HARRIS-GALVESTON SUBSIDENCE DISTRICT

DETERMINATION OF GROUNDWATER WITHDRAWAL AND SUBSIDENCE IN HARRIS AND GALVESTON COUNTIES – 2021

EXECUTIVE SUMMARY

by
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Harris-Galveston Subsidence District Report 2022-01

Harris – Galveston Subsidence District
Friendswood, TX
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Executive Summary

Groundwater was the primary source of water for the municipal, agricultural, and industrial users over the last century. Rapid increase in population in the 1950s, due to the expansion of the industrial complex in the Houston Ship Channel area, led to a dramatic increase in water demand and groundwater withdrawal. The reliance on groundwater and subsequent subsidence that was caused by its regional development resulted in the creation of the Harris-Galveston Subsidence District (District) in 1975 and the Fort Bend Subsidence District in 1989. The District's mission is to regulate the use of groundwater in Harris and Galveston counties to cease ongoing and prevent future subsidence that can lead to infrastructure damage and contribute to flooding.

This report comprises the 46th Annual Groundwater Report for the District. Pursuant to District Resolution No. 2022-1081 passed on February 9, 2022, the Board of Directors held a public hearing at 10:00 a.m. on April 28, 2022 to present climatic conditions, groundwater use, groundwater levels and measured subsidence within the District through December 31, 2021. This report provides an overview of the information presented during the Public Hearing.

Description of Study Area

Harris and Galveston counties withdraw groundwater from the Gulf Coast Aquifer System which includes two primary water bearing units: the shallow, hydrologically connected, system of the Chicot and Evangeline aquifers and the deeper Jasper aquifer. The regionally confining Burkeville unit separates the shallow and deeper systems. Only a small percentage of the total groundwater withdrawn within the District comes from the Jasper aquifer, consequently, most of the subsidence that has occurred in the District can be sourced to clay compaction in the shallow water bearing units.

The District's Regulatory Plan was developed to reduce groundwater withdrawal to a level that ceases ongoing subsidence and prevents future subsidence within the District. Since 1999, the District has been separated into three regulatory areas (**Figure 1**). Utilizing a novel regulatory approach, the amount of groundwater that may be used by a permittee is dependent upon their total water demand and location within a specific regulatory area. Regulatory Area One permittees can produce groundwater for up to 10% of their total water demand; whereas, Regulatory Areas Two and Three permittees can produce groundwater for up to 20% of their total water demand unless they are in a certified groundwater reduction plan.

The District's Regulatory Plan requires permittees to convert to alternative water supplies in order to reduce their reliance on groundwater sources. The primary alternative water supplies used in the Houston region is surface water sourced from three river basins: the Brazos River Basin, the San Jacinto River Basin and the Trinity River Basin.

In the 1950s, the City of Houston along with other entities in the region began the development of several water supply reservoirs within the San Jacinto and Trinity River Basins to provide water for the rapidly growing region. Today, water treatment plants served by these surface water sources and the Brazos River Basin are operated by the City of Houston, City of Sugar Land, City of Richmond, the Gulf Coast Water Authority, the Brazosport Water Authority, and others.

