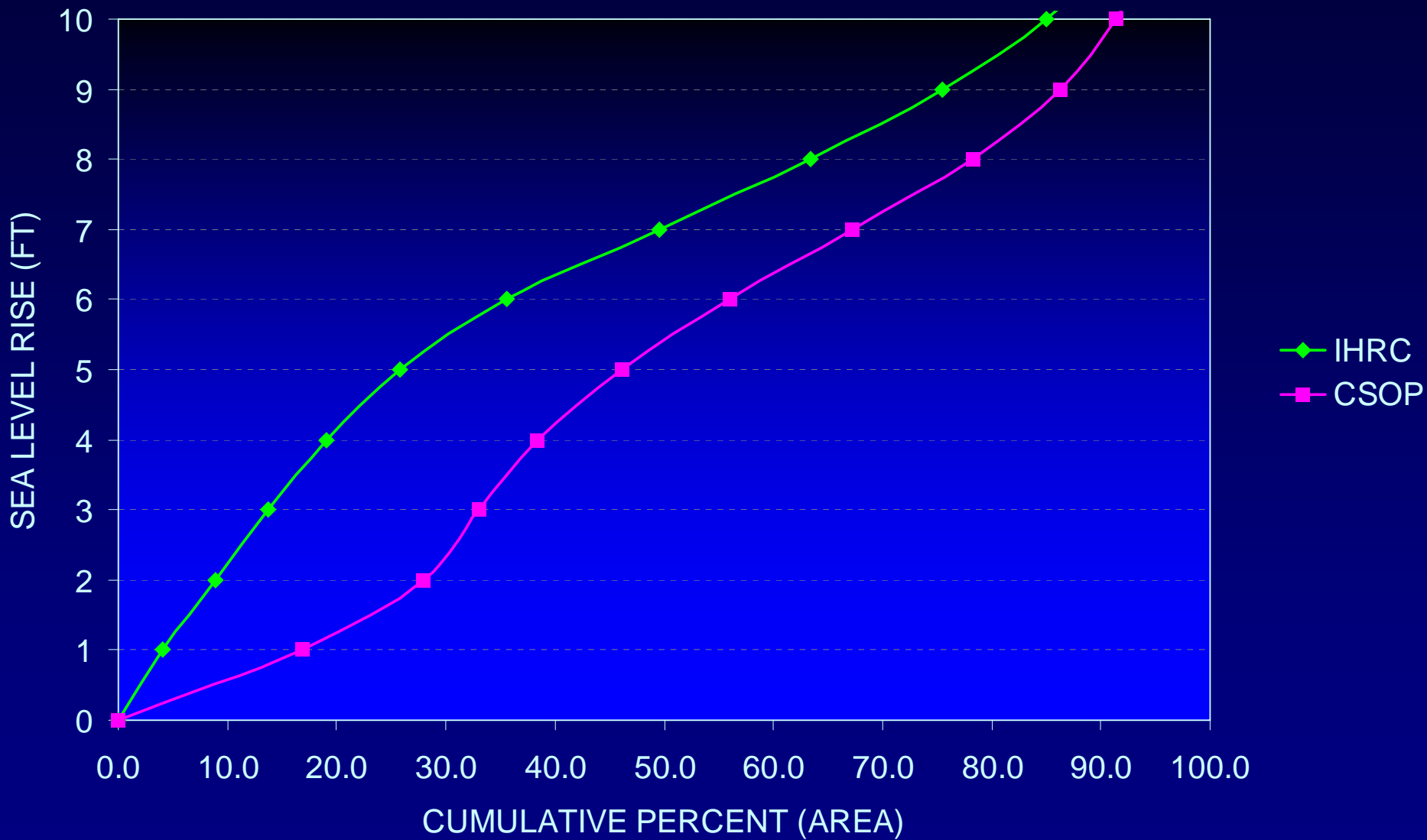


SLR = 12 Ft.

