HARRIS-GALVESTON SUBSIDENCE DISTRICT

DETERMINATION OF GROUNDWATER WITHDRAWAL AND SUBSIDENCE IN HARRIS AND GALVESTON COUNTIES – 2020

EXECUTIVE SUMMARY

by
Ashley Greuter, P.G.
Christina Petersen, Ph.D., P.E.

Harris-Galveston Subsidence District Report 2021-01

Harris – Galveston Subsidence District
Friendswood, TX
2021

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 45th Annual Groundwater Report for the District. Pursuant to District Resolution No. 2021-1071 passed on February 10, 2021, the Board of Directors held a public hearing at 9:00 a.m. on April 29, 2021 to present climatic conditions, groundwater use, groundwater levels and measured subsidence within the District through December 31, 2020. 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 Only a small percentage of the total groundwater withdrawn within the District comes from the Jasper aquifer, consequently, most of the subsidence that has occurred in the District can be sourced to clay compaction in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 each of the three regulatory areas. Area 1 permittees can produce groundwater for up to 10% of their total water demand, whereas, Area 2 and Area 3 permittees can produce groundwater for up to 20% of their total water demand unless they are in a certified groundwater reduction plan.

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. The 2020 calendar year started out with normal to below normal rainfall accumulations, followed by Tropical Storm Beta that resulted in heavy rainfall across the Galveston, Harris, and Fort Bend counties flooding roadways, bayous, and creeks in September. Towards the end of the year, rainfall accumulations averaged below normal. Overall, rainfall totals in 2020 were below normal for the majority of the District.