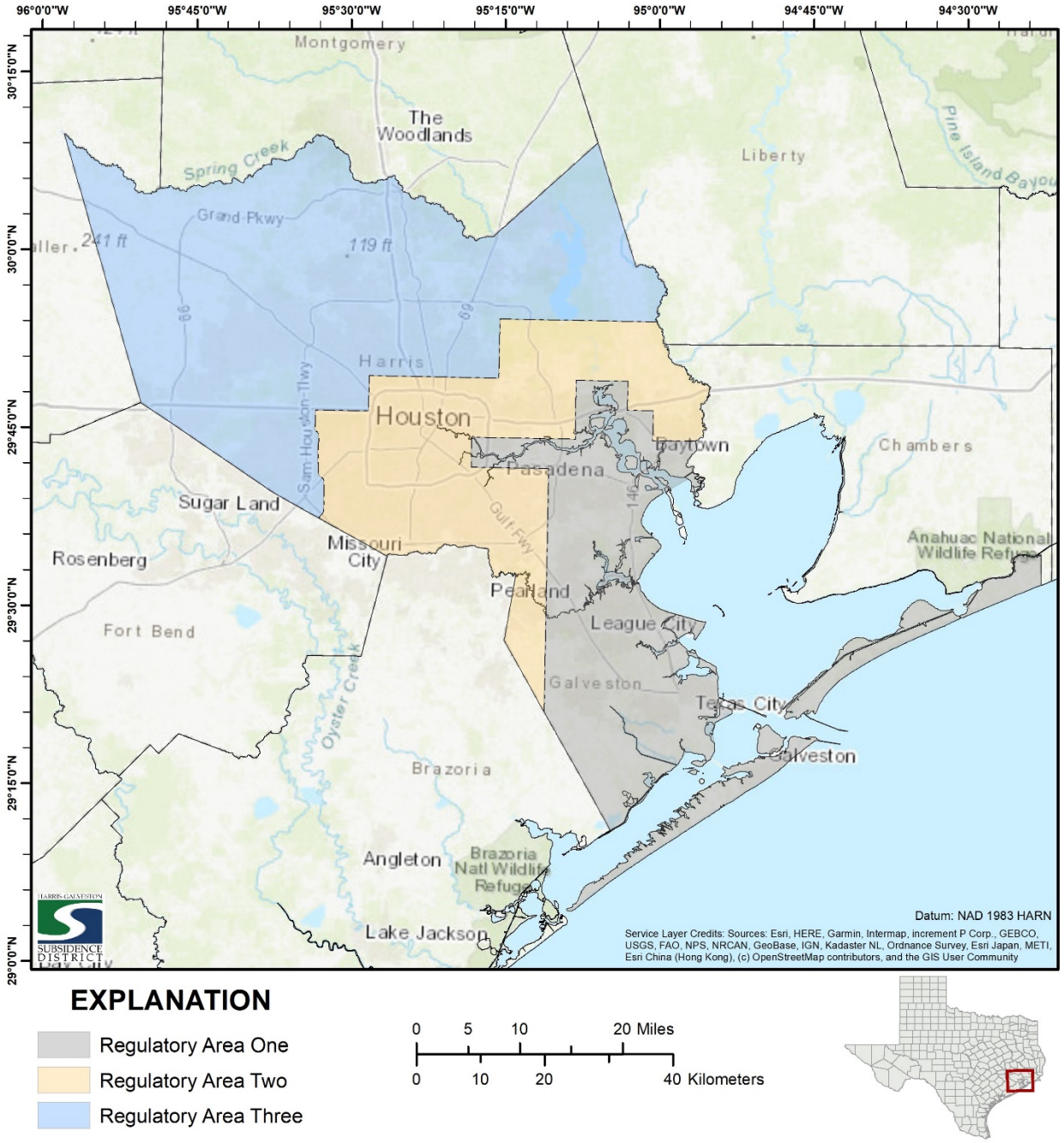

Figure 1. Location of the Harris-Galveston Subsidence District Regulatory Areas.

Climate

Annual variations in precipitation can significantly impact the total water demand in the District. Groundwater use patterns fluctuate during periods of climatic variation, which results in changes in aquifer water-levels and potentially in subsidence rates. During periods of excessive rainfall, total water demand can decline; conversely, during periods of drought, water use can increase resulting in declining water-levels in the aquifer and increased rates of subsidence. **Figure 2** shows the 2021 cumulative precipitation for four (4) climate stations compared against the 1991-2020 normal precipitation level.

The 2022 calendar year began with normal to below normal rainfall accumulations, followed by Winter Storm Uri that resulted in prolonged, record-breaking freezing temperatures and wintry precipitation affecting power grids across the Galveston, Harris, and Fort Bend counties in mid-February. From late spring through summer, the majority of climate stations experienced above normal precipitation alleviating some minor dry conditions in the District. Hurricane Nicholas made landfall as a Category 1 hurricane in southern Harris and Galveston counties in late September bringing several inches of rain and gusty winds. For the remainder of the year, rainfall accumulations averaged above normal for the majority of the District.

