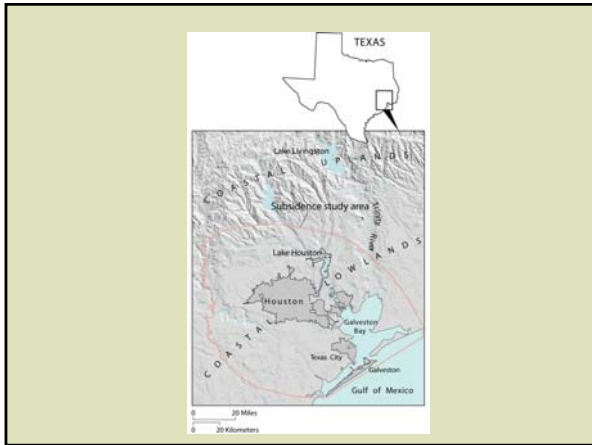
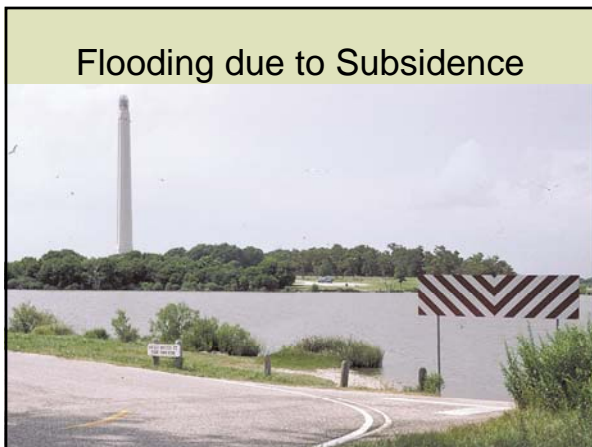
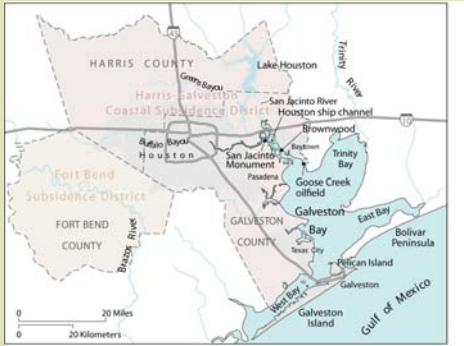


Subsidence & Groundwater Withdrawal





Houston-Galveston



Galveston Bay near Goose Creek



Greens Bayou flooded in 1989



Houston Ship Channel



Goose Creek oil field

Prolific oil production produced the region's first major subsidence

Most subsidence in the Houston area has been caused by ground-water withdrawal, but the earliest subsidence was caused by oil production. In fact, the subsidence of the Goose Creek oil field on Galveston (San Jacinto) Bay was the first

subsidence attributed to subsurface-fluid withdrawal to be described in the scientific literature. A dispute over the legal status of the land submerged by subsidence caused Texas courts to formally recognize the process.

"In 1917 a prolific oil field was developed near the mouth of Goose Creek, and during 1918 and subsequent years, millions of barrels of oil were removed from beneath its surface. Beginning in 1918 it became apparent that the Galillard Peninsula, near the center of the field, and other nearby low land was becoming submerged. Elevated plank roadways or walks were built from the mainland to the derricks. Derrick floors had to be raised. Vegetation was flooded and killed, and finally all of the peninsula disappeared beneath the water. ... The maximum measured subsidence is now more than 3 feet and the area affected is 2 1/2 miles long by 1/2 miles wide. ... Outside this area no change in elevation can be detected. ..."

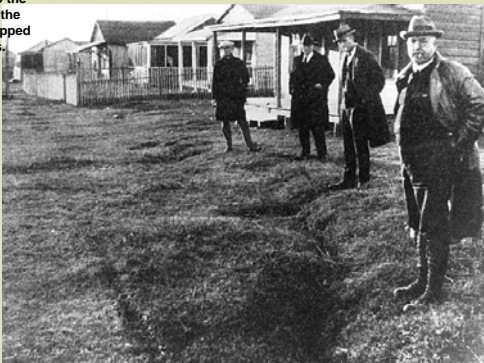
—Hart and Johnson, 1926

Between 1918 and 1926 subsidence was measured around Goose Creek oil field. Lines of equal subsidence (feet) for an 8 year period are shown in gray lines—for a 4 year period, in black lines.



"There can be no doubt, ... that the contours show correctly the essential fact that a local 'sinking' of the earth's surface has occurred in the Goose Creek region, the central area of greatest subsidence corresponding approximately with the center of the oil field."