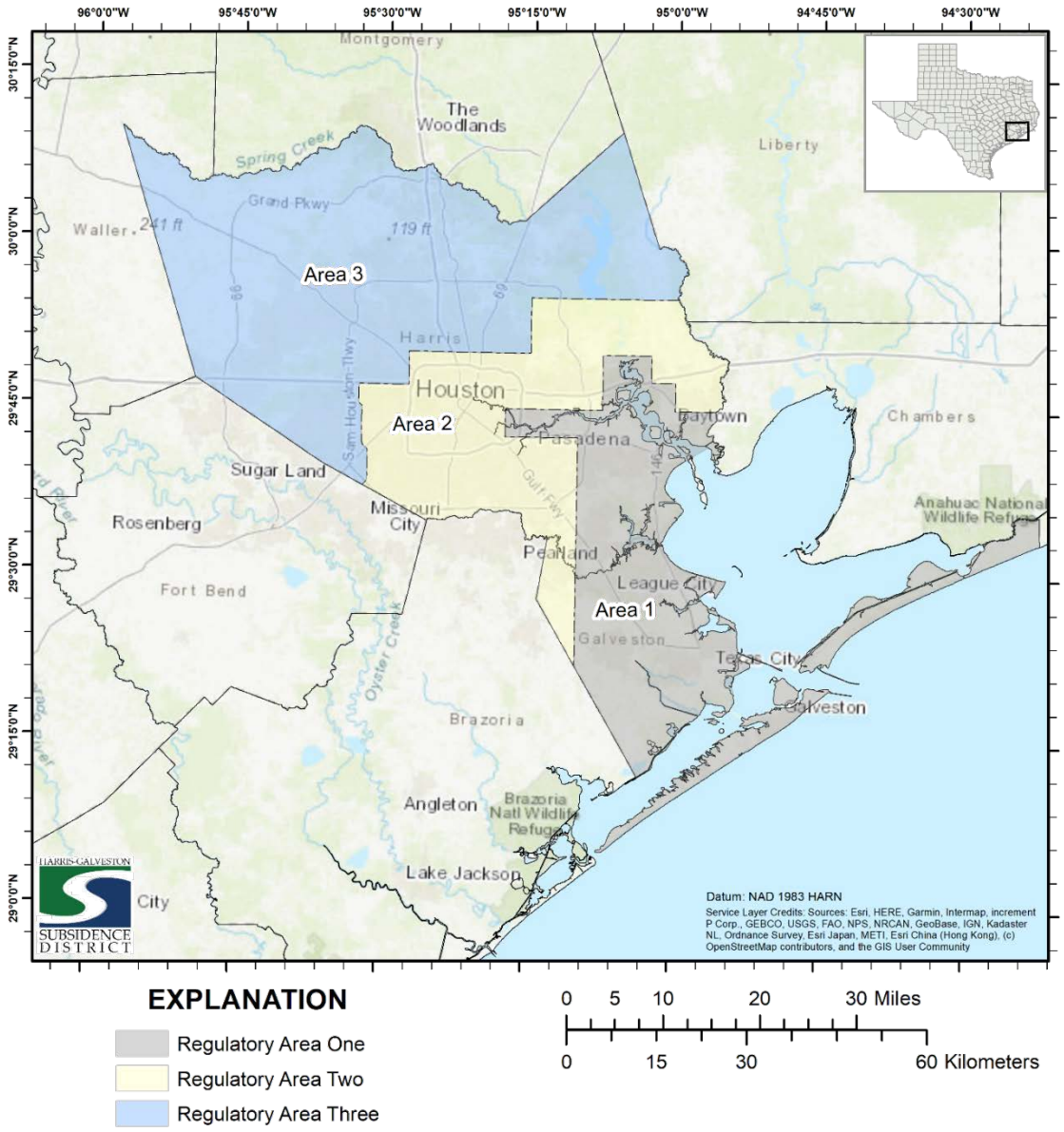

Figure 1. Location of the Harris-Galveston Subsidence District Regulatory Areas.

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 2020 (**Figure 3**). 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 2020 is 208.0 MGD, which is a nine percent decrease in pumpage from 2019 (**Figure 2**). Public supply groundwater use remains the largest single use category at 190.2 million gallons per day (MGD), a nine percent decrease from 2019, and accounts for 91 percent of groundwater used in the District. Since the last regulatory conversion milestone in 2010, public supply and industrial uses are generally unchanged where irrigation uses have decreased by about 48 percent.

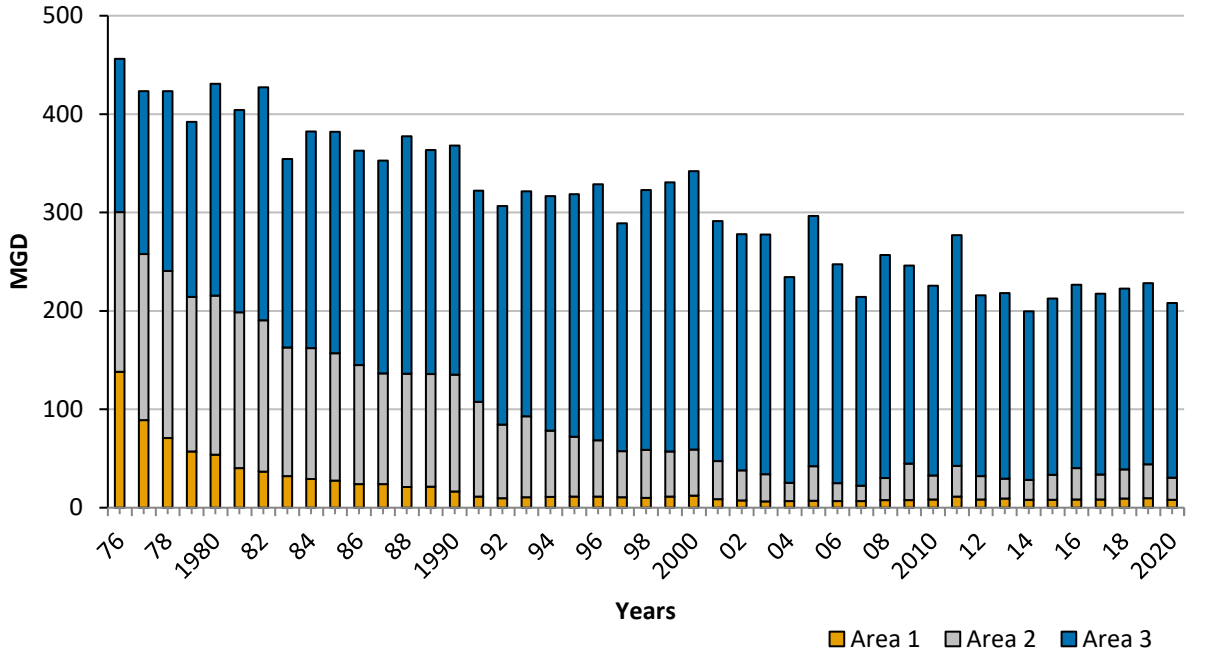

Figure 2. Groundwater withdrawals, in million gallons per day, by regulatory area from 1976 to 2020.