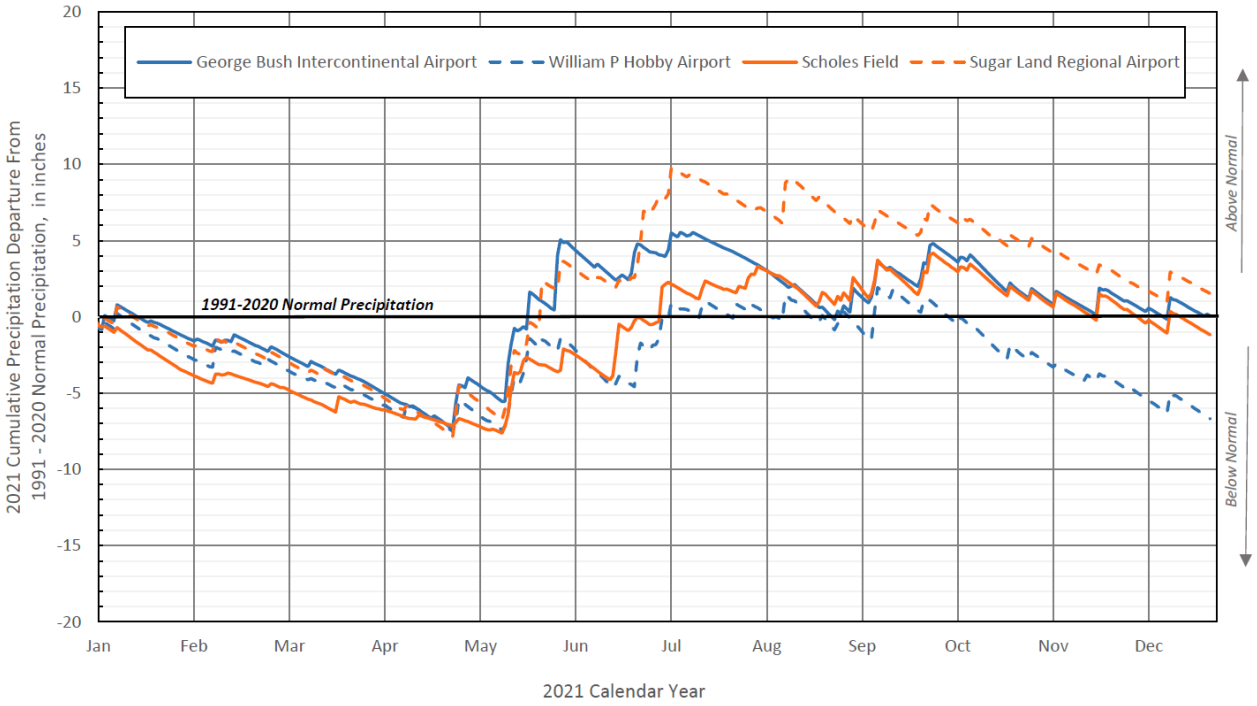

Figure 2. Cumulative precipitation departure, in inches, from 1991-2020 normal precipitation (sourced from https://www.ncei.noaa.gov/data/normals-daily/1991-2020/access/) at selected NOAA-NWS Climate Stations in the Houston region. Individual climate station data are sourced from NOWData – NOAA Online Weather Data accessed via https://www.weather.gov/wrh/Climate?wfo=hgx

Water Use

Since 1976, water users in the District have been working to change their source water from primarily groundwater to alternative sources of water, primarily treated surface water in an effort to prevent subsidence. The percent of total water demand sourced from groundwater has dropped from about 60 percent in 1976 to about 21 percent in 2021. Most of the current groundwater use occurs in Regulatory Area Three where the regulatory compliance timeline will not be completed until 2035. The three-primary water uses in the District are public supply, industrial, and irrigation. The overall groundwater use within the District in 2021 is 203.6 MGD, which is a four percent decrease in pumpage from 2020 (**Figure 3**). Public supply groundwater use remains the largest single use category at 187.2 million gallons per day (MGD), a three percent decrease from 2020, and accounts for 92 percent of groundwater used in the District.

