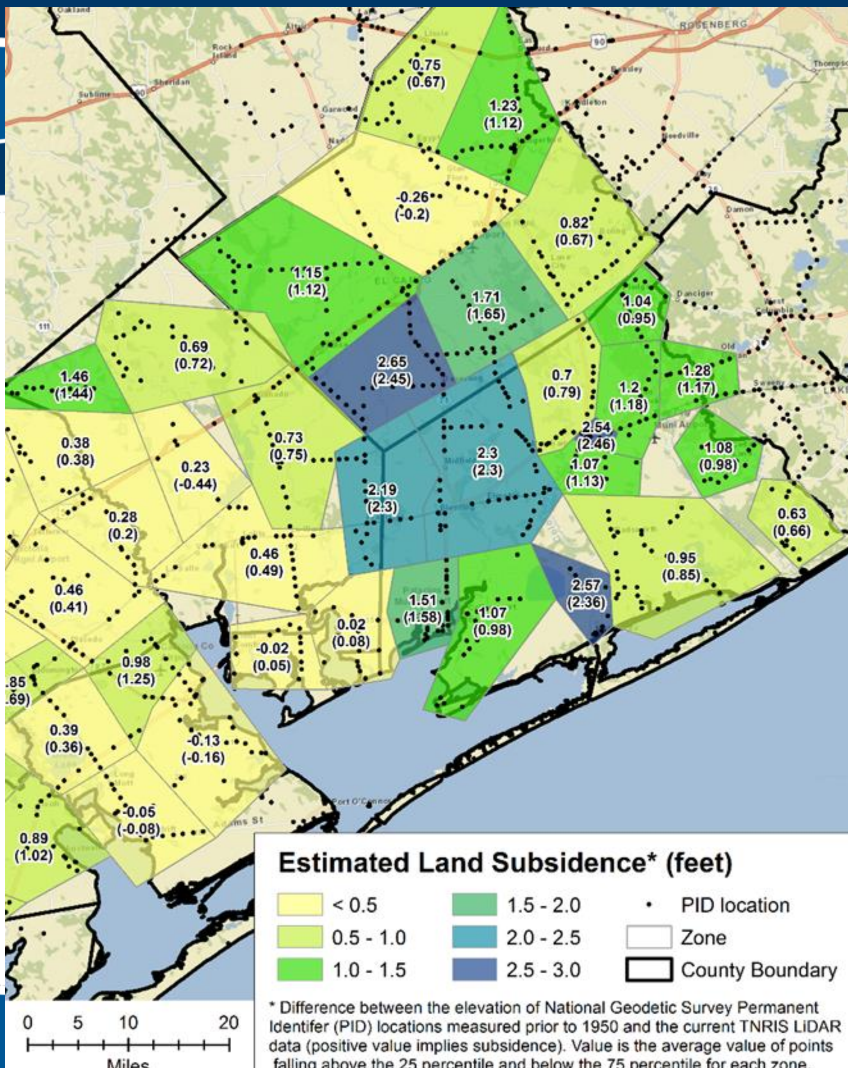
Estimates of Land Subsidence Based on Analysis of Topographic Data



Presentation to
Coastal Bend, GCD
Wharton , Texas

By Steven Young, Ph.D., PE. PG.

