frontiers | Frontiers in Water

TYPE Editorial
PUBLISHED 21 April 2023
DOI 10.3389/frwa.2023.1197829

OPEN ACCESS

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RECEIVED 31 March 2023
ACCEPTED 06 April 2023
PUBLISHED 21 April 2023

CITATION
Hanich L, Leblanc M and Fakir Y (2023) Editorial: Groundwater recharge in drylands. *Front. Water* 5:1197829. doi: 10.3389/frwa.2023.1197829

Editorial: Groundwater recharge in drylands

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KEYWORDS

groundwater recharge, water resources, climate change, hydrological system, modeling

Editorial on the Research Topic
Groundwater recharge in drylands

Groundwater is a critical resource in arid, semi-arid, and dry sub-humid areas with limited surface water sources. However, rising demand from population growth, tourism, urbanization, and expanding agricultural land under irrigation has resulted in excessive withdrawals, leading to groundwater depletion in many areas. Furthermore, climate change has complicated matters, with significant uncertainty in recharge projections.

Precipitation in drylands is highly scarce, with only a small proportion contributing to groundwater recharge on a decadal to annual scale. Groundwater recharge estimation techniques developed for humid climates are not always applicable in these regions. To quantify groundwater recharge in drylands, new, innovative, and adapted methods are required.

It has been widely assumed that as climate change occurs, drylands will become drier, resulting in a further decrease in groundwater recharge. Recent research, however, has shown that this assumption is much less specific. Warming can increase precipitation and affect the timing and magnitude of dryland recharge. Improving our understanding of groundwater recharge, its sources, hydrogeological processes, spatial and temporal variability, and evolution under global change is critical to ensuring the long-term management of dryland water resources.

Dryland groundwater management challenges are complex, and novel approaches are required to address them. One possible solution is to create region-specific models that incorporate local hydrogeological processes and account for the effects of climate change on recharge patterns. Another strategy is to invest in data collection and monitoring networks to provide better decision-making information.

The goal of this topic collection is to integrate the most recent developments in the understanding, measuring, monitoring, modeling, and management of groundwater recharge in drylands and under climate change.

Four articles make up this Research Topic. In their work, Henry et al. use interpretative recharge models and stable isotopes to look into groundwater recharge in southern Mali. The study concludes that diffuse recharge, with the rainy season serving as the primary source of recharge, is the predominant process at a regional level. Four representative unsaturated zone habitats with various soil, laterite, and sedimentary bedrock layers each have their own recharge simulations. The authors found that the timing of the simulated recharge matches well with the timing of well hydrograph, but less with the observed GRACE storage anomalies.

The second article Batsukh et al. concentrates on calculating groundwater recharge in Mongolia, where financial restrictions and a lack of research infrastructure have hampered previous studies and data. Using HYDRUS-1D in a 2-m-thick soil profile with either 0.30 or 0.97 m of root depth, the study calculates groundwater recharge over 41 study sites in Mongolia. Below 2 m depth, flow through the thick unsaturated zone is then modeled using Richard's equation and a traveling wave model. The average annual real evapotranspiration removes around 95% of the mean annual precipitation, which varies from 57 to 316 mm/year. The simulated travel time through the unsaturated zone ranges from 4 to 558 years, with the model indicating mean annual groundwater recharge rates from 0.3 to 12.0 mm/year. The relevance of available environmental characteristics in explaining the variability of data is assessed using the partial least squares regression (PLSR).

The third article Meadows and Hagedorn aimed to quantify mountain-block groundwater recharge in the South Fork Tule River watershed in the California Sierra Nevada Mountains using a soil water-balance (SWB) model, which is challenging due to hydrogeological heterogeneities, altitudinal ranges, and interbasin groundwater flow. The study discovered a high link between yearly recharge and rainfall, attesting to short residence durations in the unsaturated zone and the direct impact of droughts. The mean annual recharge and runoff were calculated to be 76.2 and 25.4 mm/yr, respectively. Throughout the course of the research, there were, however, no directional trends in either recharge or runoff. The study also identified a limitation of the SWB model in only considering soil characteristics at the surface, which may over-predict recharge and should be considered for future water supply projections in bedrock-dominated settings.

The last article on the topic Tibebe et al. examines journal articles, book chapters, and research papers to assess the impacts of water security on agriculture in the Abbay river basin. It addresses limitations brought on by climatic variability, current agricultural water management techniques, and knowledge and practice gaps that require future attention. According to the findings, the basin has enormous potential for water resources, but climate change, population increase, and land degradation are increasing the dangers to water security for agriculture.

This Research Topic offers perspectives on groundwater recharge in drylands, including the use of interpretive recharge models, stable isotopes, and soil water-balance models. The publications reveal that recharge is a cross-cutting theme in the management of groundwater.

Author contributions

LH: drafted the article. ML and YF: edited the article. All authors contributed to the article and approved the submitted version.

Conflict of interest

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