Groundwater Management Area 12 Fourth Joint Planning Cycle: Environmental Impacts

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INTERA

Land Subsidence

- Subsidence is caused by aquifer compaction due to groundwater level declines

- Three primary controls:
  - Magnitude of drawdown
  - Thickness of compressible clay
  - Clay compressibility

- Clay compressibility depends on:
  - Depth of burial
  - Age of Clay
  - Historical compaction

- Currently there are no reports expressing problems caused by subsidence but no strong evidence to show that it is not occurring or could occur in the future

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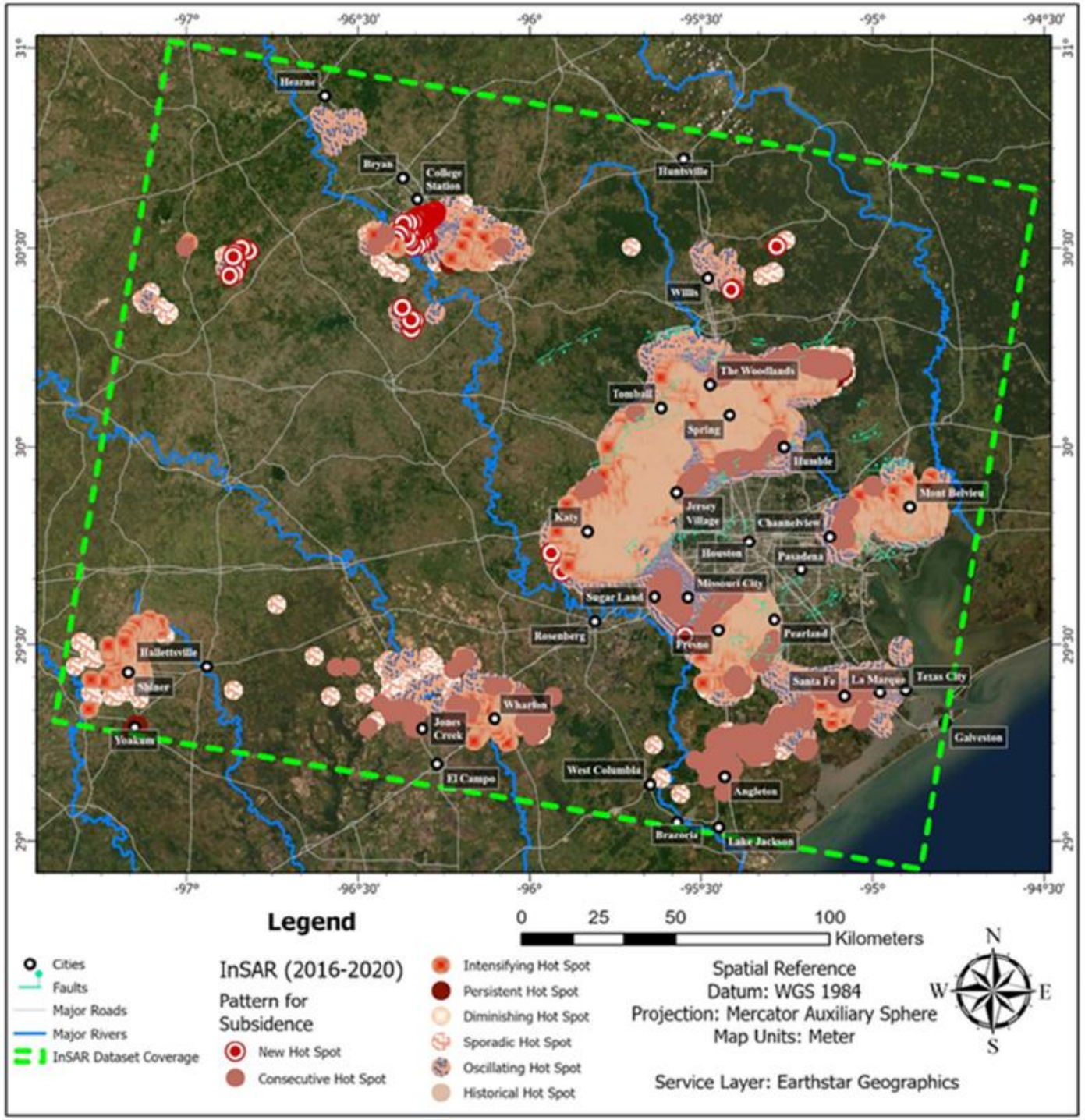
InSAR Study (Khan et al, 2022)

