Preface
Theme issue on groundwater recharge

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Groundwater recharge is a critical hydrological parameter that, depending on the application, may need to be estimated at a variety of spatial and temporal scales. Quantification of water fluxes from the atmosphere to underlying aquifers is important for global water budgets. Aquifer-scale recharge estimates are essential to water-resource assessment and management, whereas local-scale recharge is critical to assessment of groundwater contamination from point sources. Estimation of recharge may be required on temporal scales ranging from days (for recharge of dynamic karst aquifers and for contaminant transport) to thousands of years (for identifying sites appropriate for disposal of radioactive waste). Water resources are being managed much more aggressively now. As aquifers are depleted, recharge estimates have become more essential in determining appropriate levels of groundwater withdrawal. Estimation of recharge is also becoming more important for contaminant transport, as aquifer management expands from cleanup of existing contamination to aquifer protection by delineation of areas of high recharge.

The collection of papers in this volume covers a wide range of issues related to groundwater recharge. The paper by de Vries and Simmers (2002) provides a broad overview of recharge processes, which is important for quantification of recharge. Bouwer (2002) includes a comprehensive review of artificial recharge and pertinent issues related to its design and implementation. Artificial recharge will probably become more prevalent because it can be used to buffer against climatic variability and associated floods and droughts and because the water demands of large populations are expected to continue to increase. Bohlke, (2002) demonstrates how information on recharge rates can be used to quantify past variations in nitrate loading from agricultural contamination. Sophocleous (2002) outlines the mechanisms of interactions between groundwater and surface water as they affect recharge–discharge processes, and he emphasizes the ecological significance and human impacts of such interactions.

Many of the papers focus directly or indirectly on techniques for quantifying groundwater recharge. The science of remote sensing has advanced appreciably in the last century with improvements in technology and analysis. Jackson (2002) reviews the potential for remote sensing in quantifying groundwater recharge on a large scale through measurements of soil moisture and water-balance modeling. Scanlon and others (2002) examine techniques and their applicable space and time scales for quantifying recharge. The theoretical background, uncertainties, and applications of well-bore hydrograph analysis for inferring groundwater recharge are reviewed by Healy and Cook (2002). Sanford (2002) provides an overview of the limitations of some traditional groundwater modeling approaches for estimating recharge and emphasizes the need for additional information from groundwater-flow and tracer data to constrain recharge estimates. Walker and others (2002) review the use of soil–vegetation–atmosphere transfer models of varying complexity to simulate groundwater recharge and relate recharge to soil properties and land use in Australia. There, recharge management is a priority as part of an effort to address dryland salinity.

Topical issues related to groundwater recharge are discussed in several papers. Lerner (2002) reviews techniques for identifying and quantifying urban recharge. Three case studies are presented that describe recharge in arid settings. Flint and others (2002) describe a wide variety of approaches, including physical, chemical, and modeling techniques, for quantifying recharge at Yucca Mountain, Nevada, USA, which is the proposed site for disposal of high-level radioactive waste in the US. Edmunds and others (2002) evaluate spatial and temporal variability in recharge in northern Nigeria using chloride. Edmunds and Tyler (2002) review the ability of natural and isotopic tracers in unsaturated-zone moisture profiles to reconstruct recharge history and paleoclimatic or paleobotanical conditions over time scales ranging from 20–120,000 years using data from North America

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and Africa. Lewis and Walker (2002) discuss variability of recharge over shorter time frames and examine the importance of episodic recharge in aquifers in Western Australia.

Increasing demand for recharge estimates is forcing the research community to develop approaches for building a more thorough understanding of recharge and more comprehensive approaches for delineating recharge zones and quantifying recharge rates that reduce uncertainties and increase confidence in recharge estimates.

Keywords Groundwater recharge · Groundwater management · Field techniques

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