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

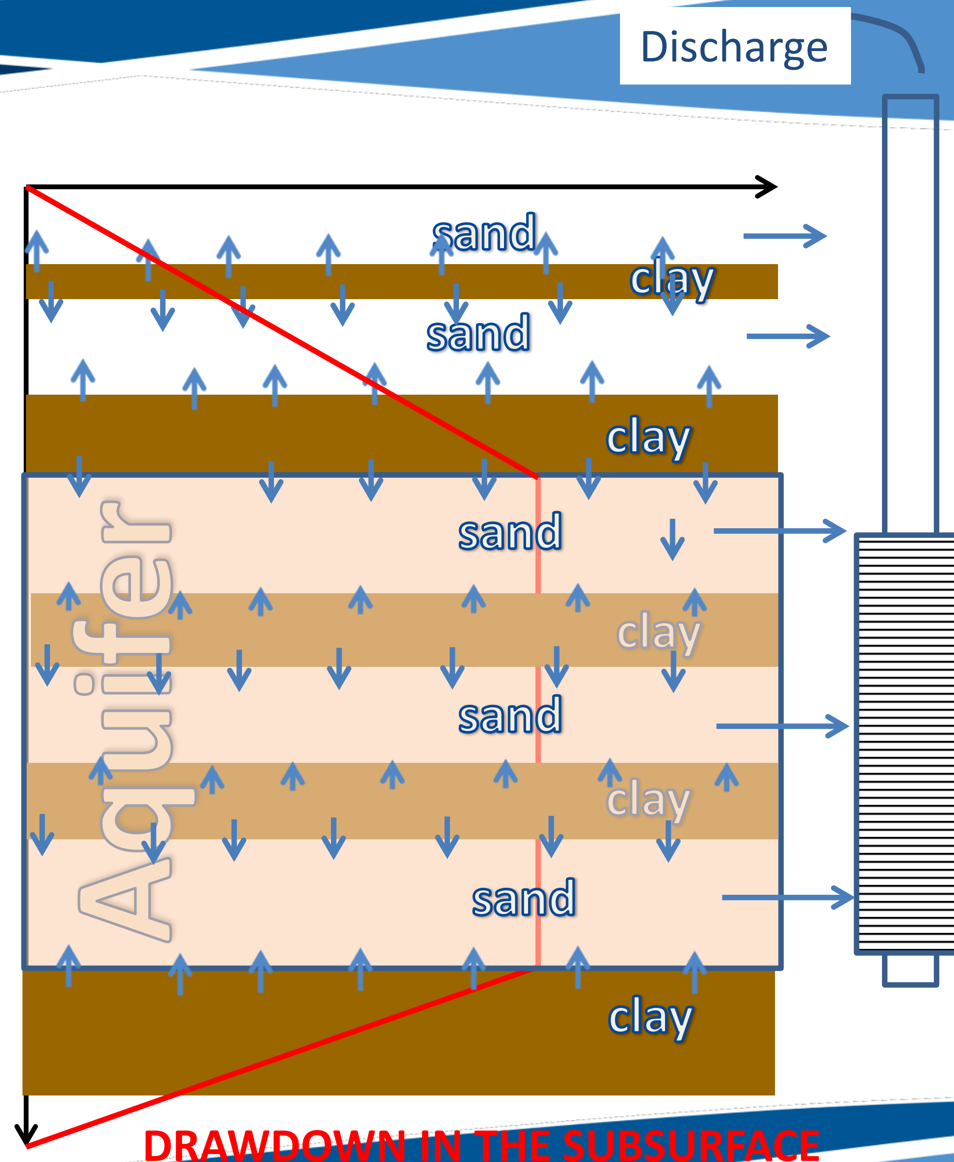
April 21, 2015

Presentation Outline

- Processes that Cause Land Subsidence
- Previous Estimates of Land Subsidence
- Approach for Using Topographic Data
- Data Sources
- Estimated Land Subsidence
- Summary

Conceptualization of a Model for Land Subsidence

- **Land subsidence occurs only from clay consolidating from above**
- **Sand drain first and then clays**
- **Clays drain much slower than sands**
- **Subsidence = Drawdown * Compressibility**
- **When Water Level is less than a Presconsolidation Water Level then Clay Compressibility is non-elastic and land subsidence occurs**
- **Laboratory Values of Clay Compressibility ≠ Field Values of Clay Compressibility**



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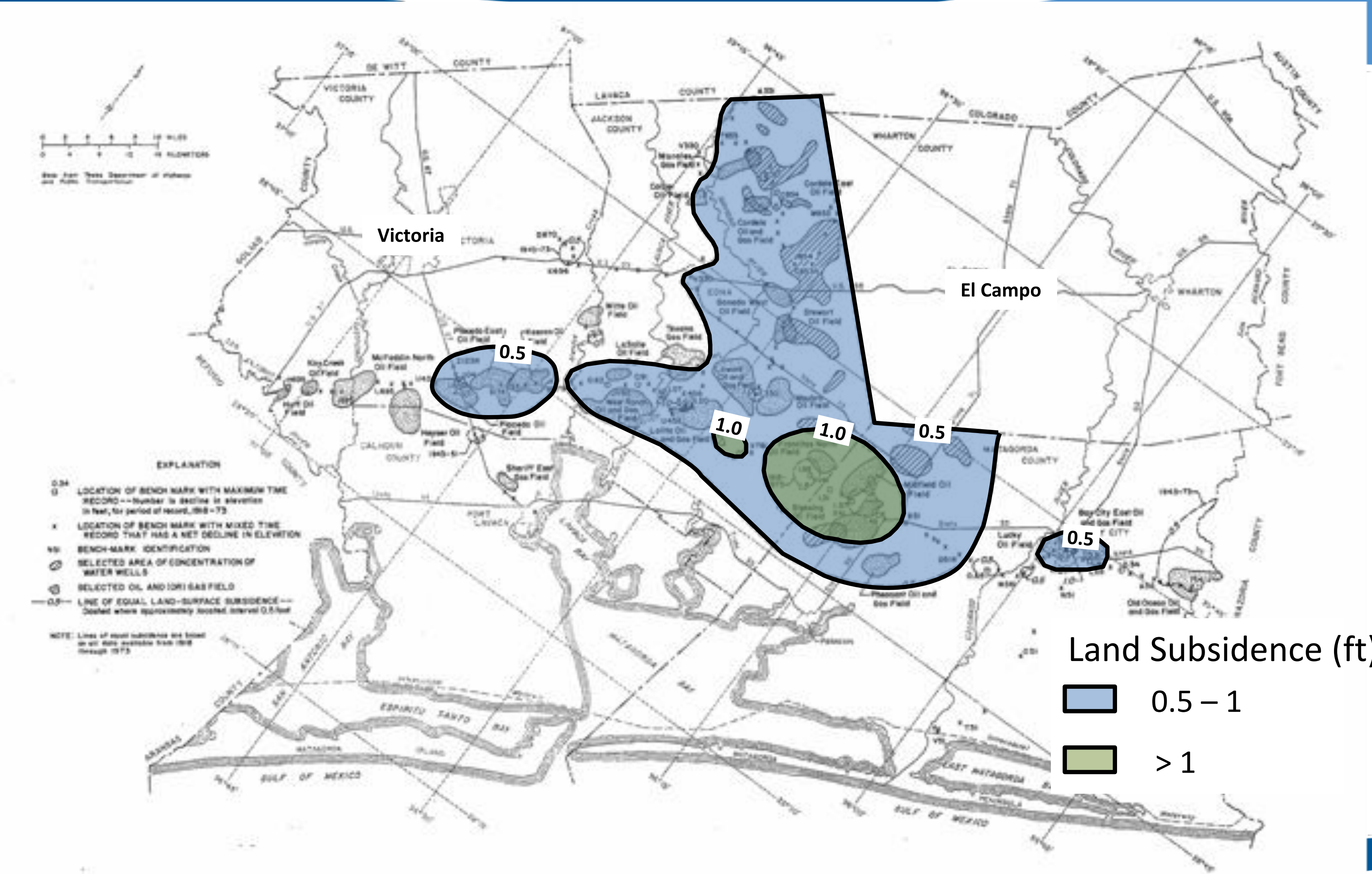
Estimated Land Subsidence (Ratzlaff, 1982)



Simulated Land Subsidence by Houston Area Groundwater Model (HAGM) (1891-2009)