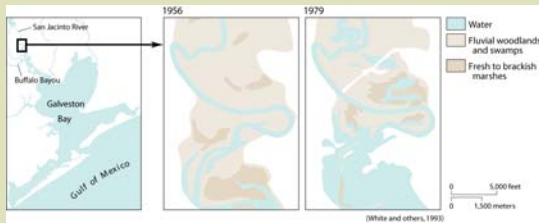
This photograph taken about 1926 shows a 'fault fissure' in Pelley, one-half mile north of the oil fields. To the left of the fault, the ground had dropped about 16 inches.



Brownwood Subdivision



Wetlands Loss due to Subsidence

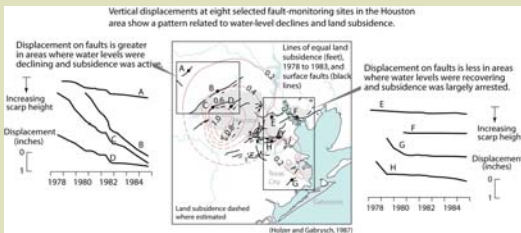


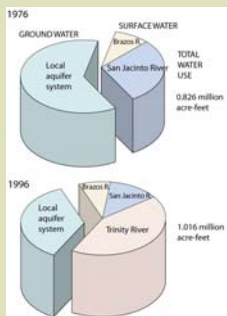
Drowned Coastal Woodlands



Subsidence activates faults

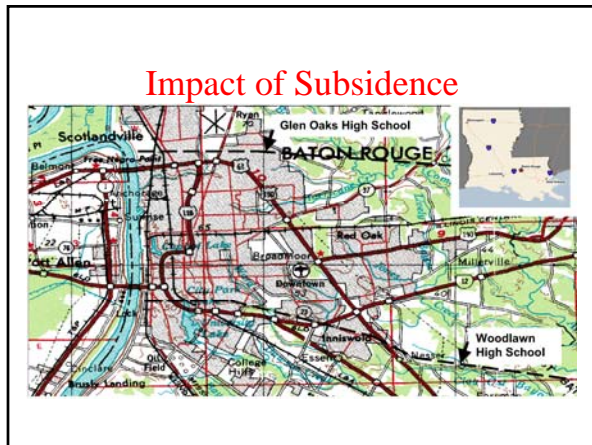


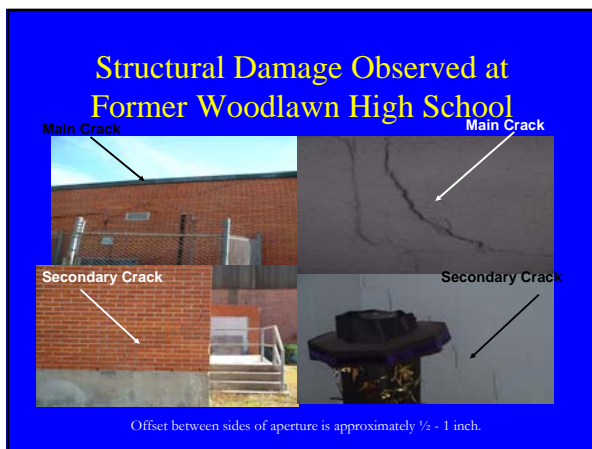




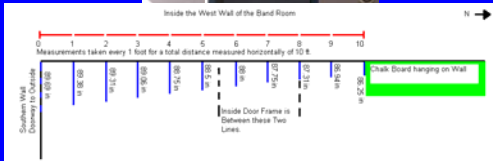
As a percentage of the total groundwater use has dropped significantly, but total water use is rising.







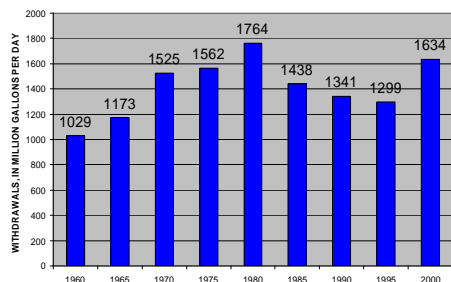
Laser Level Measurements Inside Western Band Room Wall