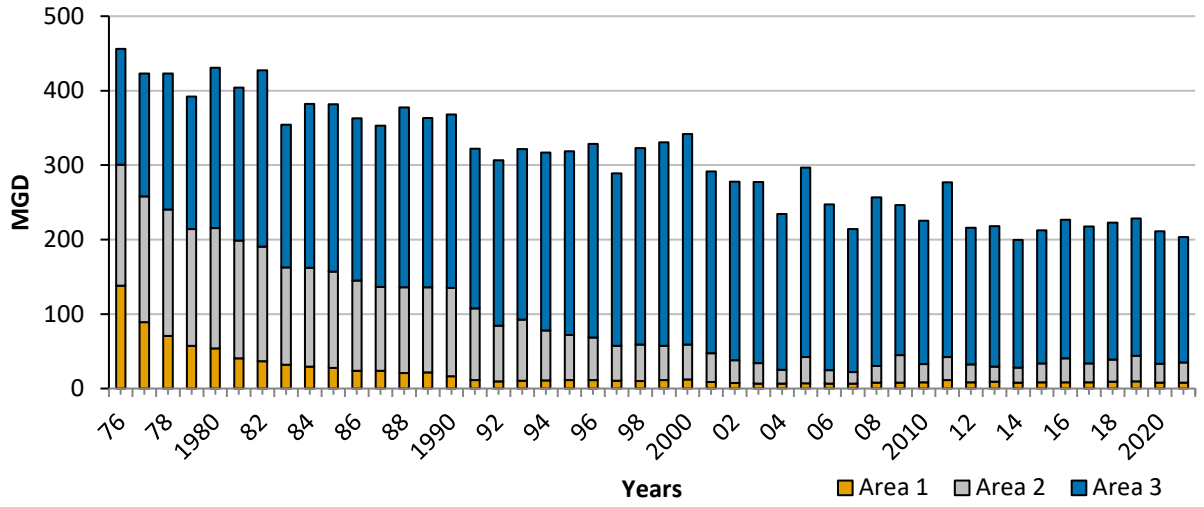

Figure 3. Groundwater withdrawals, in million gallons per day, by regulatory area from 1976 to 2021. In 2021, a total of 7.9 MGD of groundwater was used in Regulatory Area One, with 27 MGD used in Regulatory Area Two and 168.7 MGD used in Regulatory Area Three.