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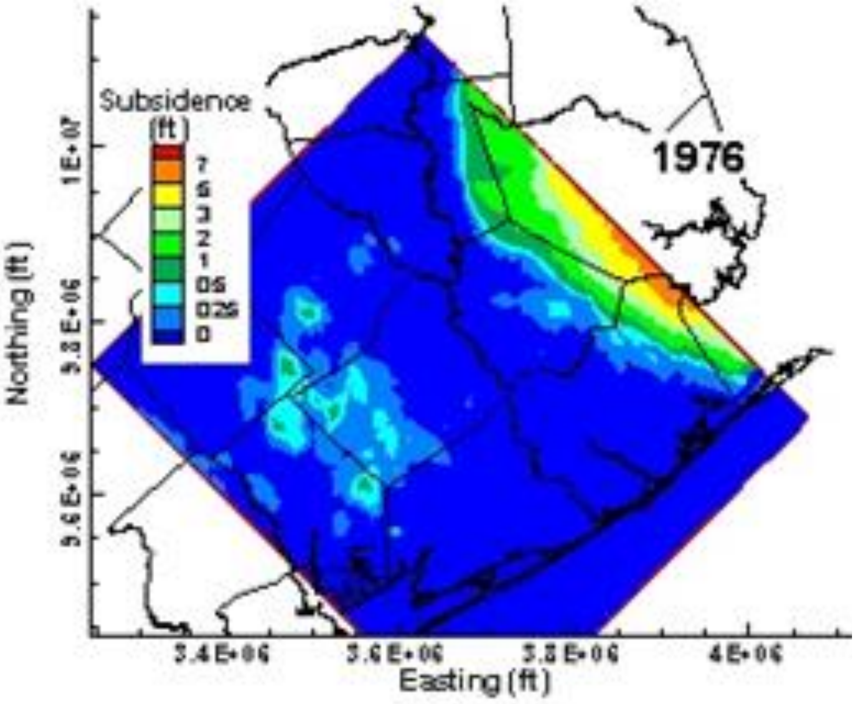
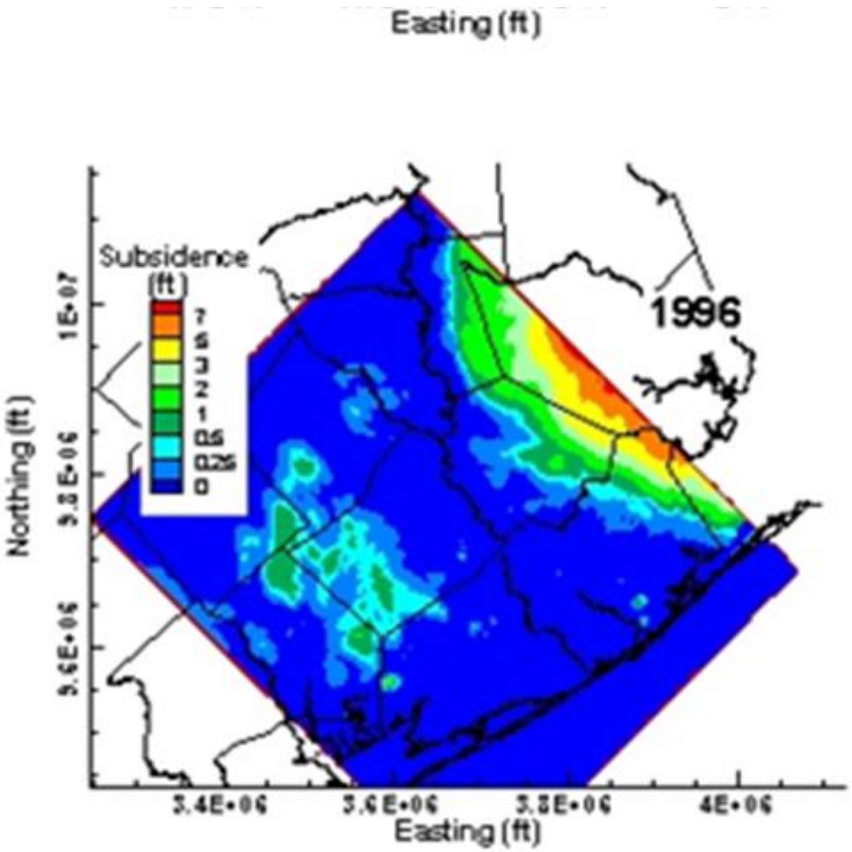
Simulated Land Subsidence by Lower Colorado River Basin (LCRB) Model