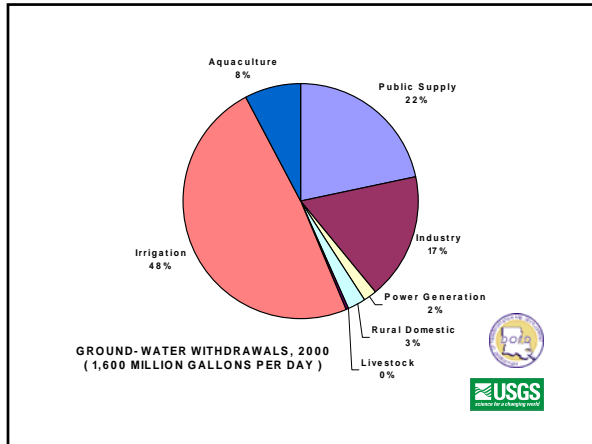


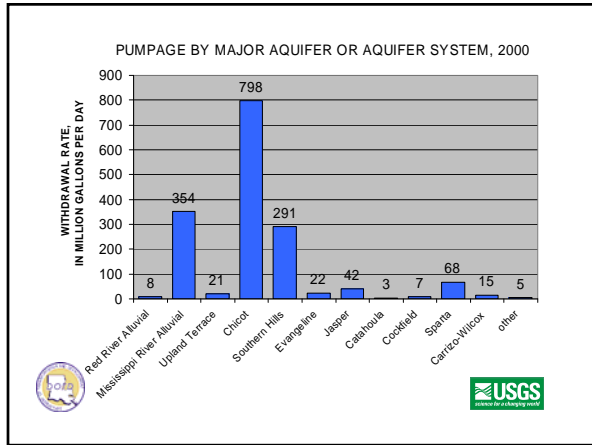
Surface extent of Louisiana's aquifers and aquifer systems

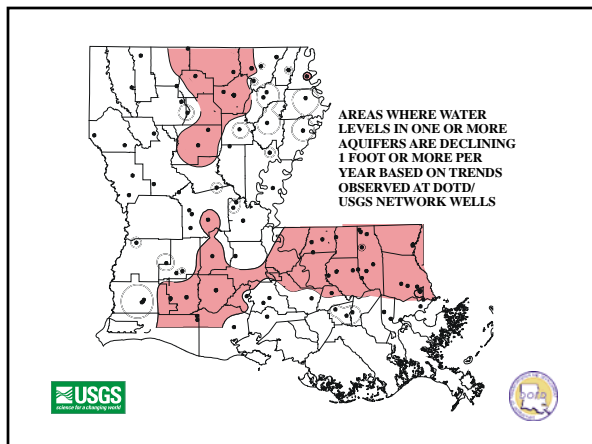


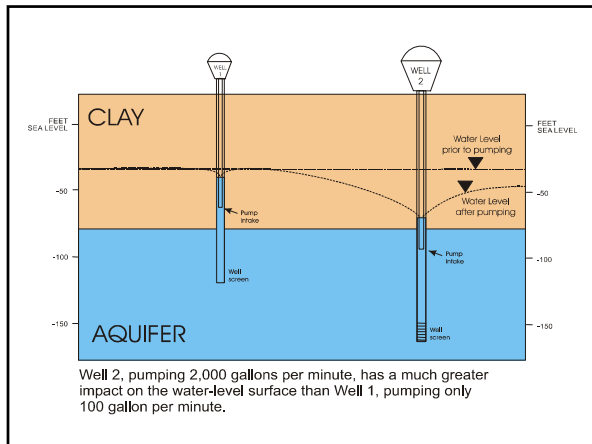
GROUND-WATER WITHDRAWALS IN LOUISIANA, 1960-2000