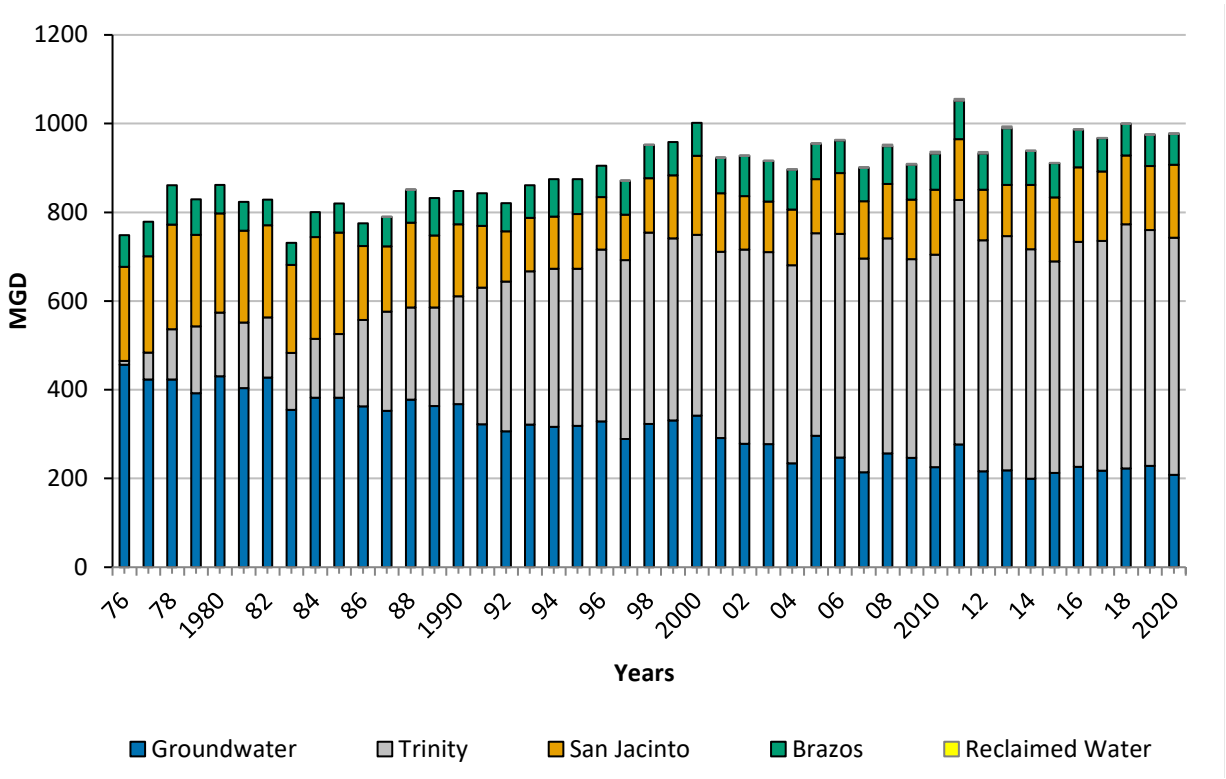

Figure 3. Total water use for the District, in million gallons per day, by source water, from 1976 to 2020. The reported total water use for the District in 2020 was 978.5 MGD.

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 2020, the total alternative water use was 770.5 MGD, with the Trinity River remaining the single largest source of alternative water providing a total of 534.7 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 978.6 MGD in 2020, which is 0.4 percent lower than the reported water use in 2019.

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/Evangeline aquifers since 1977 clearly shows the impact of District regulation on the aquifers (**Figure 4**). Generally, Regulatory Areas One and Two have seen a significant rise in the potentiometric water-level up to 352 feet in the Chicot/Evangeline 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 nearby in southern Montgomery County, water-levels continue to be significantly lower than the historical benchmark, declines of nearly 370 feet in the Chicot/Evangeline aquifers. These areas are growing rapidly and the conversion to alternative sources of water will not be completed in the District until 2035 and in the Fort Bend Subsidence District until 2025.