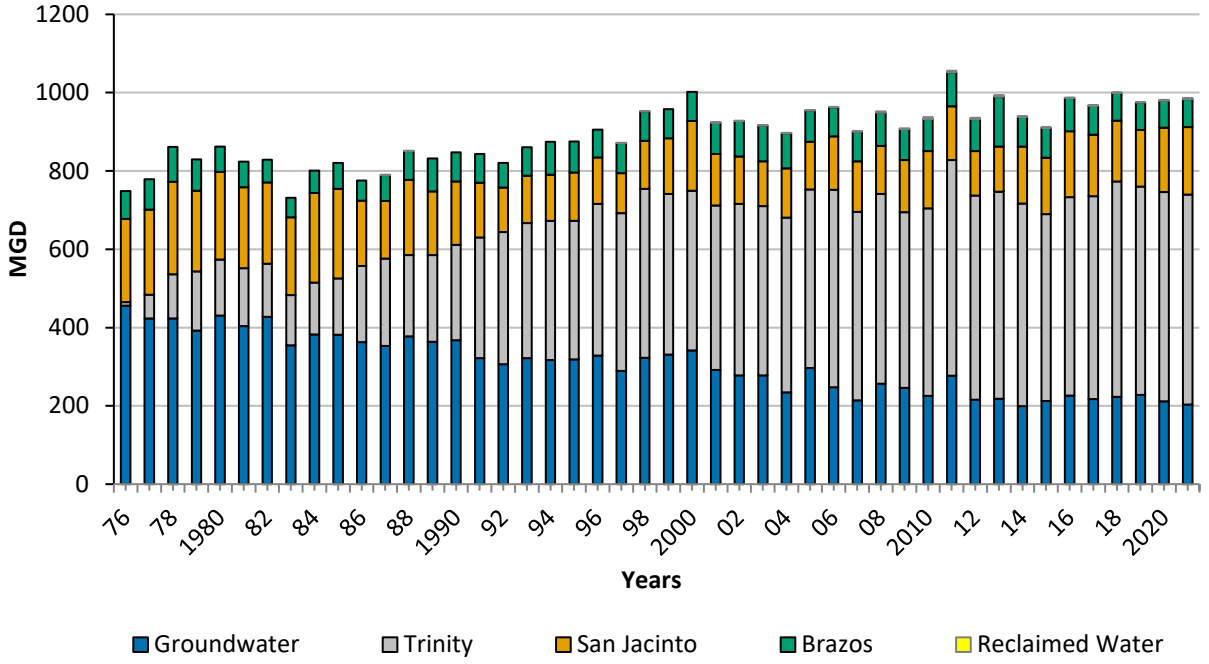

Figure 4. Total water use for the District, in million gallons per day, by source water, from 1976 to 2021. The reported total water use for the District in 2021 was 986.7 MGD.

The District's Regulatory Plan requires permittees to convert to alternative water supplies in order to reduce their reliance on groundwater. The primary alternative water supply used in our region is surface water sourced from three river basins: the Brazos River Basin, the San Jacinto River Basin and the Trinity River Basin. In 2021, the total alternative water use was 783 MGD, with the Trinity River remaining the single largest source of alternative water providing a total of 535.9 MGD in surface water supply. Groundwater remains the second largest source of water supply within the District as a whole. The total

water use for the District was 986.7 MGD in 2021, which is half a percent higher than the reported water use in 2020 (**Figure 4**).

Groundwater Levels

Annually, since 1975, the United States Geological Survey (USGS) has measured the water level in hundreds of wells throughout the Houston region in cooperation with the District through a joint funding agreement along with additional cities, subsidence districts and groundwater conservation districts to monitor and provide reports on groundwater level altitude data for the Chicot/Evangeline and Jasper aquifers. Since aquifer water level is the best measure of the pressure in the aquifer, this information is also of vital importance to understanding the impact of changes in water use on subsidence.

The change in water-level in the Chicot and Evangeline (undifferentiated) aquifers since 1977 clearly shows the impact of District regulation on the aquifers (**Figure 5**). Generally, Regulatory Areas One and Two have seen a significant rise in the potentiometric water-level over 230 feet (70 meters) in the Chicot and Evangeline (undifferentiated) aquifers. The area of rise is a result of the reduction of groundwater use required by the District's Regulatory Plan. Conversely, in Regulatory Area Three and in southern Montgomery County, water-levels continue to be significantly lower than the historical benchmark, declines of over 250 feet (76 meters) in the Chicot and Evangeline (undifferentiated) aquifers. These areas are growing rapidly and the conversion to alternative sources of water will not be completed in the District until 2035.

Subsidence

Since the 1990s, the District has utilized global positioning system (GPS) technology to monitor the land surface deformation in the area. Working collaboratively with University of Houston researchers, the subsidence monitoring network has grown to over 220 GPS stations throughout the region. These stations are operated by the District, the Fort Bend Subsidence District (FBSD), the University of Houston (UH), the Lone Star Groundwater Conservation District (LSGCD), the Brazoria County Groundwater Conservation District (BCGCD), Texas Department of Transportation (TXDOT), and other local entities.

The average annual rate of vertical movement is a useful measure to show current conditions at a GPS station. The 2017 to 2021 subsidence rates are shown in **Figure 6**. The annual rates of subsidence observed in Regulatory Areas One and Two are stable, since both areas have reached their full regulatory conversion level (1990 and 1995, respectively) and Chicot/Evangeline water-levels have risen. Subsidence rates are generally above 0.5 centimeters (cm) per year throughout Regulatory Area Three as groundwater is still the primary source water in this area, and groundwater levels are significantly below the historical benchmarks. Regulatory Area Three is actively developing water infrastructure to reduce groundwater use in those areas by 2025 and 2035 as specified in the District Regulatory Plan.