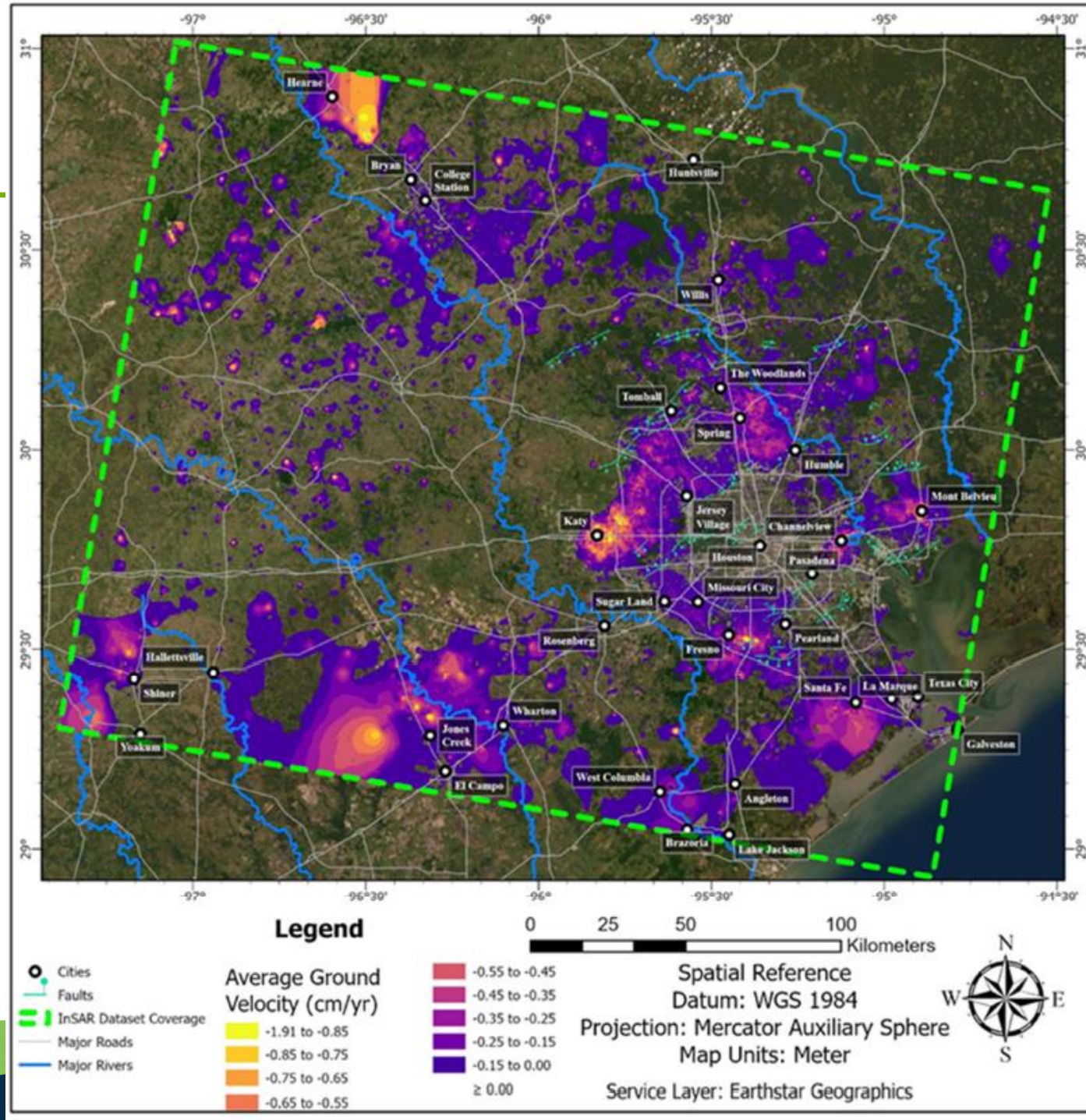
- Statistical hot spot analysis of subsidence patterns over time (2016–2020)