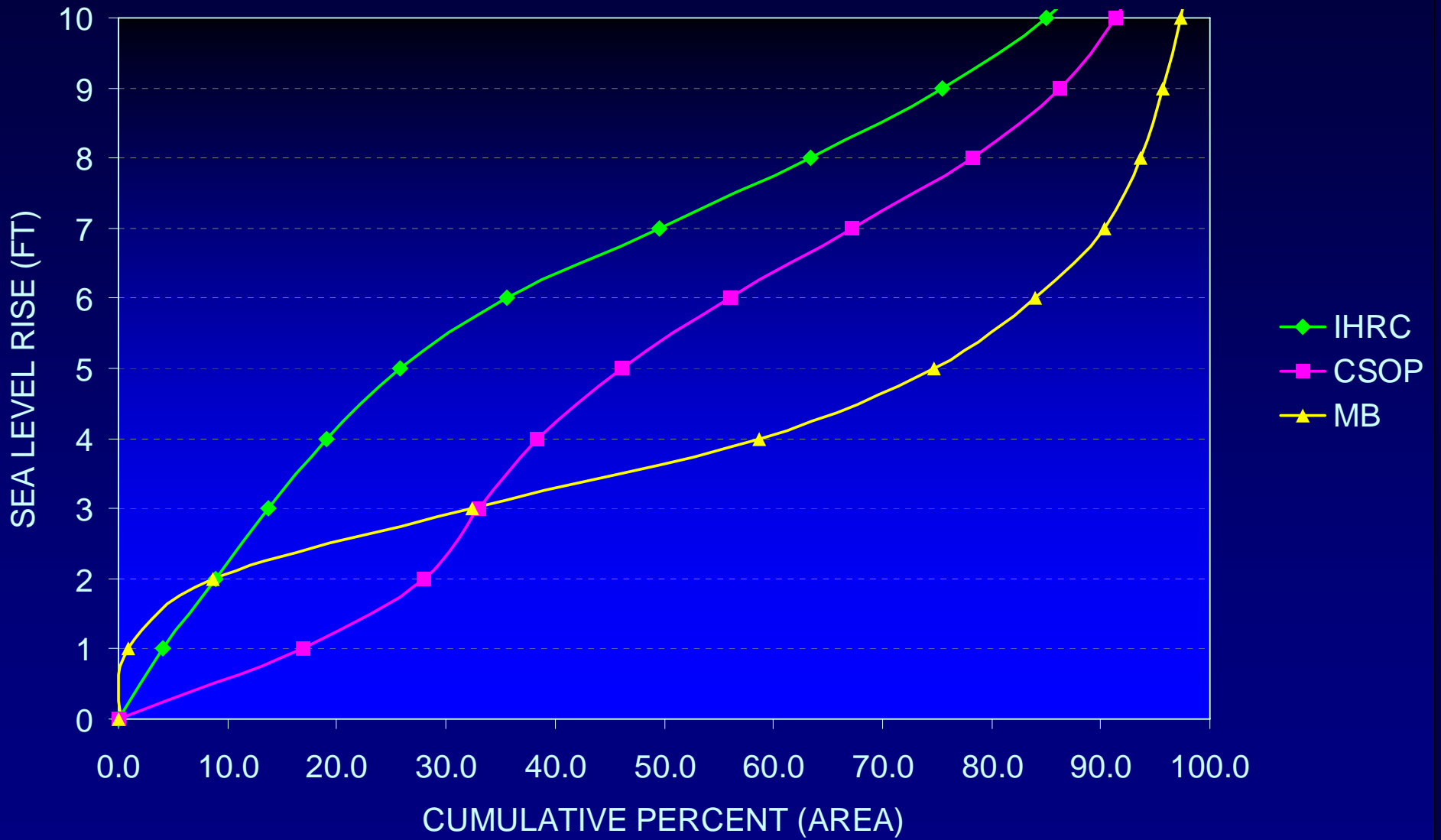
DATE = 2159

- 3% of land surface remaining.
- Rise may not be steady state.
- Geologic record suggests jumps.
- Rise may be greater than shown here.