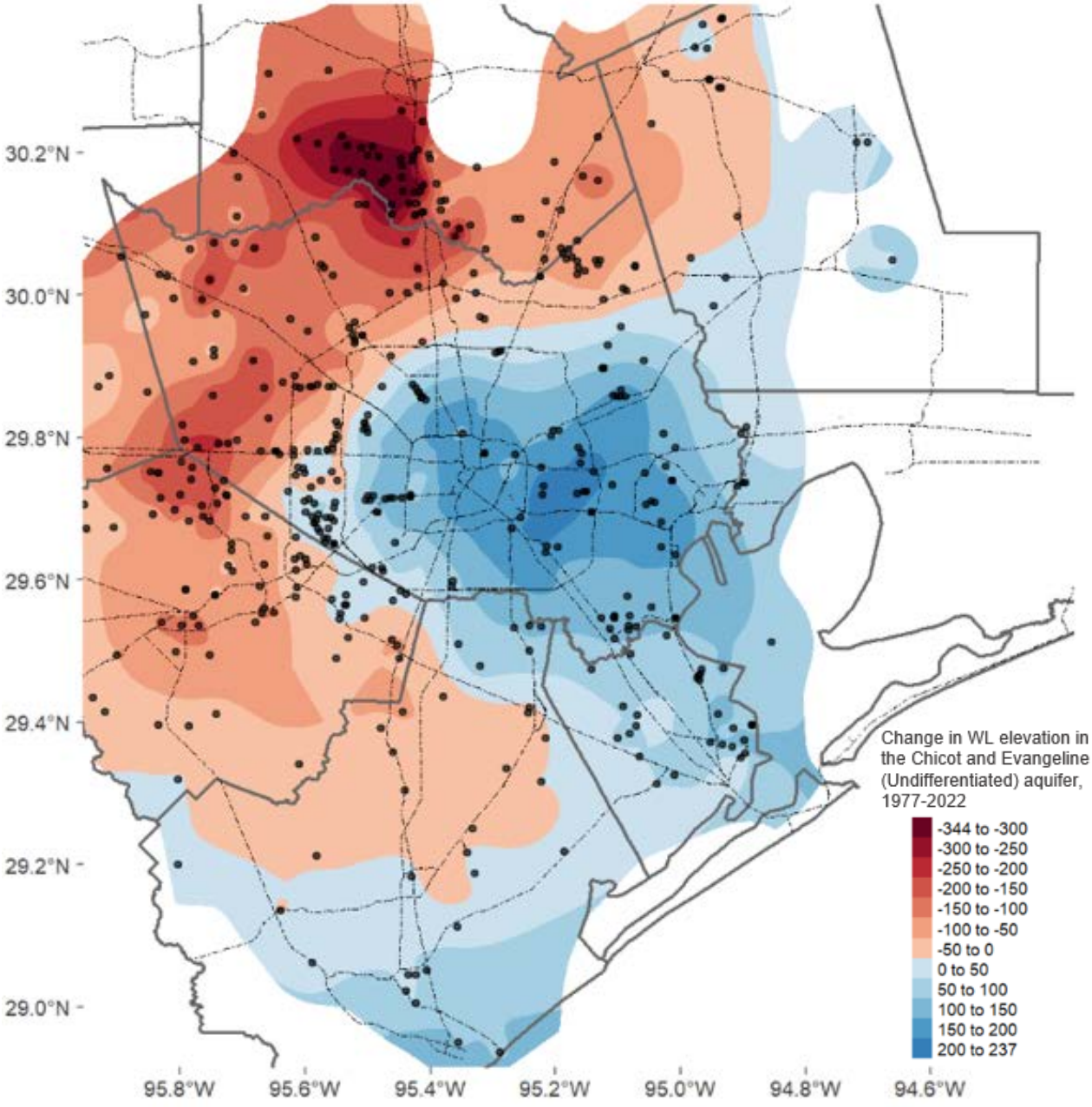

Figure 5. Potentiometric water-level change at wells screened in the Chicot/Evangeline aquifer, Houston region, Texas, 1977 to 2022 (Source: USGS provisional data – preliminary and subject to change).