- Identifies areas where subsidence is:
  - Persistent
  - Intensifying
  - Newly emerging



InSAR Velocity Map (Khan et al, 2022)

- Average annual ground velocity from 2016–2020 derived from InSAR (satellite radar) data
- Negative values (warm colors) indicate subsidence (ground sinking)
- Positive/near-zero values indicate stable or uplift conditions



Technical Memo on Subsidence in Vista Ridge (2019)

Table 2. Potential Subsidence Predicted by TWDB Subsidence Tool

	Feet of Potential Subsidence (Min/Max)								
Simulation	**Sparta**	**Weches**	**Queen City**	**Reklaw**	**Carrizo**	**Calvert Bluff**	**Simsboro**	**Hooper**	**Total**
MODGAM with DFC pumpage no Vista Ridge	0/0	0.01/0.02	0.02/0.04	0.04/0.07	0.02/0.03	0.42/0.8	0.04/0.07	0.41/0.77	1.01/1.93
MODGAM with DFC pumpage plus Vista Ridge	0/0	0.01/0.02	0.03/0.05	0.15/0.28	0.12/0.23	1.18/2.25	0.13/0.26	0.75/1.43	2.37/4.52
MODGAM Subsidence from Vista Ridge Pumpage only	0/0	0/0	0/0.01	0.11/0.21	0.1/0.19	0.76/1.44	0.09/0.18	0.35/0.66	1.36/2.59

- A technical memo was prepared in 2019 that looked at potential subsidence impacts at vista ridge in 2019 using the TWDB subsidence tool

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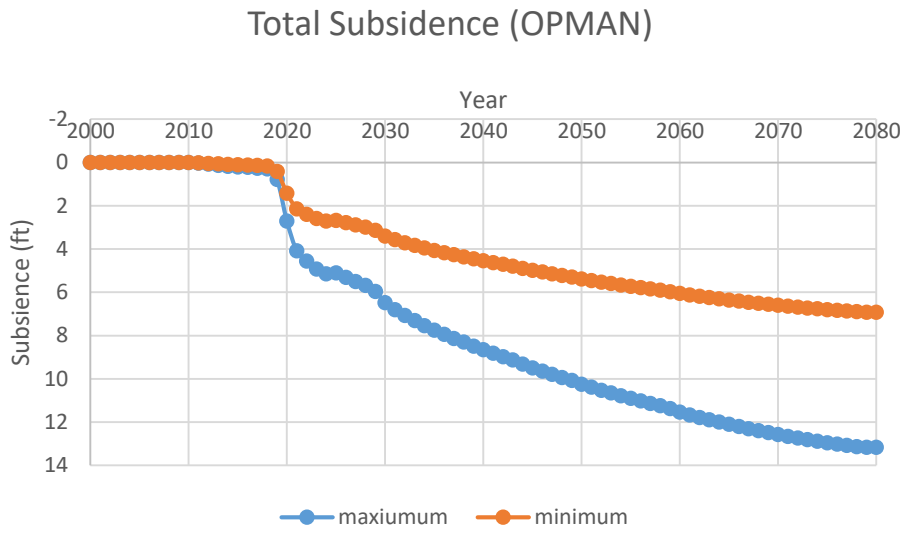
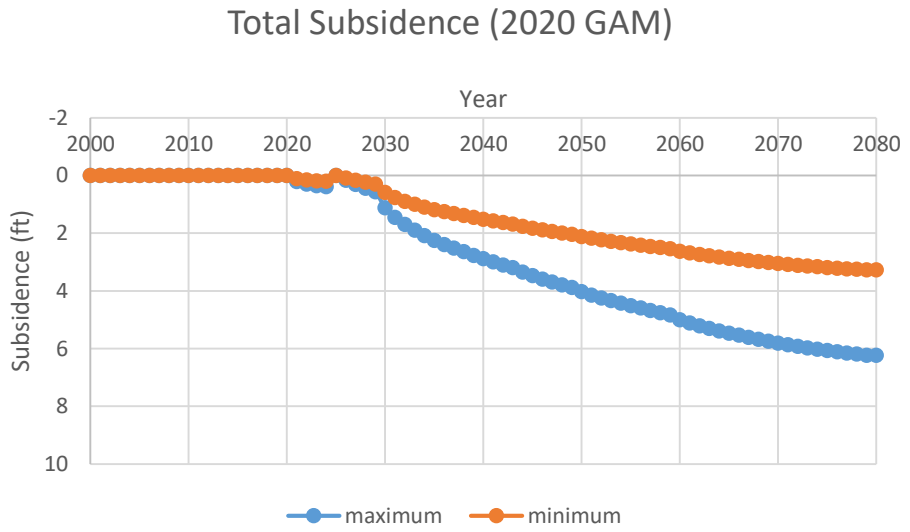
TWDB Tool Subsidence