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 the University of Houston researchers, the subsidence monitoring network has grown to over 250 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 movement is a useful measure to show current conditions at a GPS station. The annual rates of subsidence observed in Regulatory Areas One and Two are generally stable, since both areas have reached their full regulatory conversion level (1990 and 1995, respectively) and Chicot/Evangeline water-levels have risen (**Figure 5**). Subsidence rates are generally above 0.5 centimeters (cm) per year throughout Regulatory Area Three as this area is still undergoing conversion to alternative water supply.

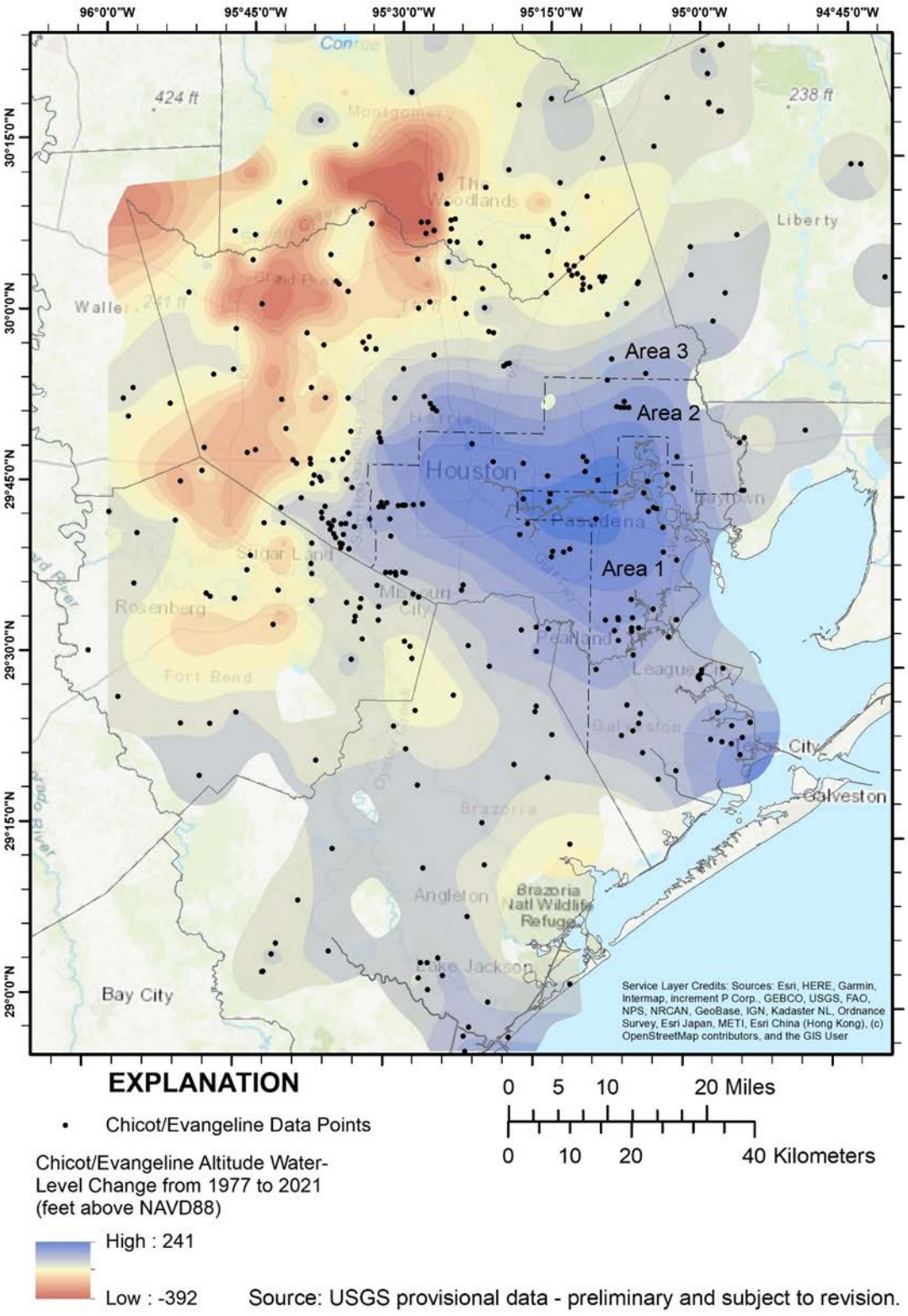

Figure 4. Potentiometric water-level change at wells screened in the Chicot/Evangeline aquifer, Houston region, Texas, 1977 to 2021 (Source: USGS provisional data – preliminary and subject to change).

