Regional Nitrate and Pesticide Trends in Ground Water in the Eastern San Joaquin Valley, California

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Protection of ground water for present and future use requires monitoring and understanding of the mechanisms controlling long-term quality of ground water. In this study, spatial and temporal trends in concentrations of nitrate and pesticides in ground water in the eastern San Joaquin Valley, California, were evaluated to determine the long-term effects of agricultural and urban development on regional ground-water quality. Trends in concentrations of nitrate, the nematocide 1,2-dibromo-3-chloropropane, and the herbicide simazine during the last two decades are generally consistent with known nitrogen fertilizer and pesticide use and with the position of the well networks in the regional ground-water flow system. Concentrations of nitrate and pesticides are higher in the shallow part of the aquifer system where domestic wells are typically screened, whereas concentrations are lower in the deep part of the aquifer system where public-supply wells are typically screened. Attenuation processes do not seem to significantly affect concentrations. Historical data indicate that concentrations of nitrate have increased since the 1950s in the shallow and deep parts of the aquifer system. Concentrations of nitrate and detection of pesticides in the deep part of the aquifer system will likely increase as the proportion of highly affected water contributed to these wells increases with time. Because of the time of travel between the water table and the deep part of the aquifer system, current concentrations in public-supply wells likely reflect the effects of 40- to 50-yr-old management practices.

In 2000, ground water provided 37% of the public drinking water supplies used by 242 million people in the USA (Hutson et al., 2004). Dependence on ground water for public supply has increased fivefold over the last 50 yr, causing increased concern about the sustainability of the quality of water pumped by public-supply wells. Ground-water withdrawals from the Central Valley Principal aquifer are the second largest in the USA, accounting for 13% of total withdrawals (Maupin and Barber, 2005). Irrigation is the dominant water use, and most of the population and ground-water use in the Central Valley is in the eastern San Joaquin Valley, where intensive farming and rapid population growth are expected to increase reliance on ground water.

Widespread occurrence of nitrate and pesticides in ground water at concentrations of concern affects rural and public drinking water supplies in the eastern San Joaquin Valley (Schmidt, 1972; Miller and Smith, 1976; Nightingale and Bianchi, 1974; Schmidt, 1986, 1987; Burow et al., 1998a; Harter et al., 1998; Loague et al., 1998a, 1998b; Loague and Abrams, 1999). In shallow ground water, concentrations of nitrate exceeded the U.S. Environmental Protection Agency's maximum contaminant level (MCL) of 10 mg L^{-1} in 24% of wells sampled during 1993–95 (Dubrovsky et al., 1998), and the Central Valley is one of the top three regions in the state in the number of public drinking water wells in which the MCL for nitrate is exceeded (California State Water Resources Control Board, 2002b). Elevated concentrations of nitrate in ground water in the eastern San Joaquin Valley are expected to persist over the long term, owing to continued anthropogenic nitrogen inputs and generally oxic geochemical conditions. Pesticides were detected in 61% of wells sampled during 1993–95 in shallow ground water in the eastern San Joaquin Valley. Two of the most frequently detected pesticides, simazine and 1,2-dibromo-3-chloropropane (DBCP), were detected in 35 and 24% of the wells, respectively (Dubrovsky et al., 1998). Although concentrations of simazine were generally low (<1 μg L^{-1}), DBCP persists in ground water in this region at concentrations above the MCL of 0.2 μg L^{-1}, posing a threat to drinking water supplies more than 25 yr after it was banned from use (California State Water Resources Control Board, 2002a).

Protection of ground water for present and future use requires monitoring and understanding of the mechanisms controlling long-term quality of ground water. Some studies have analyzed data on temporal trends in concentration of nitrate and pesticides in the eastern San Joaquin Valley (Nightingale, 1970; Schmidt, 1972; California State University Fresno Foundation, 1994; Kloos, 1996; Burow et al.,

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Abbreviations: USGS, United States Geological Survey; NAWQA, National Water-Quality Assessment; MCL, U.S. Environmental Protection Agency Maximum Contaminant Level; DBCP, 1,2-dibromo-3-chloropropane; DHS, California Department of Health Services.