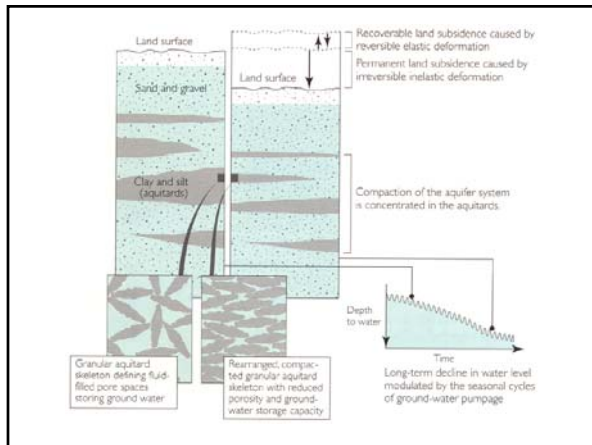


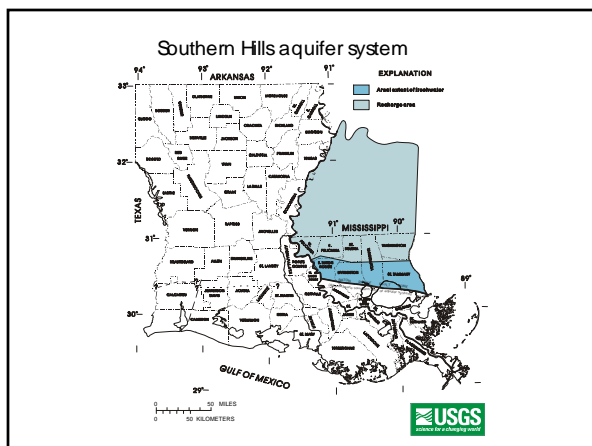


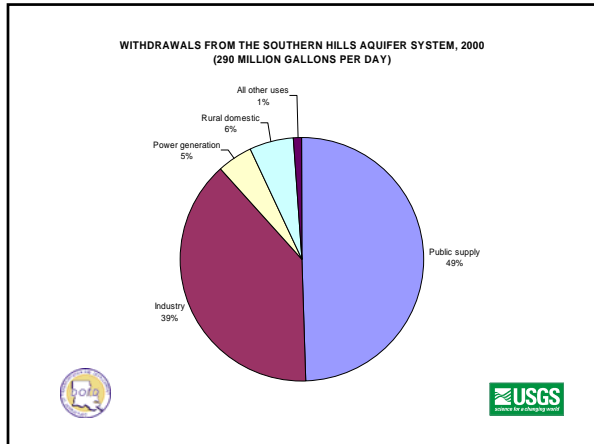


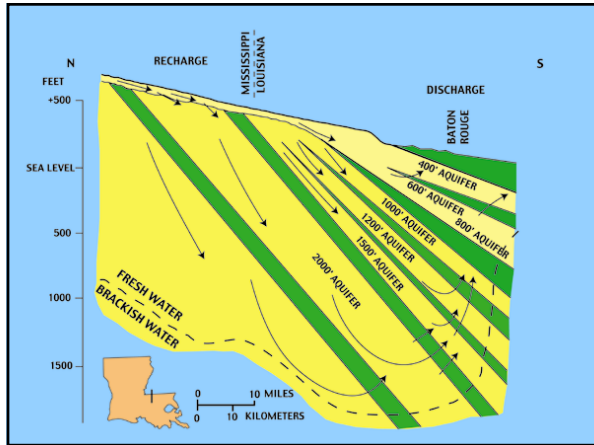


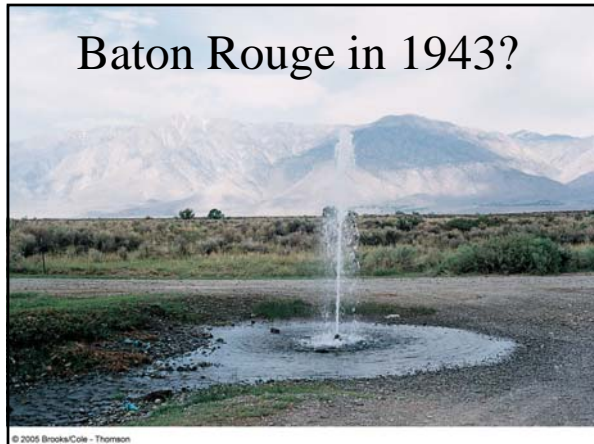


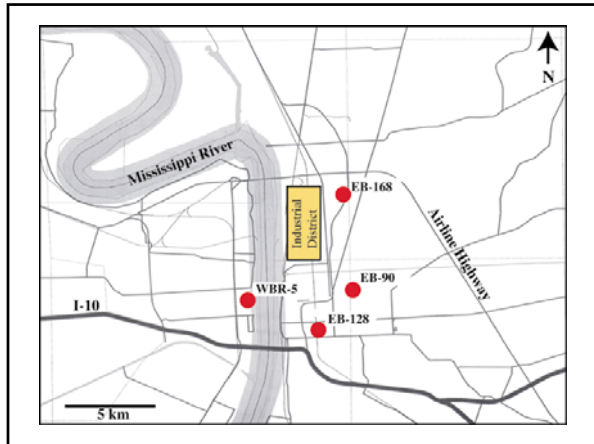