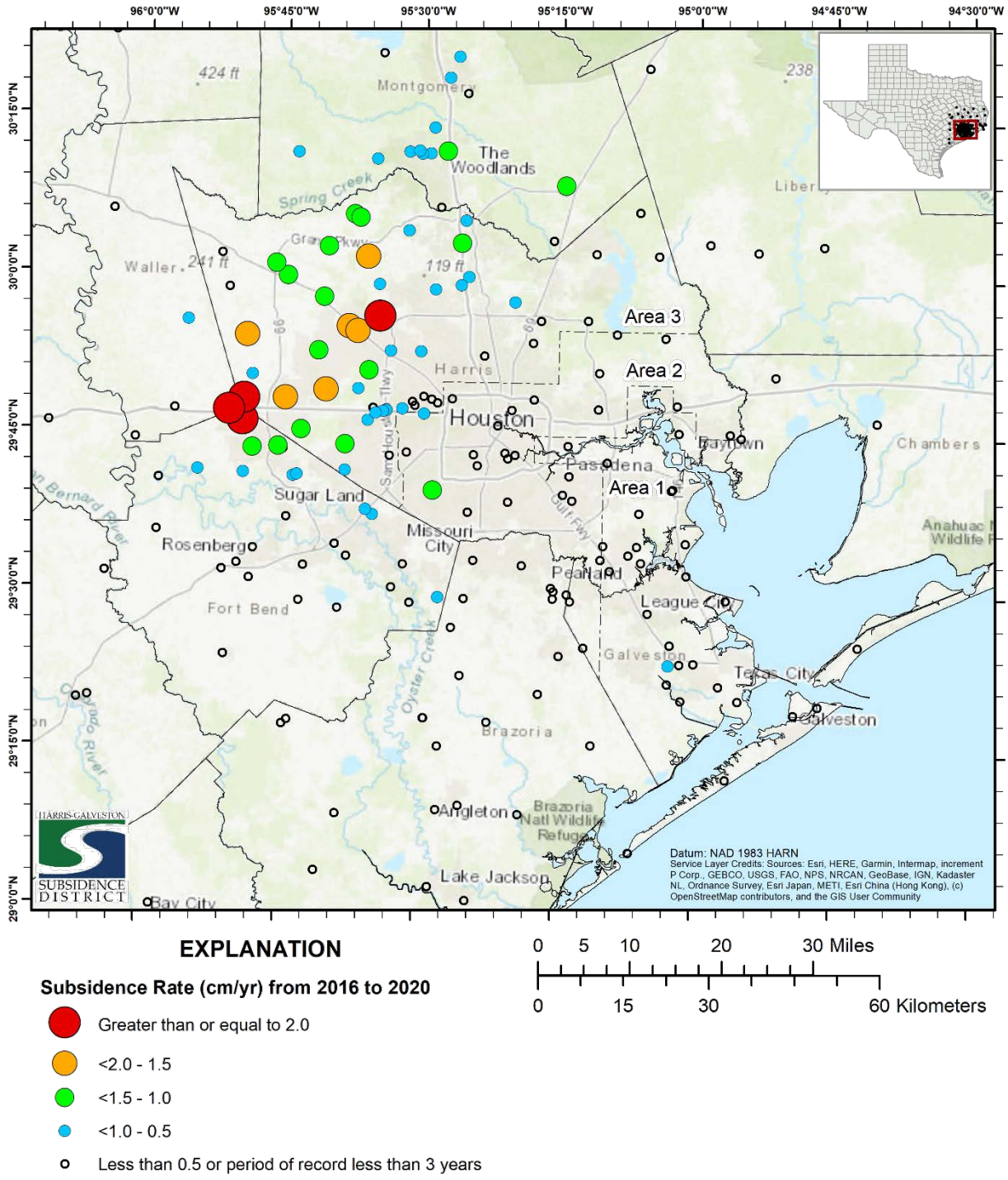

Figure 5. Annual subsidence rate, measured in centimeters per year, referenced to Houston20 and estimated from three or more years of GPS data collected from GPS stations in Harris and surrounding counties, Texas, averaged from 2016 to 2020.