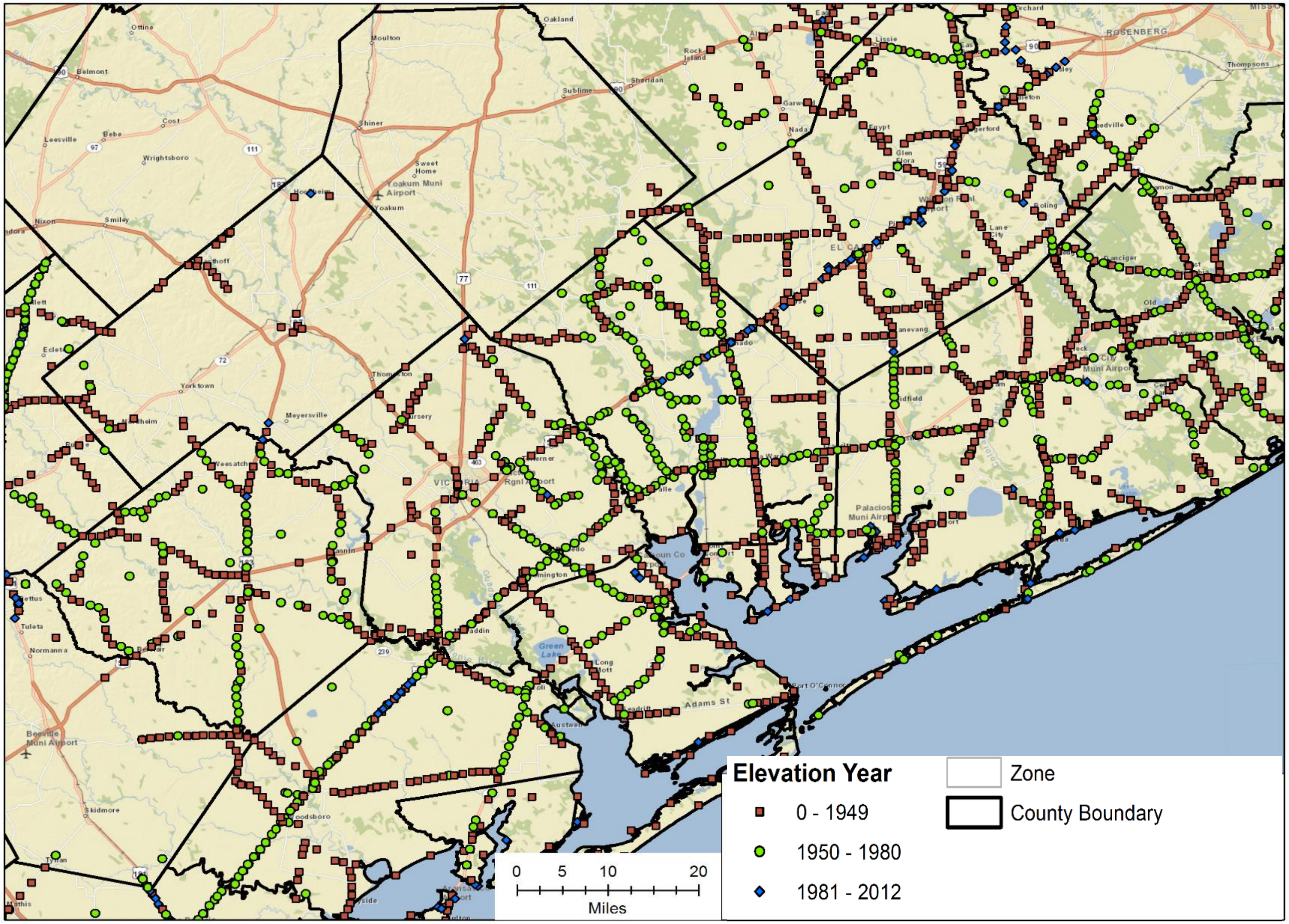




Approach for Using Topographic Data

- Land Elevation $_{(time\ 1)}$ - Land Elevation $_{(time\ 2)}$
- Assemble measurements over area and perform statistical analysis to estimate an “average” value
- Remove outliers (very high and low values) before statistical analyses
- Point measurements of Land Elevation
  - Group across decades and across 20 – 30 square mile areas to increase count
  - Calculate average difference based on values between 25% and 75% percentile
- Maps of Land Elevation
  - Old Topography Maps
    - Digitize and interpolate contour maps to generate continuous set of values
    - Sample at 500-ft spacing
  - LIDAR Maps
    - Mosiac tiles
    - Sample at 500-ft spacing
  - Group points within 1 mile square areas and then average using ESRI sofware
- Identify regions of Possible Land Subsidence

National Geodectic Survey Permanent Identifier (PIDs) Locations



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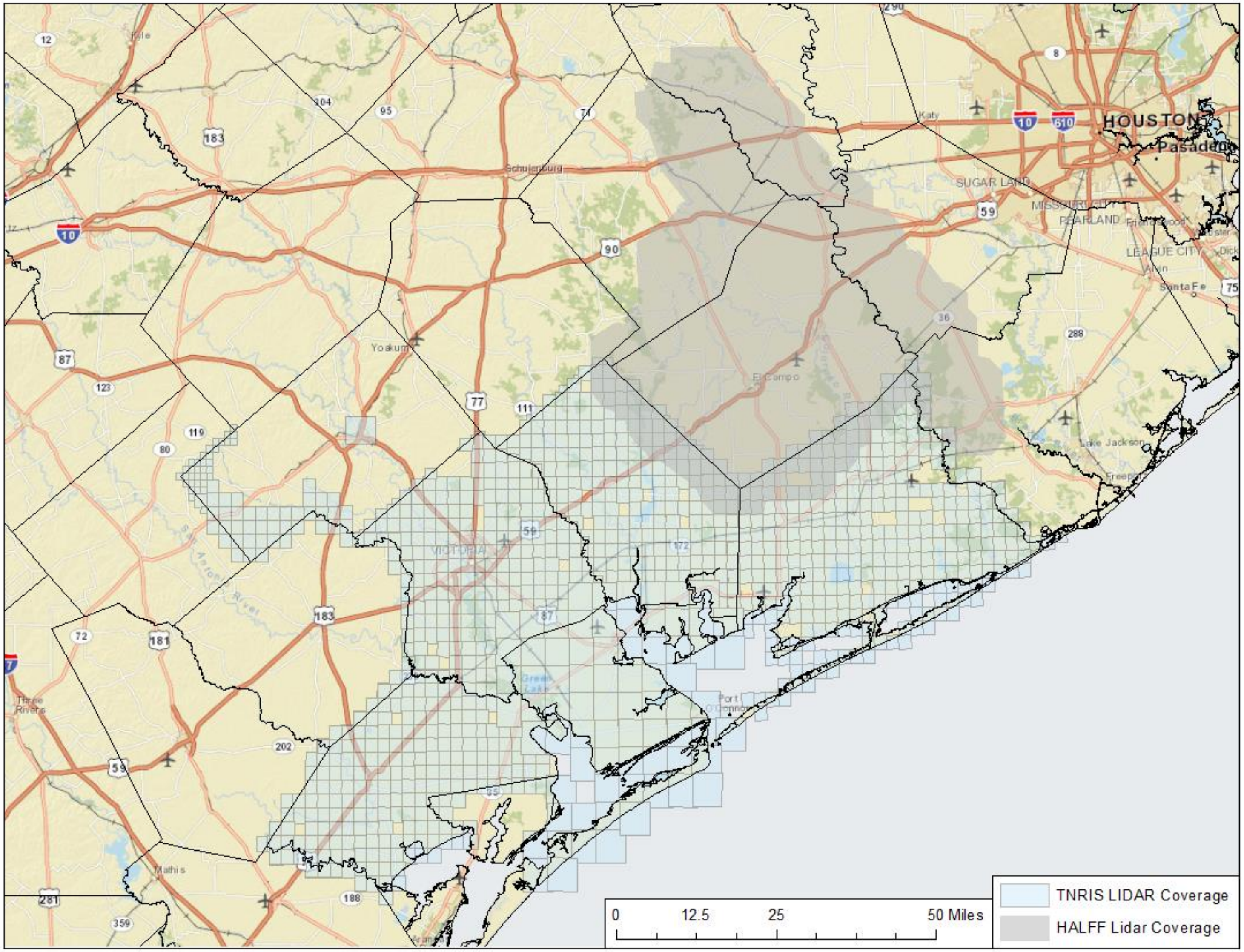
LIDAR (LIght & raDAR) Coverage