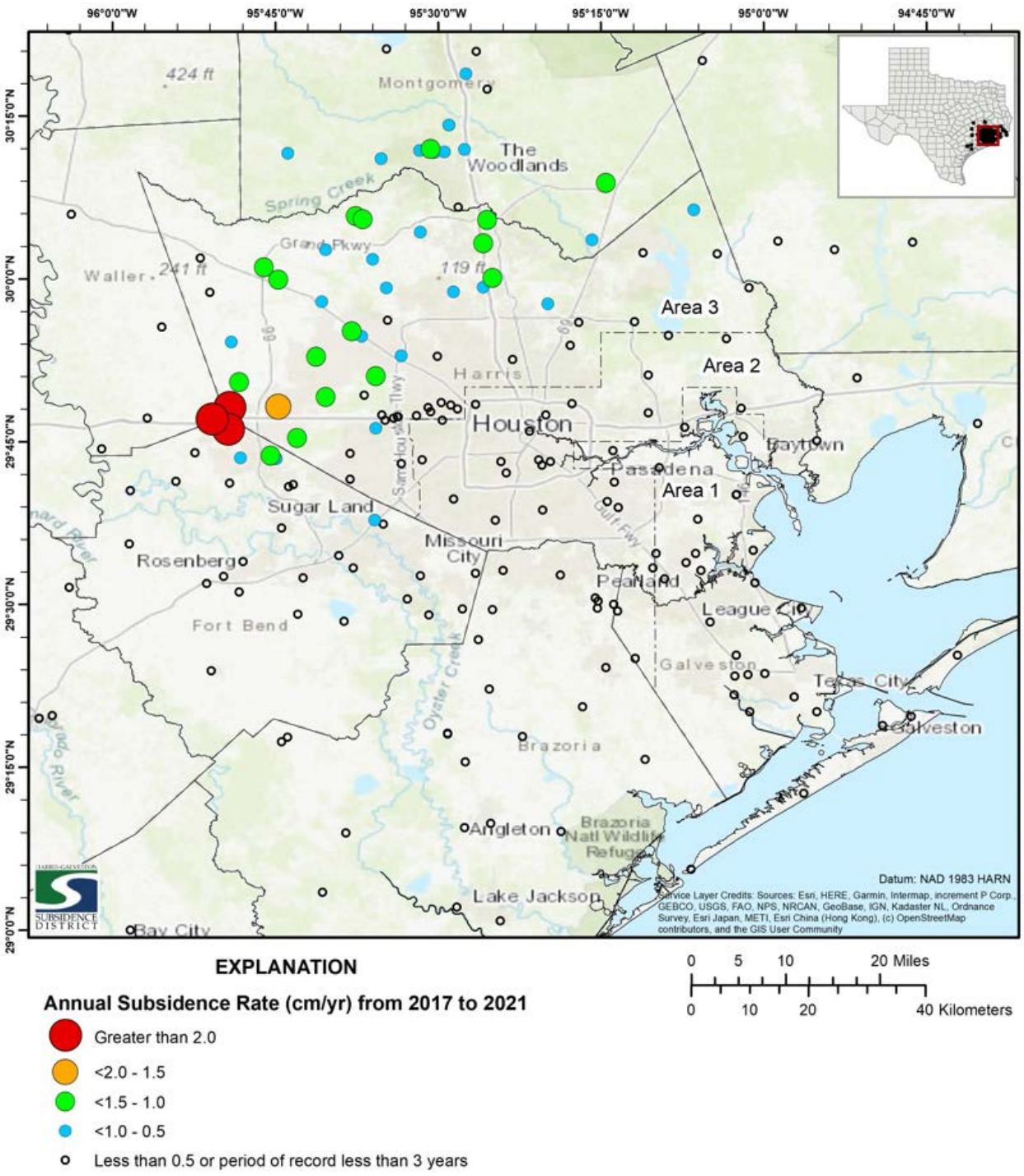

Figure 6. Annual subsidence rate, measured in centimeters per year, from 2017 to 2021, referenced to Houston20 and estimated from three or more years of GPS data collected from GPS stations in Harris and surrounding counties, Texas.