

Water-Level Changes in the High Plains Aquifer, 1980 to 1999

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The High Plains aquifer underlies one of the major agricultural regions in the world, including parts of eight States—Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming. In the High Plains region, the total number of acres irrigated with ground water expanded rapidly after 1940: 1949—2.1 million acres, 1980—13.7 million acres, and 1997—13.9 million acres (Gutentag and others, 1984; Thelin and Heimes, 1987; U.S. Department of Agriculture, 1999). Water-level declines started to occur in the High Plains aquifer soon after the beginning of extensive ground-water irrigation development. The water-level declines in the High Plains aquifer occur because of an imbalance between discharge, the largest component of which is ground-water withdrawals for irrigation, and recharge, which is primarily from precipitation. By 1980, water levels in the High Plains aquifer in parts of southwestern Kansas, New Mexico, Oklahoma, and Texas had declined more than 100 feet (Luckey and others, 1981). In response to these declines, the U.S. Geological Survey, in cooperation with numerous Federal, State, and local water-resource agencies, began a ground-water monitoring program in 1988 to assess annual water-level change in the aquifer using water-level measurements from more than 7,000 wells. The purpose of this report is to present water-level changes in the High Plains aquifer from 1980 to 1999 and from 1998 to 1999. The water-level measurements used in this report were collected in winter or early spring when irrigation wells were not pumping. Map scale and density of water-level data preclude showing small areas in the maps of water-level change where the value may be more or less than indicated.

WATER-LEVEL CHANGES, 1980 to 1999

The pattern of water-level changes in the High Plains aquifer from 1980 to 1999 (fig. 1) is based on water levels from 4,818 wells that were measured in 1980 and 1999 (table 1) and 248 wells in New Mexico that were measured in 1980 and between 1995 and 1998 but not measured in 1999. The two largest areas with more than 60 feet of water-level decline from 1980 to 1999 are an area south of the Canadian River in New Mexico and Texas and an area in southwestern Kansas (fig. 1). The area in New Mexico and Texas had from 50 to 175 feet of water-level decline from predevelopment (about 1950) to 1980, and the area in southwestern Kansas had from 10 to 50 feet of water-level decline from predevelopment to 1980 (Luckey and others, 1981; fig. 1). Areas with 40 to 60 feet of water-level decline from 1980 to 1999 generally are in or adjacent to areas that had more than 50 feet of decline from predevelopment to 1980.

Ninety-nine percent of all water-level changes from 1980 to 1999 are within a rise of 34 feet and a decline of 67 feet. The average area-weighted water level in the High Plains aquifer declined 3.2 feet from 1980 to 1999 compared to a decline of 9.9 feet from predevelopment to 1980 (table 2). In the areas with from 50 to 175 feet of water-level decline from predevelopment to 1980 (figure 1), the average water-level decline from 1980 to 1999 was 26 feet or about 1.4 feet per year. This rate is an estimated average linear rate for 1980 to 1999; because rates of water-level decline increase as the aquifer becomes unsaturated, the rate of decline in these areas in the latter part of this 19-year period may be greater than 1.4 feet per year.