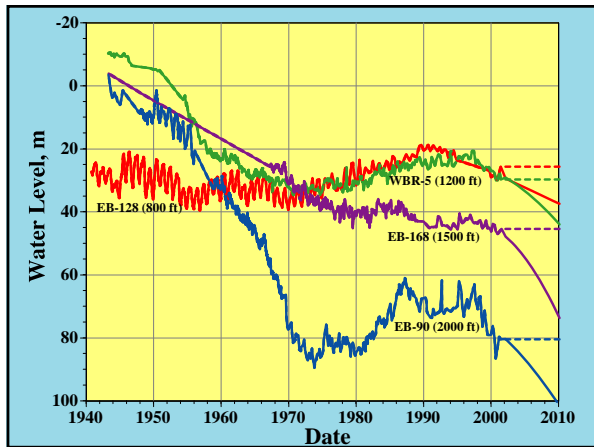


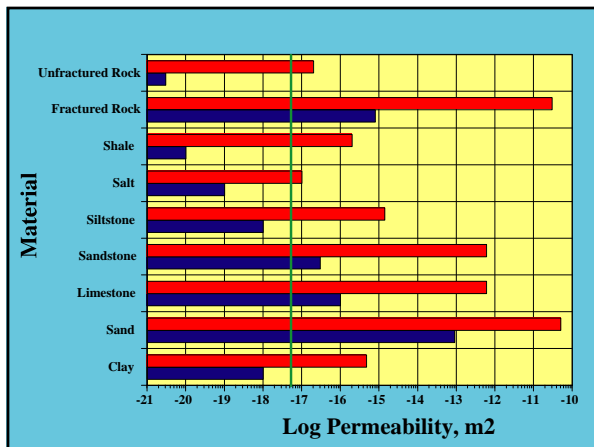


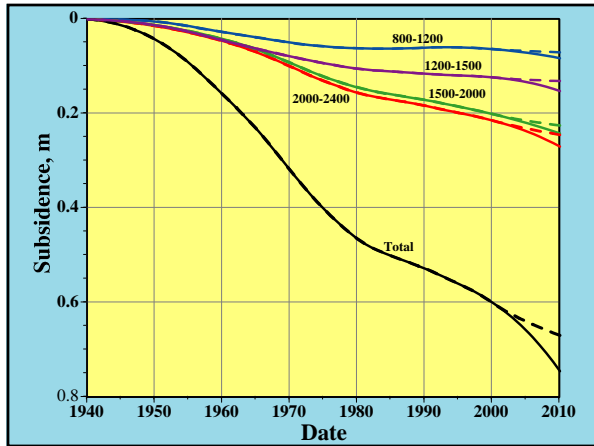
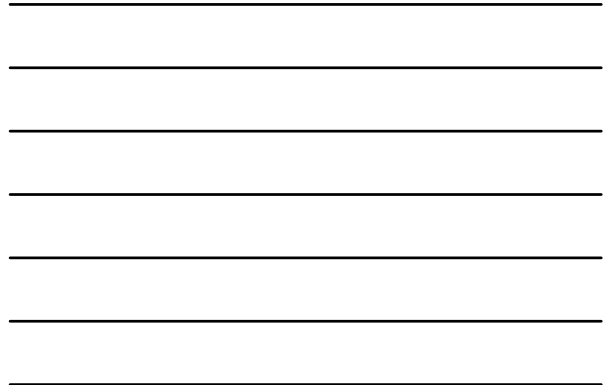
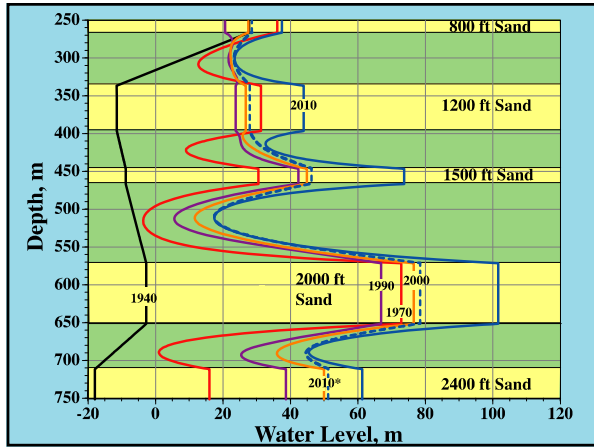
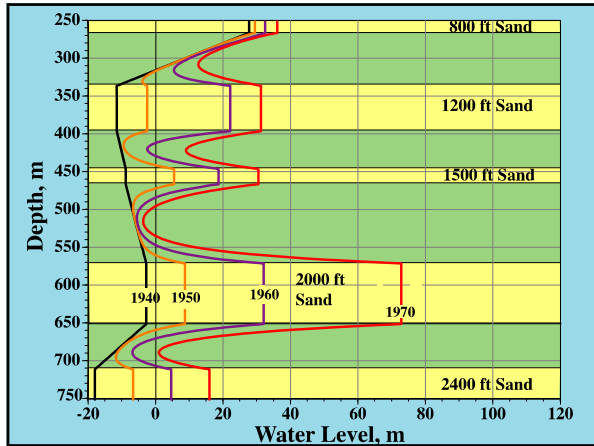