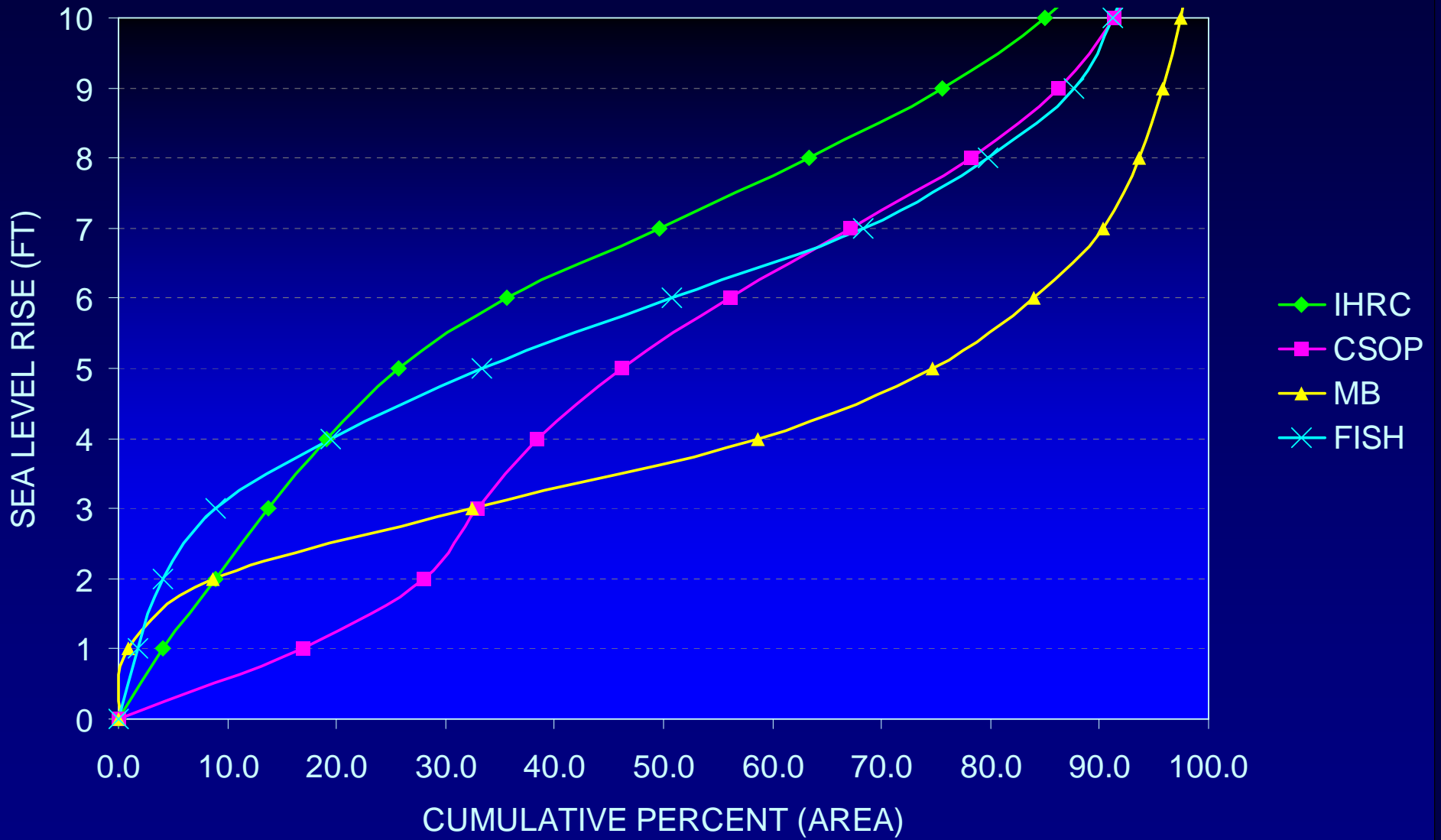
HYPSOGRAPHY - MIAMI-DADE COUNTY



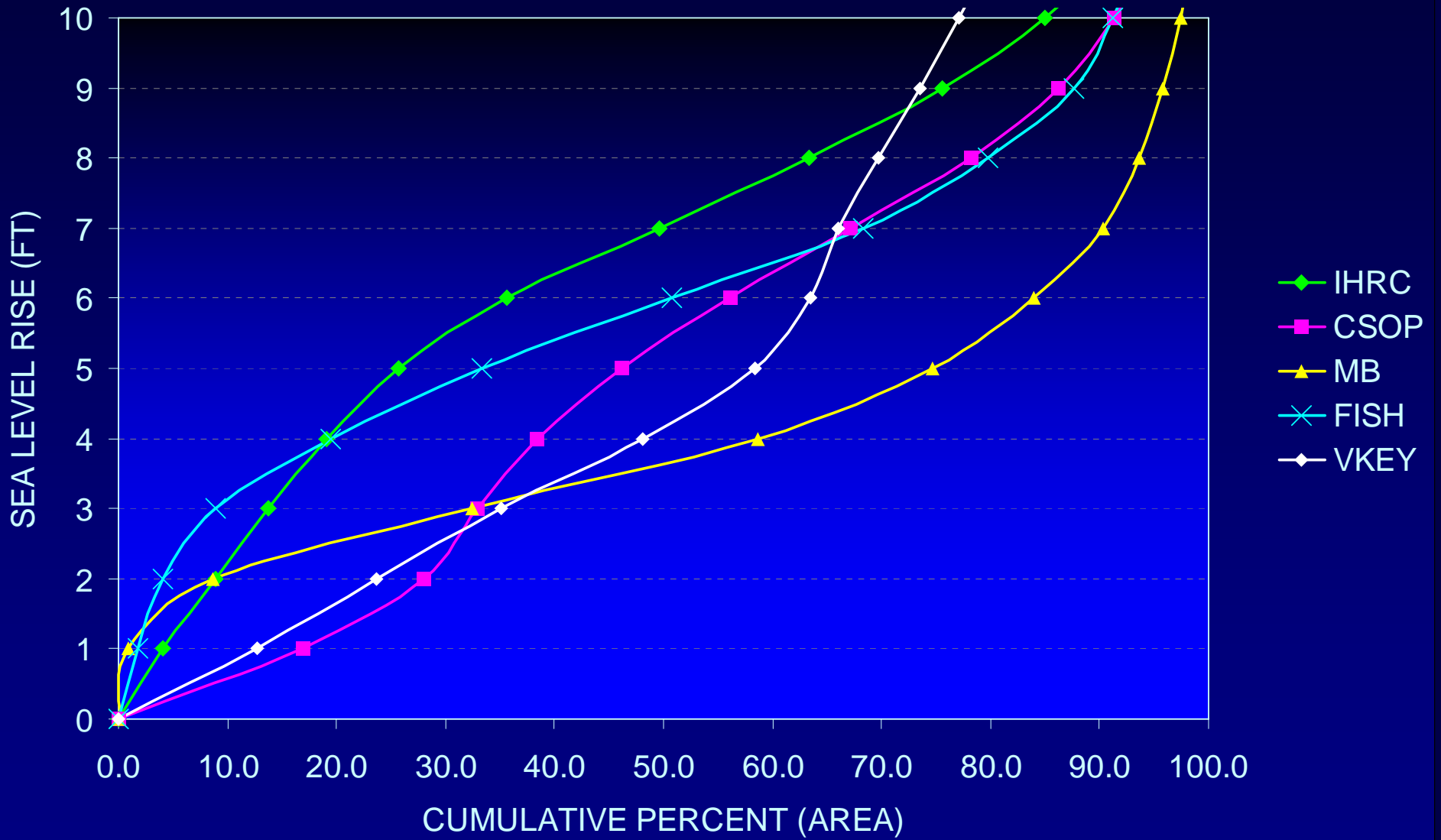
HYPSOGRAPHY - MIAMI-DADE COUNTY



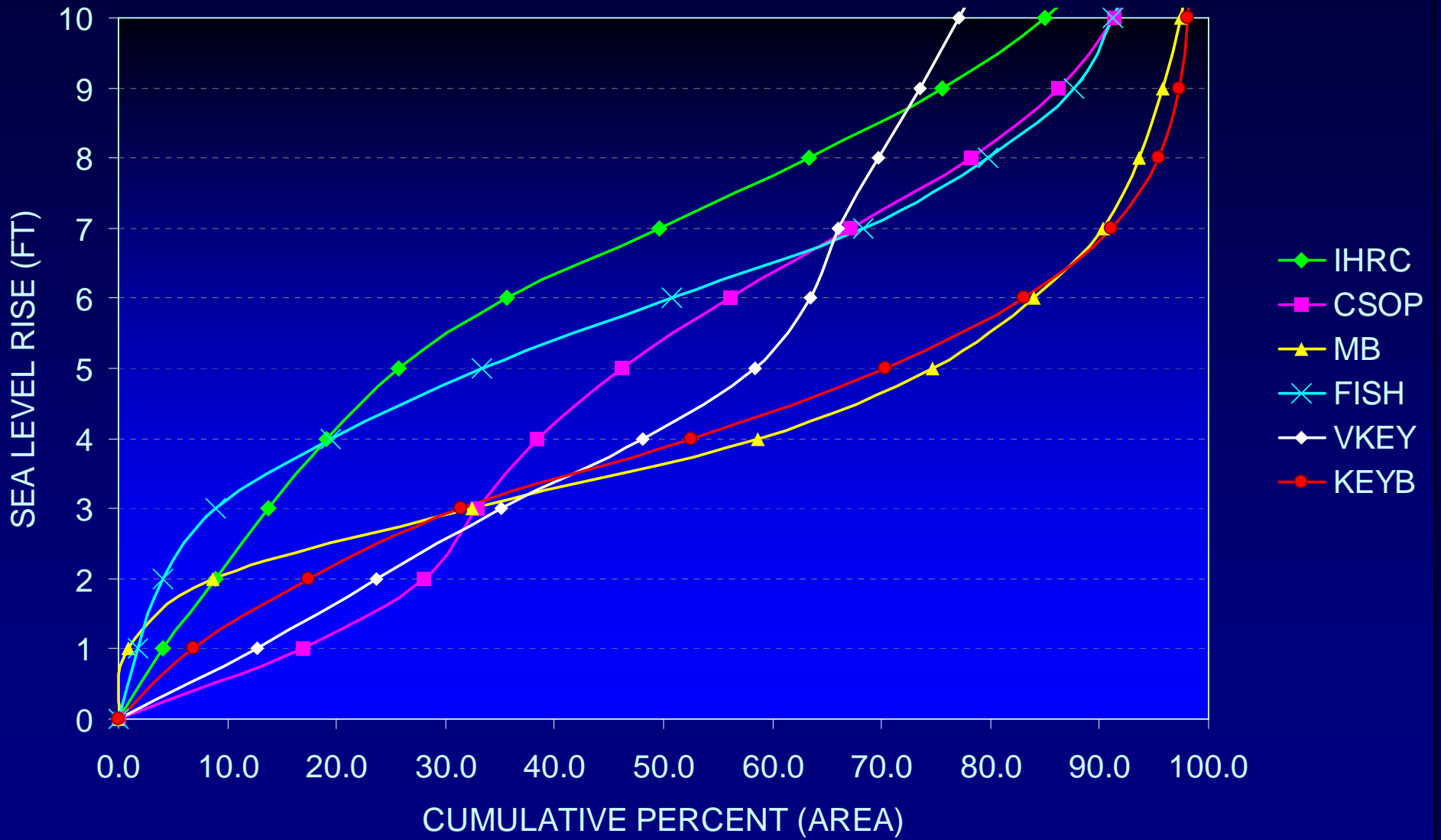
HYPSOGRAPHY - MIAMI-DADE COUNTY



HYPSOGRAPHY - MIAMI-DADE COUNTY



HYPSOGRAPHY - MIAMI-DADE COUNTY



Implications of Sea Level Rise

- Damage to anthropogenic structures including those used to manage coastal ecosystems.
- Loss of freshwater storage capacity with significant effect on habitability.
- Loss of present coastal wetlands with resulting change in dependant biological systems.
- Expansion of Biscayne Bay westward and Florida Bay northward.

Managing Sea Level Rise

- Rise must be monitored.
- Development below 12ft. must be curtailed.
- Economic and environmental management strategies need to be adaptive.
- Human modifications to environment will add difficulties.
- Human reaction likely negative – beach erosion, expensive real estate, landfills and power plants - all are problematic.

“Stationarity is Dead”*

- Properly planned **strategic withdrawal** from the coast will be required.
- There are no quick fixes.
- The longer you wait the less options available.
- Proper management of the GEER region will buy time and make the transition more economically and ecologically sound.

*Milly, et al., Science, 319 (2008)

Acknowledgements

LiDAR: IHRC, FIU; CSOP, Miami-Dade DERM

Coastal outline: US Census Bureau

Henry Brechenoh –graphing help.

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