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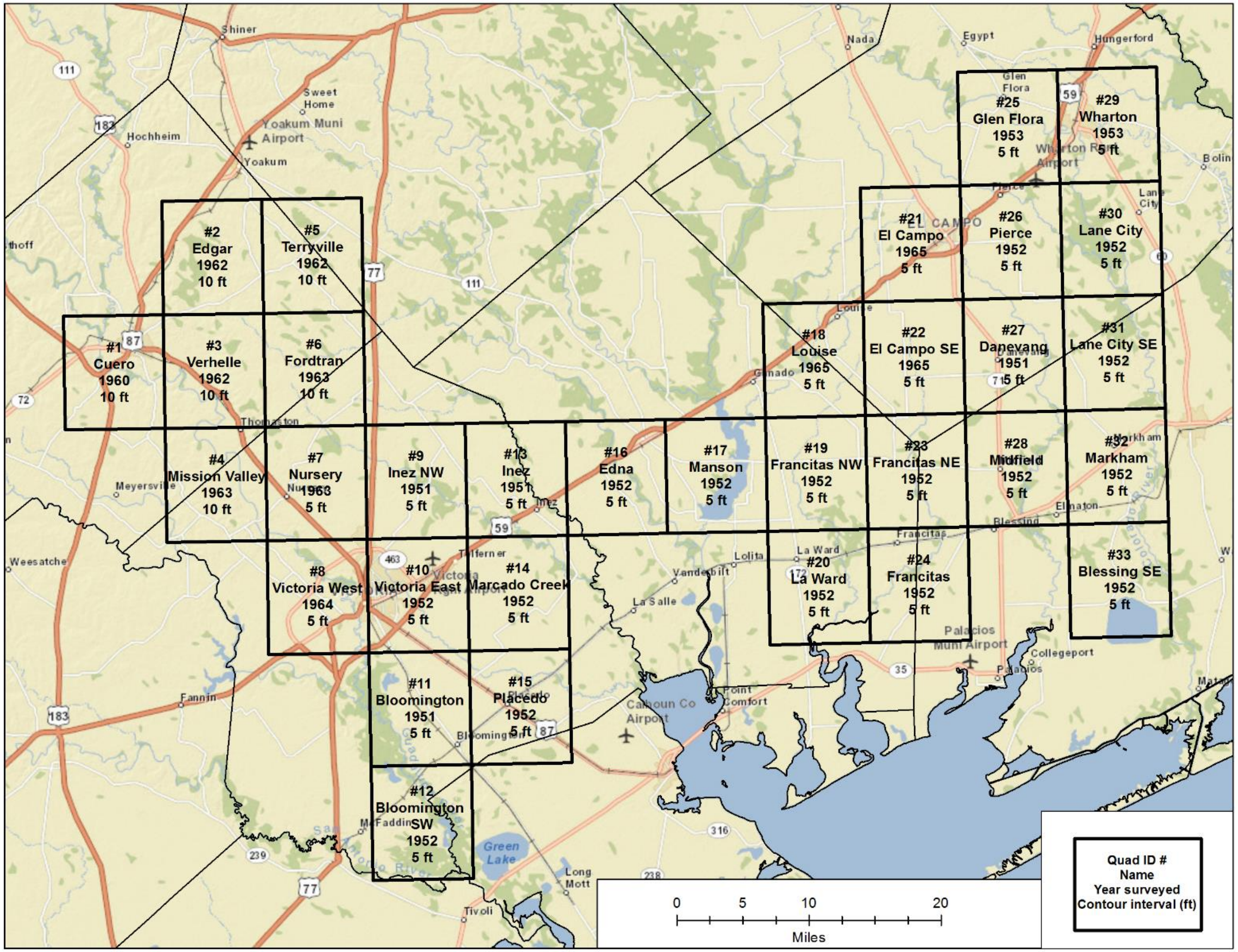
USGS Quadrangle Maps (1951 to 1962)
(5-ft to 10-ft contour interval)



