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TEMPORAL CHANGES IN GROUNDWATER CONCENTRATIONS OF PESTICIDES AND NITRATE, AND THEIR RELATION TO REGIONAL AGRICHEMICAL USAGE PATTERNS AND OTHER POTENTIAL CONTROLLING FACTORS

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Current understanding of temporal variability of pesticides in groundwater is limited by the sparsity of long-term, repeat monitoring records. Monitoring records from a well network in Florida's "ridge" citrus croplands, a region underlain by sandy soils prone to pesticide leaching, exhibited both short-term variability and long-term trends in agrichemical concentrations. The monitoring network included wells screened in a surficial aquifer in citrus orchards and in non-citrus land use where water-table depths ranged from 1.5 to 30 m below land surface. Sampling occurred during 1990 through 2010, with quarterly to semi-annual sampling during 1999-2010. This period included changes in agrichemical management practices consisting of the discontinued use of bromacil (to protect water quality), and the increased usage of several pesticides (to replace discontinued chemicals, or to combat the widespread recent onset of citrus greening disease). In citrus areas, nitrate (as N) concentrations in groundwater typically exceeded 10-15 mg/L, and the most frequently detected pesticides in recent years included norflurazon (and its degradate desmethyl norflurazon), imidacloprid, the aldicarb degradates aldicarb sulfone and sulfoxide, diuron, bromacil, and simazine. Some changes in pesticides detected during the monitored period, as well as changes in their detection frequencies, appeared to reflect relatively rapid response to changes in usage patterns. Compared to non-citrus areas, the groundwater underlying citrus areas contained higher concentrations of nitrate and pesticides, as well as several inorganic agrichemical constituents (Ca, Mg, Cl, SO_4, K). Significant short-term variability in concentrations of some pesticides, such as aldicarb and its degradates, occurred at some locations; other pesticides, such as norflurazon, often exhibited more uniform trends. In a number of wells, temporal patterns in nitrate concentrations, and in some pesticide concentrations to a lesser degree, mirrored changes in chloride concentrations in groundwater, suggesting similarity in the availability of source inputs and in transport of these chemicals. Collectively, the observed changes in pesticide concentrations in samples from the network wells indicated the persistence of some chemicals within the groundwater system; temporal concentration patterns characteristic of specific pesticides; temporal changes in the pesticide mixtures detected; long-term trends in concentrations of some pesticides, and the episodic occurrence of others.

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