Paramter	Sparta	Queen City	Carrizo	Calvert Bluff	Simsboro	Hooper
Land Surface (feet MSL)	350	350	350	350	350	350
Aquifer Top (feet MSL)	319	67	-522	-880	-522	-2566
Aquifer Thickness	205	488	358	1049	358	697
Clay Thickness within Aquifer	82	195	69	482	69	279
Groundwater Temperature	20	20	20	20	20	20
Groundwater Total Dissolved Solids (TDS)	403	403	403	403	403	403
Predevelopment Water Level (feet MSL)	313	330	300	292	224	263
Current Water Level (feet MSL)	311	324	-6	162	-49	155
Unsaturated Thickness	50	50	25	25	50	50
Preconsolidation (deepest) Water Level (feet MSL)	241	280	300	292	224	263
Base Water Level (feet MSL)	311	280	300	292	224	263
Future Water Level (feet MSL)	308	315	-153	-63	-503	-271
Beginning Year for Subsidence Evaluation	2000	2000	2000	2000	2000	2000
Ending Year for Subsidence Evaluation	2080	2080	2080	2080	2080	2080

- Results were replicated using:
  - Improved clay thickness estimates from geophysical logs
  - Refined estimates of preconsolidation head
- TWDB Tool predicts:
  - 2020 GAM: ~6 ft of subsidence by 2080
  - OPMAN: ~13.5 ft of subsidence by 2080





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TWDB Tool Observations

- TWDB Tool default clay compressibility seem high for Carrizo-Wilcox sediments
- Measurements of clay compressibility from Gulf Coast Aquifer subsidence studies show much lower compressibility that also varies by depth of burial
- TWDB tool also does not consider time dependent consolidation

Aquifer Subsidence Calculations based on overall aquifer information and user supplied input values		Units
Water Level Trend	0.00	ft/year; negative for decline
Predominant Aquifer Lithology	Unconsolidated Clastic	Description
Aquifer Storage Coefficient	0.15	Dimensionless
Aquifer Porosity	35	Percent
Predominant Aquifer Clay Type	Hard Clay	Type
Aquifer Clay Porosity	50	Percent
Minimum Aquifer Compressibility	3.59E-04	psi^{-1}
Maximum Aquifer Compressibility	6.89E-04	psi^{-1}
Minimum Clay Compressibility	4.76E-04	psi^{-1}
Maximum Clay Compressibility	8.96E-04	psi^{-1}
Minimum Elastic Specific Storage (S_{ske})	9.33E-07	ft^{-1}
Maximum Elastic Specific Storage (S_{ske})	1.78E-06	ft^{-1}
Minimum Inelastic Specific Storage (S_{skv})	9.33E-05	ft^{-1}
Maximum Inelastic Specific Storage (S_{skv})	1.78E-04	ft^{-1}

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Summary

- No reported evidence of subsidence impacts
  - Potentially due the sediments being older and more consolidated
- InSAR data indicates low-magnitude deformation in some areas
- TWDB subsidence tool predicts large subsidence magnitudes (6–13 ft) not representative of what's being observed
- At Vista Ridge there is an opportunity to investigate the potential for subsidence in the Carrizo-Wilcox aquifer because there is a study that covers the baseline land deformation before the wellfield was installed

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