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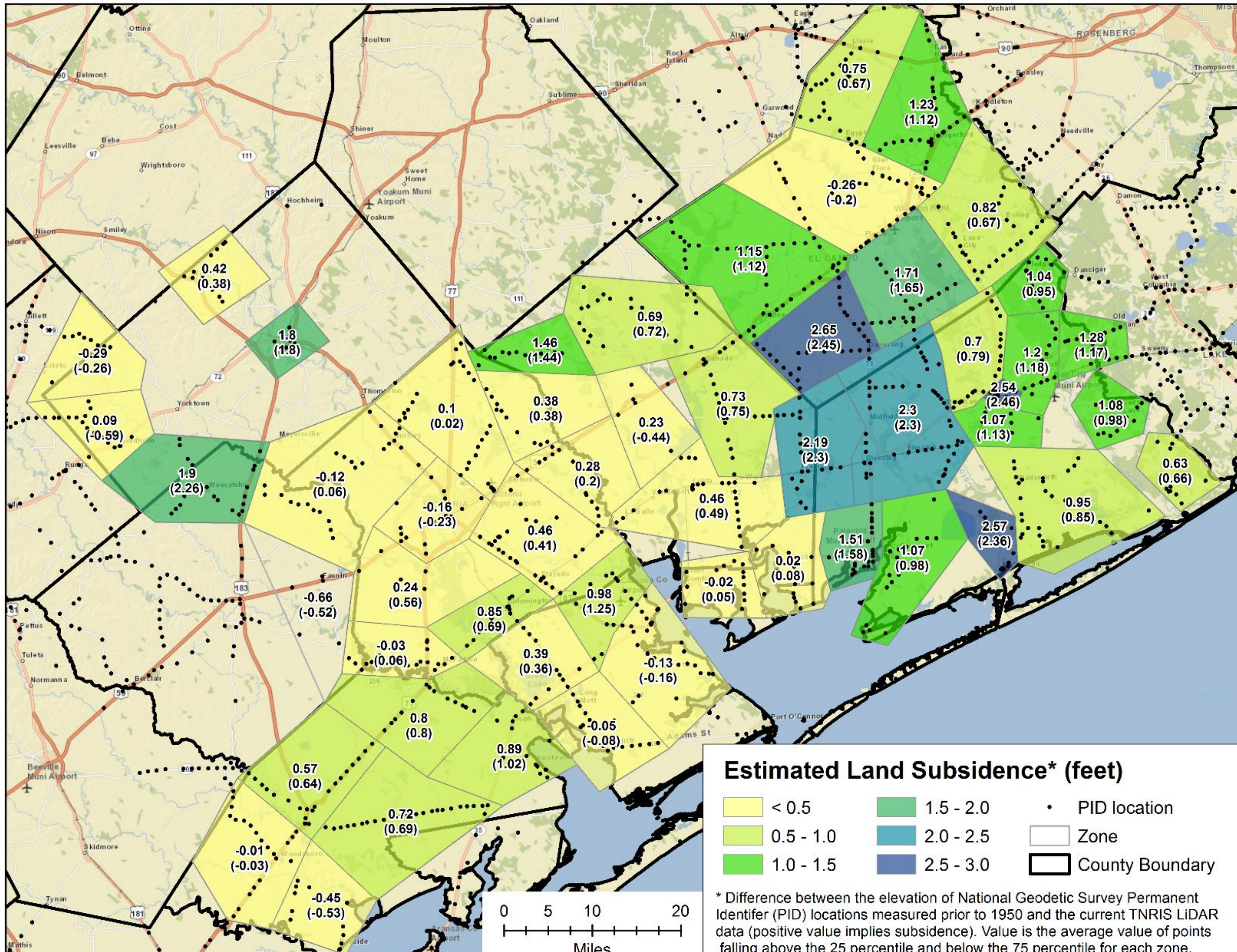
Estimated Land Subsidence based on PIDS (pre 1950s)

- Zones based on Grouping of PIDS with Similar Values
- Top Value is Weighted Average
- Bottom Value is Median
- Weighted Average based on values between 25% and 75% percentile
-



Preliminary Results - do not cite

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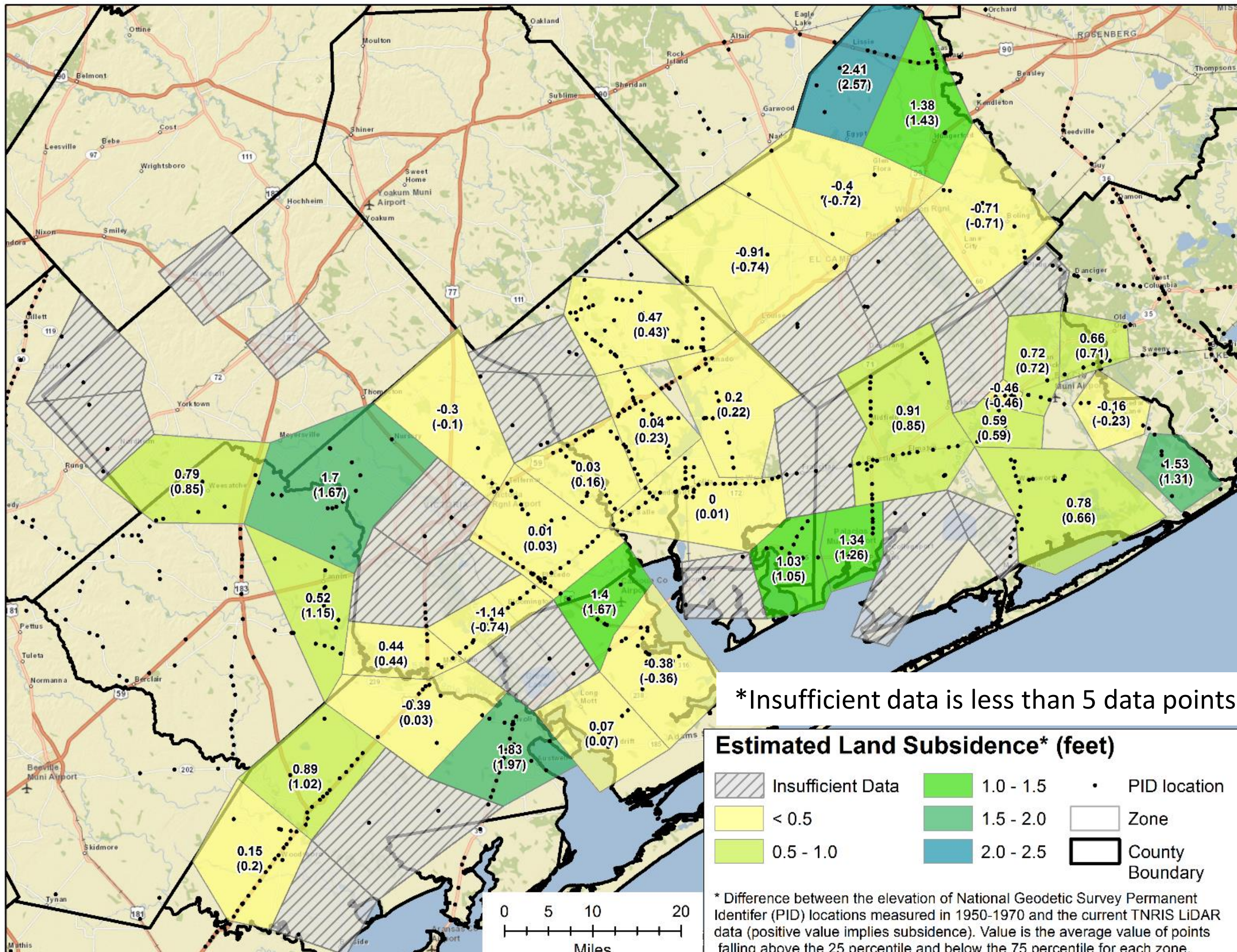
Estimated Land Subsidence based on PIDS (1950 -1980)