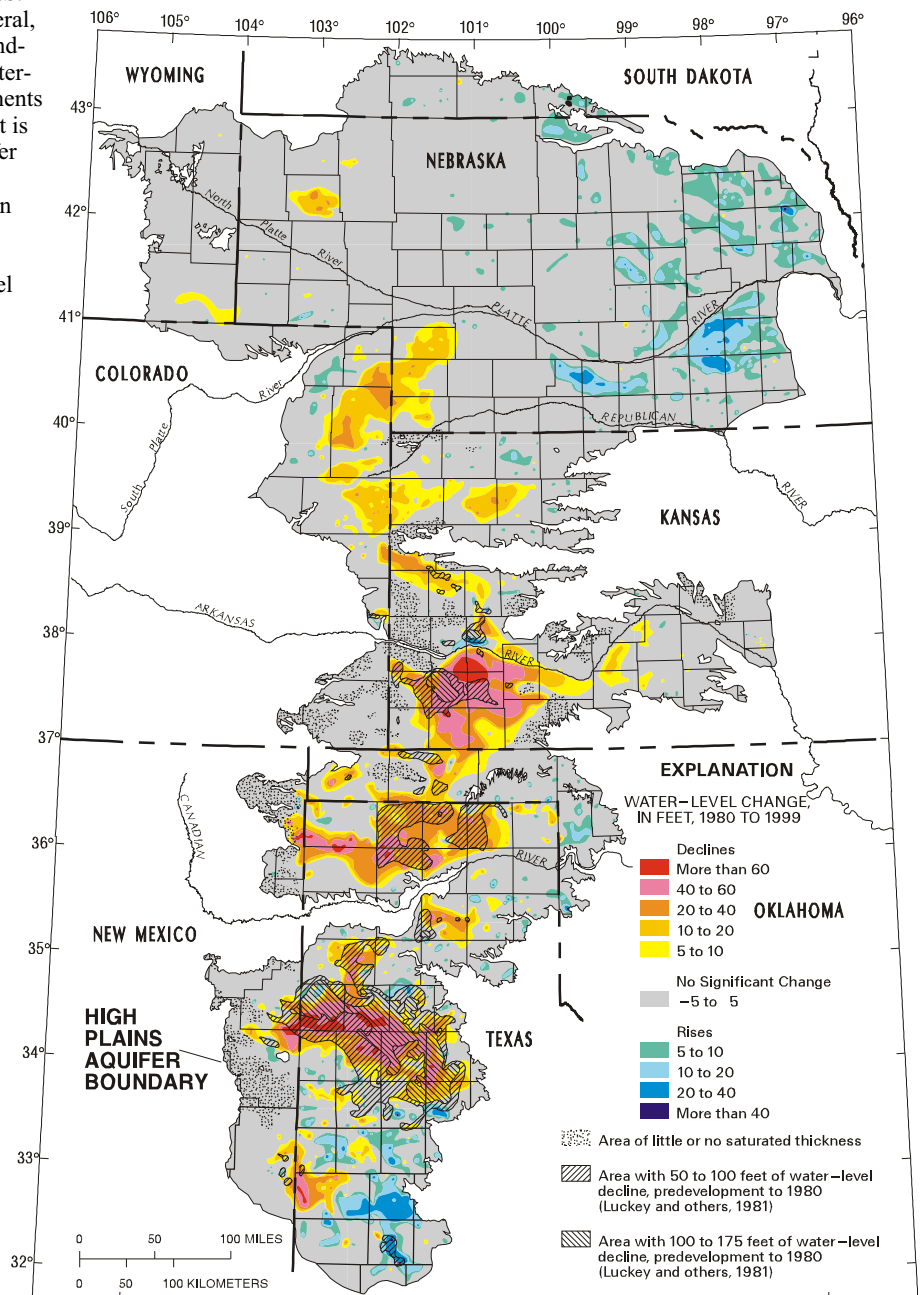


Figure 1. Water-level changes in the High Plains aquifer, 1980 to 1999, and areas with 50 to 100 feet and 100 to 175 feet of water-level decline in the High Plains aquifer, predevelopment to 1980.

Table 1. Number of High Plains aquifer wells measured for 1999 and used for the water-level comparison periods 1980 to 1999 and 1998 to 1999

State	Wells measured for 1999	Wells used in water-level comparison periods	
		1980 and 1999	1998 and 1999
Colorado	571	485	554
Kansas	1,274	740	1,223
Nebraska	3,608	1,830	3,484
New Mexico	24	18	20
Oklahoma	243	135	196
South Dakota	112	72	111
Texas	2,554	1,524	2,217
Wyoming	54	14	42
High Plains	8,440	4,818	7,847

WATER-LEVEL CHANGES, 1998 to 1999

Ninety-nine percent of all water-level changes from 1998 to 1999 were within a rise of 8 feet and a decline of 11 feet. The average area-weighted water-level in the High Plains aquifer declined 0.25 foot from 1998 to 1999 (table 2) based on 1998 and 1999 measurements from 7,847 wells (table 1). The average area-weighted water-level change in the High Plains aquifer from 1998 to 1999 by State ranged from a rise of 1.01 feet in South Dakota to a decline of 1.49 feet in Texas (table 2). Water-level declines of more than 3 feet are common in southwestern Kansas and in much of the Texas Panhandle (fig. 2); these areas generally are in areas where there was greater than 40 feet of water-level decline from 1980 to 1999 (fig. 1).