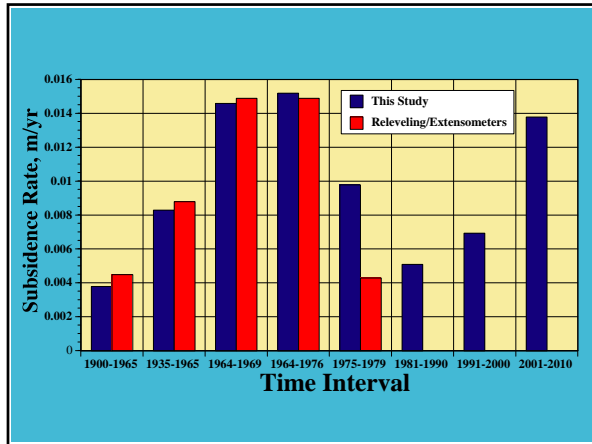


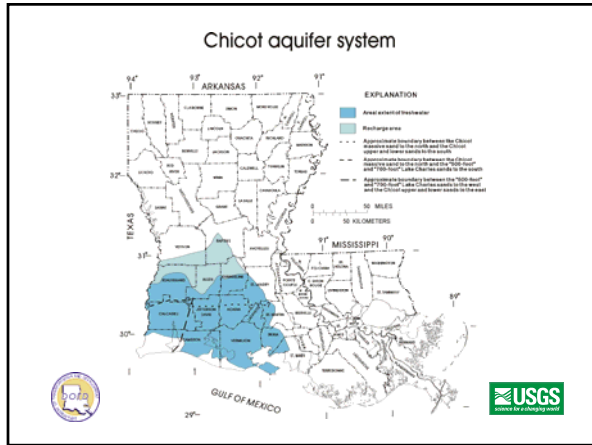


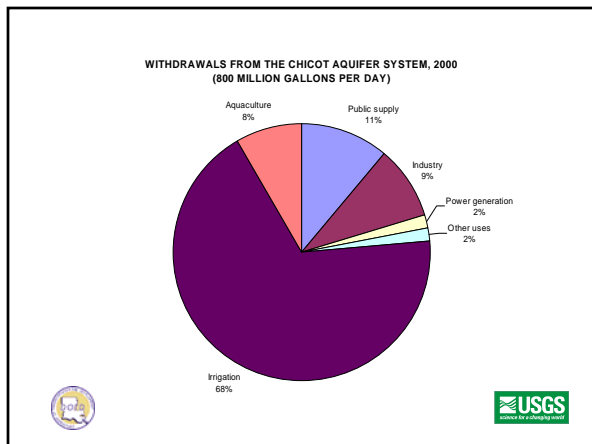


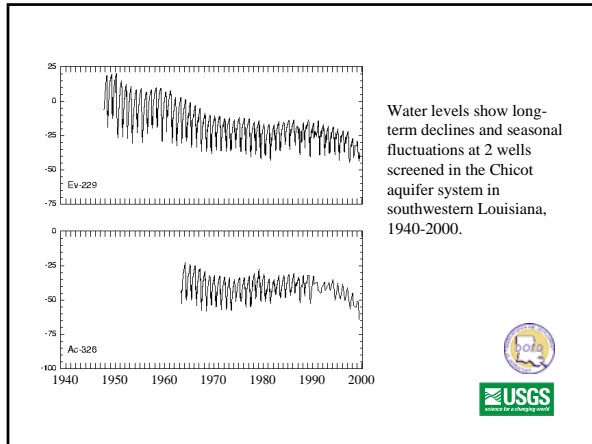


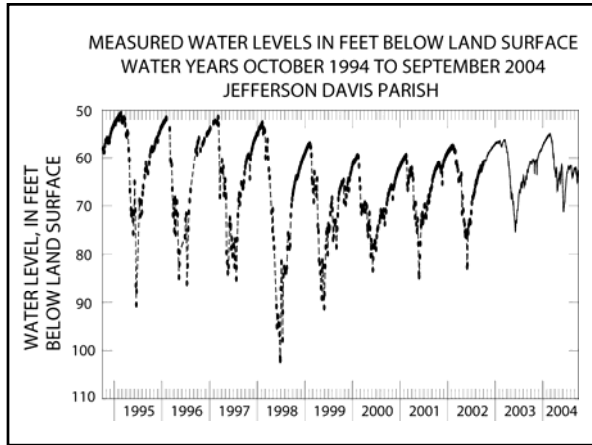


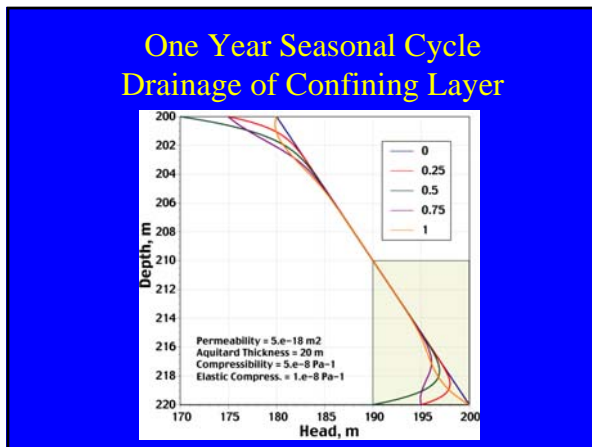




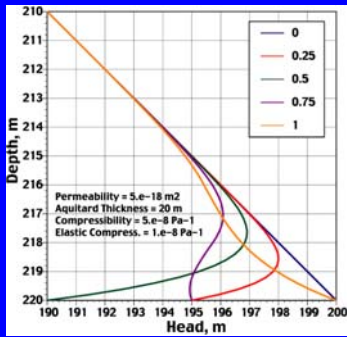




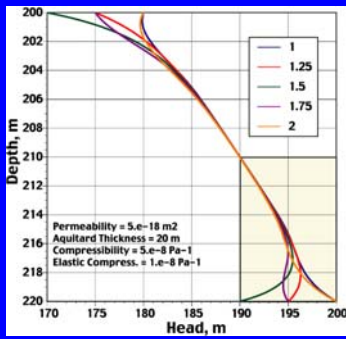




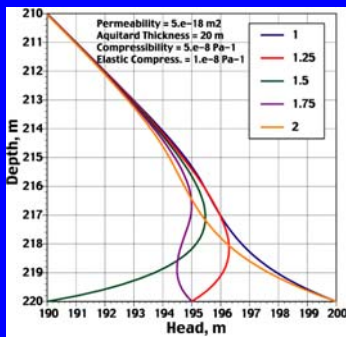