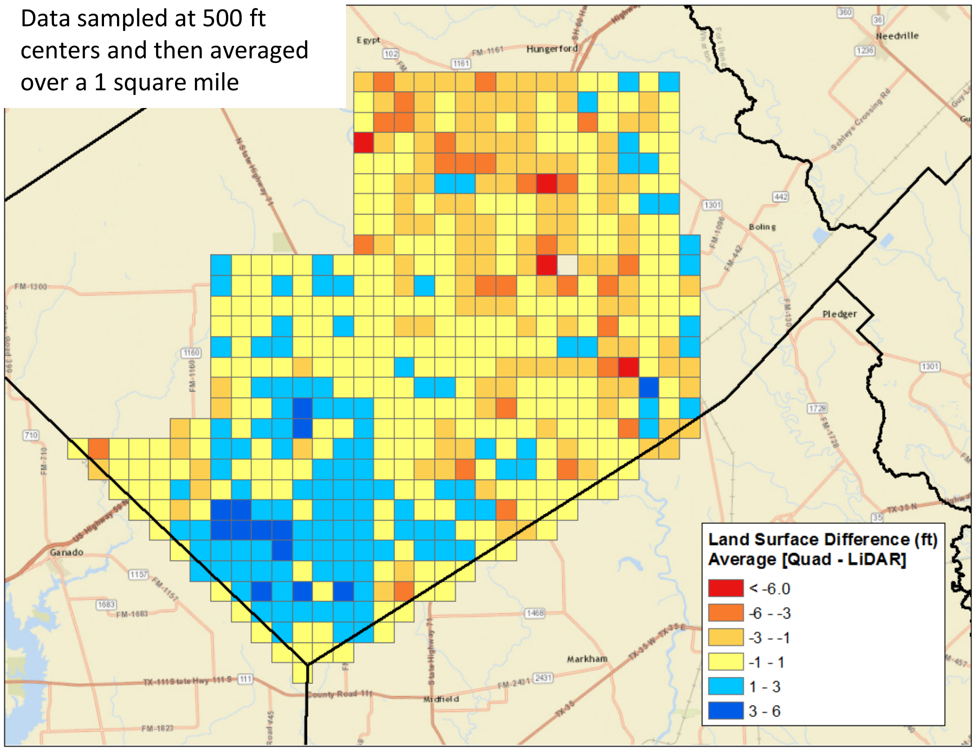
- Zones based on Grouping of PIDS with Similar Values
- Top Value is Weighted Average
- Bottom Value is Median
- Weighted Average based on values between 25% and 75% percentile
-

