Invited Talk

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# Understanding groundwater response to human- and climate-induced stresses: High Plains Aquifer, United States

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## Abstract
The High Plains (or "Ogallala") aquifer underlies about 450,700 $km^2$ in the semi-arid west-central United States (US). The aquifer has profound importance for US agriculture, providing water for 27 percent of the irrigated land in the US, and supplying about 30 percent of the groundwater used for irrigation in the US. Human-induced stresses on groundwater, in the form of withdrawals of water from the aquifer for irrigation and agrichemical use, have resulted in water-table declines greater than 30 meters in some areas and widespread elevated nitrate and pesticide concentrations in groundwater. This has raised questions about resource sustainability and health concerns for nearly 2 million people who rely on the aquifer as a source of drinking water. Research is beginning to focus on interannual to interdecadal natural climatic variability that can augment or diminish human-induced stresses on groundwater availability and quality. The interaction between these climate cycles produces a cumulative climate variability that, for example, affects the distribution of precipitation and, in turn, affects water needs for irrigation, recharge, and agrichemical flux to groundwater. Groundwater can respond dramatically when climate variability from different cycles lie coincident in a positive (wet) or negative (dry) phase of variability. This presentation provides results from field and modeling studies by the U.S. Geological Survey that build a conceptual understanding of water quantity and quality responses in the unsaturated zone and groundwater to spatial and temporal variability of human- and natural climate-induced stresses. Focus is placed on changes in recharge rates, water levels, chemical fluxes, and groundwater vulnerability in response to historical and present-day stresses from human activity and natural climate variability. Process-based understanding of the complex relation between human-induced stresses and natural-climate variability and groundwater system response is challenging, but is a necessary step toward better simulating groundwater system response under future global-climate-change scenarios.