One Year Seasonal Cycle Bottom Half of Confining Layer



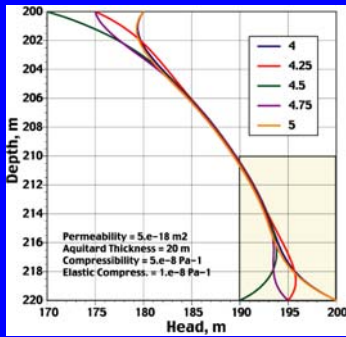
Second Seasonal Cycle Drainage of Confining Layer



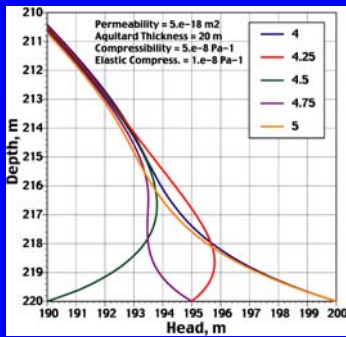
Second Seasonal Cycle Bottom Half of Confining Layer



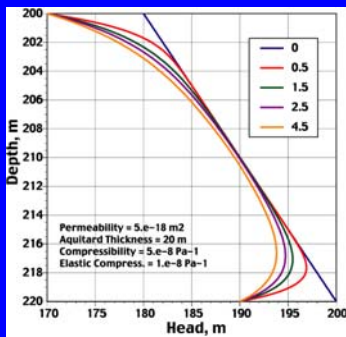
Fifth Seasonal Cycle Drainage of Confining Layer



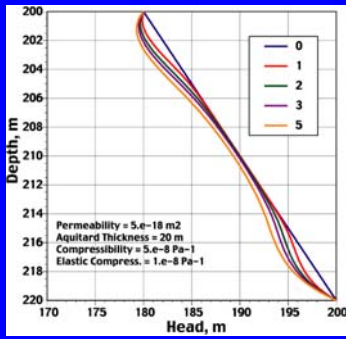
Fifth Seasonal Cycle Bottom Half of Confining Layer

