Data Related Uncertainty in Near-Surface Vulnerability Assessments for Agrochemicals in the San Joaquin Valley

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Precious groundwater resources across the United States have been contaminated due to decades-long nonpoint-source applications of agricultural chemicals. Assessing the impact of past, ongoing, and future chemical applications for large-scale agriculture operations is timely for designing best-management practices to prevent subsurface pollution. Presented here are the results from a series of regional-scale vulnerability assessments for the San Joaquin Valley (SJV). Two relatively simple indices, the retardation and attenuation factors, are used to estimate near-surface vulnerabilities based on the chemical properties of 32 pesticides and the variability of both soil characteristics and recharge rates across the SJV. The uncertainties inherit to these assessments, derived from the uncertainties within the chemical and soil data bases, are estimated using first-order analyses. The results are used to screen and rank the chemicals based on mobility and leaching potential, without and with consideration of data-related uncertainties. Chemicals of historic high visibility in the SJV (e.g., atrazine, DBCP [dibromochloropropane], ethylene dibromide, and simazine) are ranked in the top half of those considered. Vulnerability maps generated for atrazine and DBCP, featured for their legacy status in the study area, clearly illustrate variations within and across the assessments. For example, the leaching potential is greater for DBCP than for atrazine, the leaching potential for DBCP is greater for the spatially variable recharge values than for the average recharge rate, and the leaching potentials for both DBCP and atrazine are greater for the annual recharge estimates than for the monthly recharge estimates. The data-related uncertainties identified in this study can be significant, targeting opportunities for improving future vulnerability assessments.

Everything should be made as simple as possible, but not simpler.
—attributed to Albert Einstein

There’s no such thing as a free lunch.
—Milton Friedman

The challenge of assessing groundwater vulnerability at the regional scale due to nonpoint-source agrochemical applications is not a trivial one (Corwin et al., 1997, 1999). The use of simple mobility–leaching indices to generate assessments of subsurface vulnerability provides information that can be useful within the decision-management arena. These assessments rest on chemical, soil, and recharge data that are sparse and, therefore, contain uncertainty.

The ~12,000-km² San Joaquin Valley (SJV) is the regional-scale system of interest in this study. Located at the southern end of California’s Central Valley (Fig. 1), the SJV is a structural basin filled with thousands of meters of sedimentary material creating a nearly flat alluvial plain (Loague et al., 1998b). The soils on the more fertile eastern side of the SJV are derived from the granitic Sierra Nevada, with large areas of wind-deposited sands underlain by deep coarse-textured alluvial material (National Research Council, 1993). The sediments of the SJV tend to be interlayered gravel, sand, silt, and clay derived from the surrounding mountains and deposited in alluvial-fan, floodplain, flood basin, lacustrine, and marsh environments (Domagalski, 1998). As a direct result of large-scale irrigation infrastructure and agrochemical use, the SJV has produced a significant fraction of the food grown in North America for decades. The availability of precious groundwater resources in the SJV is well documented (e.g., Belitz, 1988; Faunt, 2009). The impacts from agrochemicals to groundwater quality within the SJV have received considerable attention (e.g., Holden, 1986; Smith, 1989; Domagalski and Dubrovsky, 1992; National Research Council, 1993; Barbash and Resek, 1996; Burow et al., 1998a,b, 1999, 2007).

There are now excellent regional-scale examples that illustrate the spatial variability of information and response for the near surface (e.g., Lemieux et al., 2008; Gleeson et al., 2011a,b). The...