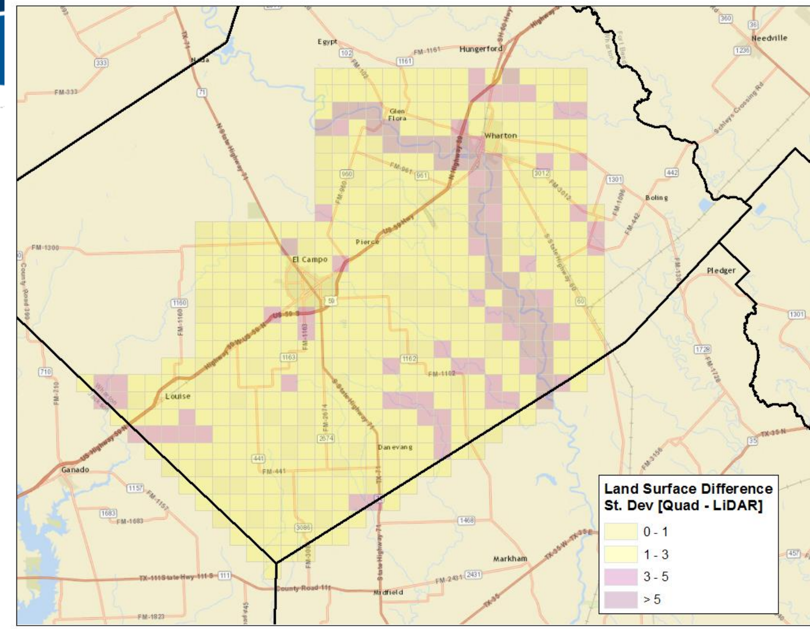


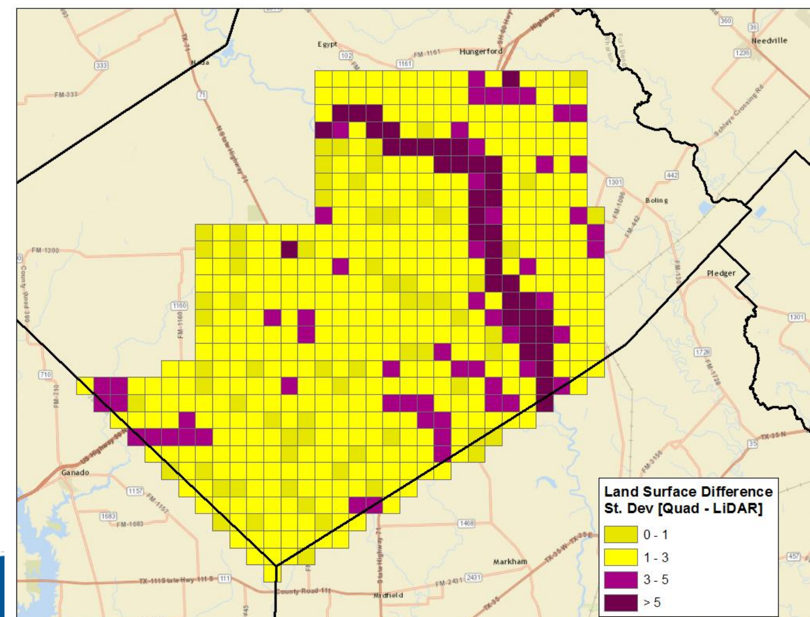
Preliminary Results - do not cite

Estimated Land Subsidence Using USGS Quadrangle data and LiDAR From HALFF

Data sampled at 500 ft centers and then averaged over a 1 square mile



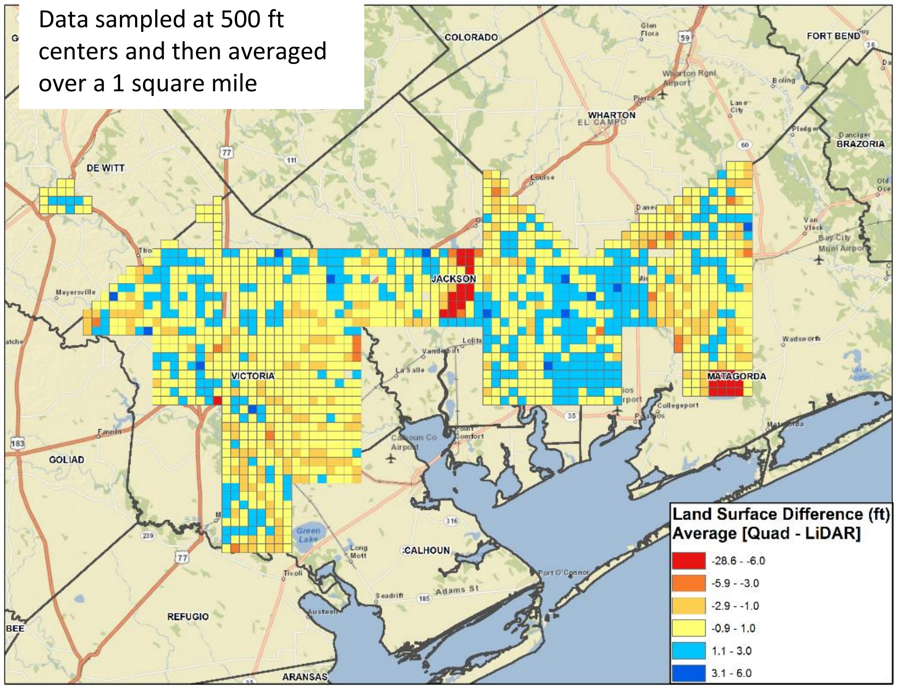


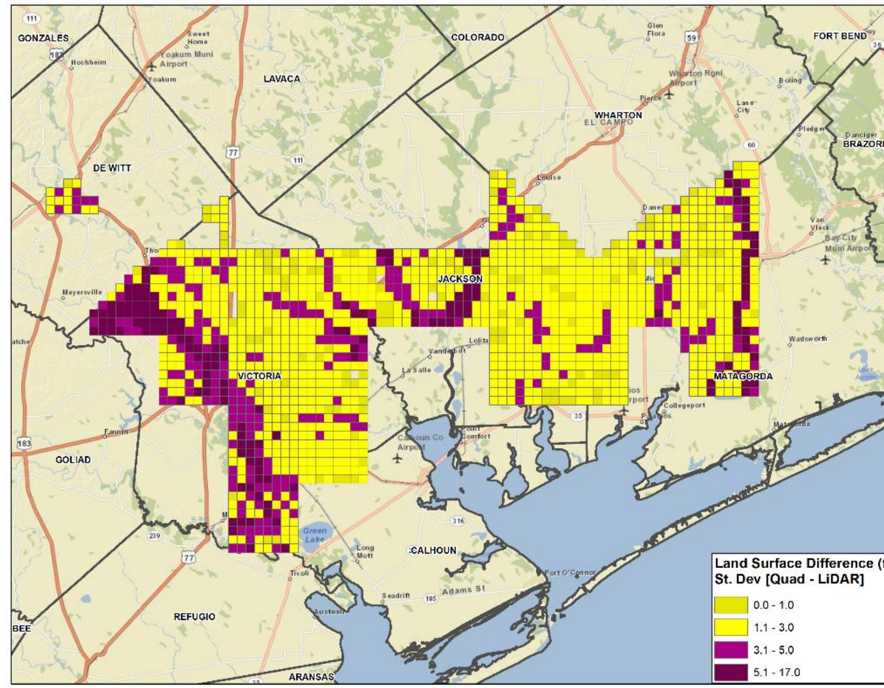


Preliminary Results - do not cite

Estimated Land Subsidence Using USGS Quadrangle data and LIDAR From TNRIS

Data sampled at 500 ft centers and then averaged over a 1 square mile





Preliminary Results - do not cite

Summary

- **Land subsidence has occurred during last 70 years**

- **Analysis of PID and LIDAR data**
  - **Time period from <1950 to >2010**
  - **Most of Wharton County has experienced about 1 foot of subsidence has occurred**
  - **Maximum subsidence occurred in southwest quadrant and is about 5 ft at a point and about 2.5 feet across a the area**
  - **Error estimated at ±0.5 feet**

- **Analysis of Quadrangle and LIDAR data**
  - **Time period from 1950-1960 to > 2010**
  - **Not reliable near streams**
  - **Indicates a smaller area in Wharton has experienced subsidence than the point data – Quadrangle data may be biased low 1-2 feet**
  - **Maximum subsidence occurred in southwest quadrant and is about 5.5 ft at a point and about 2.5 feet across the area**
  - **Error estimated at ±1.5 feet in area away from streams**