Table 2. Average area-weighted water-level changes in the High Plains aquifer, predevelopment to 1980, 1980 to 1999, and 1998 to 1999

State	Average area-weighted water-level change			
	Predevelopment (1950) to 1980		1980 to 1999	1998 to 1999
	Water-level change ¹ (ft)	Rate of change (ft/yr)	Water-level change (ft)	Water-level change (ft)
Colorado	-4.2	-0.14	-6.2	-0.24
Kansas	-9.9	-0.33	-8.4	-0.39
Nebraska	0	0	+2.6	-0.49
New Mexico	-9.8	-0.33	-5.1	-1.03
Oklahoma	-11.3	-0.38	-4.6	-0.57
South Dakota	0	0	+3.1	+1.01
Texas	-33.7	-1.12	-8.9	-1.49
Wyoming	0	0	-3.2	-0.15
High Plains	-9.9	-0.33	-3.2	-0.25

¹Lucky and others (1981).

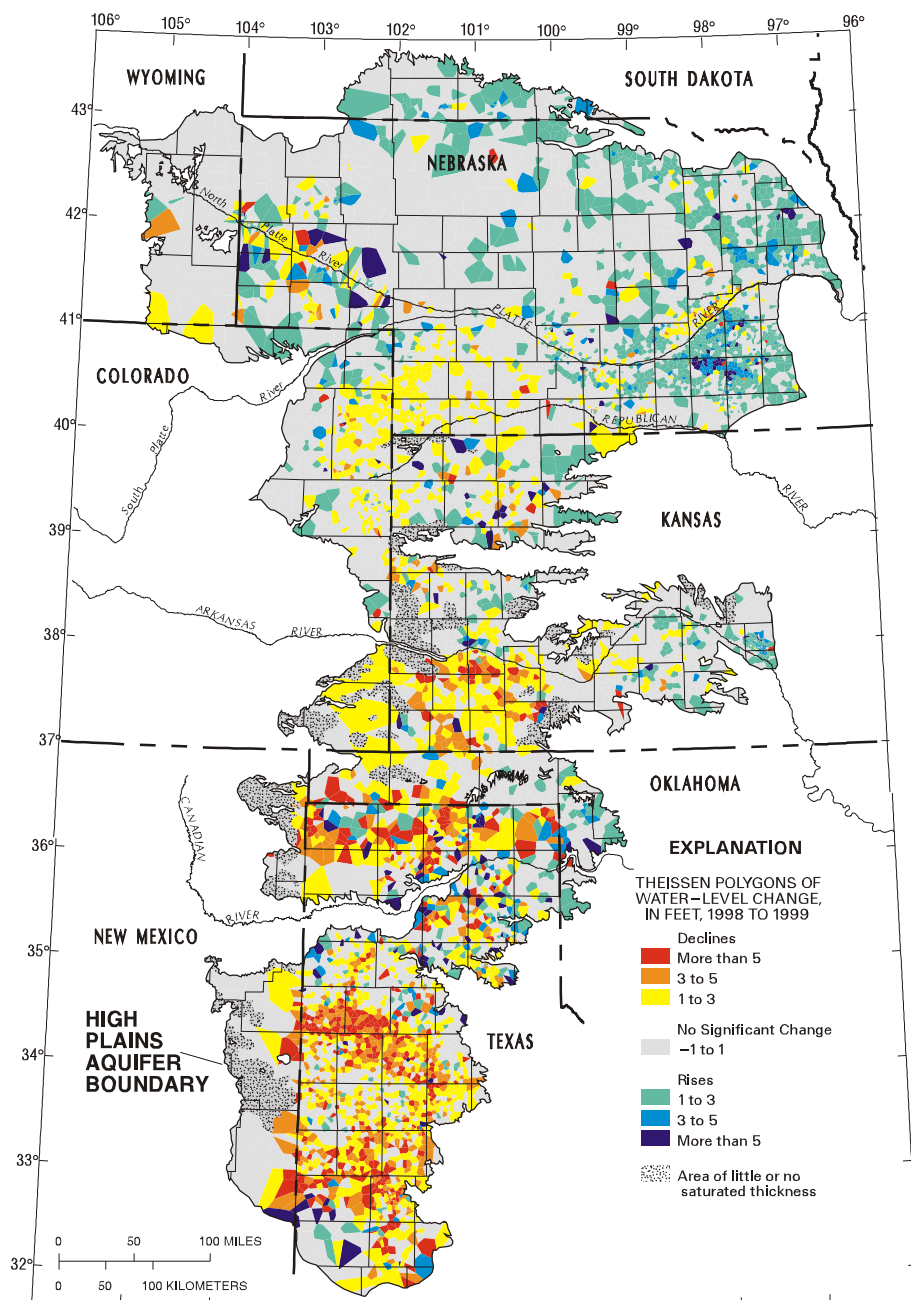


Figure 2. Generalized water-level changes in the High Plains aquifer, 1998 to 1999.

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