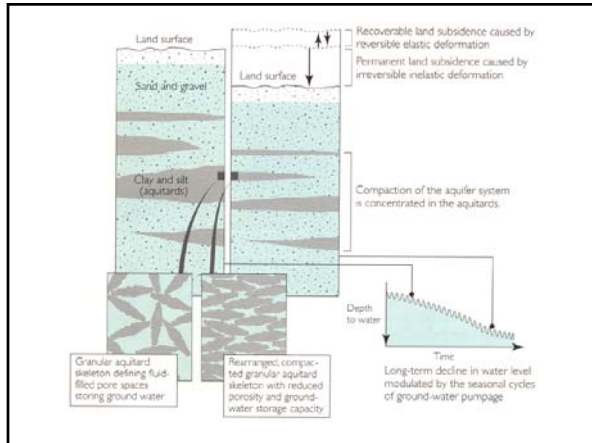


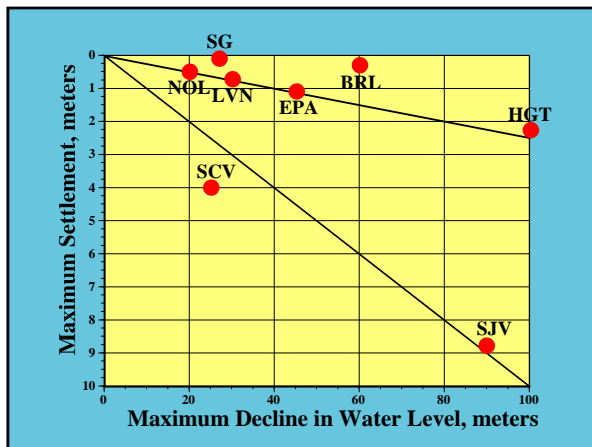
Five Seasonal Cycles Drainage at Low Water Level

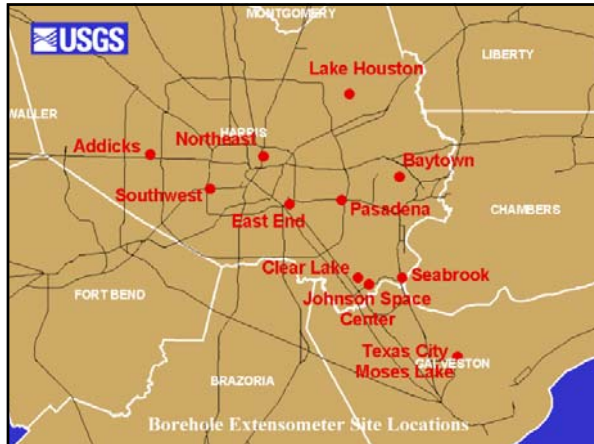


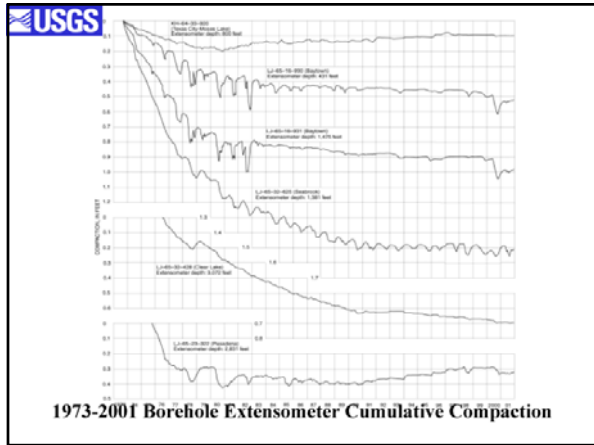
Five Seasonal Cycles Drainage at Low Water Level









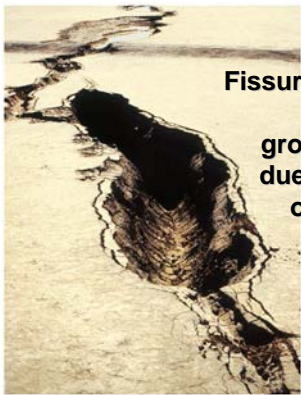


CONCLUSIONS

- Declining water levels in the Chicot and Southern Hills Aquifers should drain intervening clay layers and produce significant compaction and land surface subsidence
- The amount and temporal distribution of subsidence will depend on the number and thickness of clay layers which varies both North to South and East to West

CONCLUSIONS

- Drainage and compaction of confining layers also can result from seasonal variations in water levels even if long term water levels do not change
- Land surface subsidence will continue in the region even if water levels remain constant.
- The potential for future land surface subsidence in the region is high.



Fissures and depressions caused by ground subsidence due to overpumping of groundwater





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