# Estimating groundwater recharge using chloride mass balance in the Umm Er Radhuma Aquifer (south), Saudi Arabia

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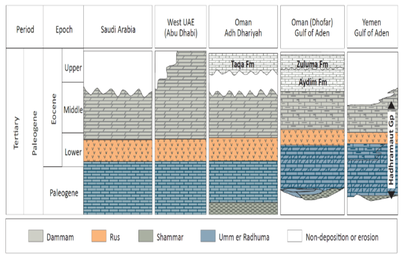
## Introduction:

- This study applies the chloride mass balance (CMB) method to estimate groundwater recharge in the Umm Er Radhuma aquifer (south), Rub' al Khali, where few studies have been conducted.
- Understanding natural recharge rates is essential for sustainable groundwater management in arid regions, aiding long-term planning for domestic, agricultural, and industrial water use. This aligns with Saudi Arabia's *Vision 2030* goals to enhance water security and optimize water resources for sustainable development.

## Site Description:

- The Umm Er-Radhuma aquifer (UER) is located in the Rub' al Khali, Saudi Arabia, a desert with a tropical arid climate with rainfall below 10 mm/month for most of the year.
- The aquifer consists mainly of interbedded limestone and dolomite with intercalations of marl and chert.




Lithostratigraphy of the Umm er Radhuma-Dammam Aquifer System (South). Reprinted from Inventory of Shared Water Resources in Western Asia, by UN-ESCWA and BGR.

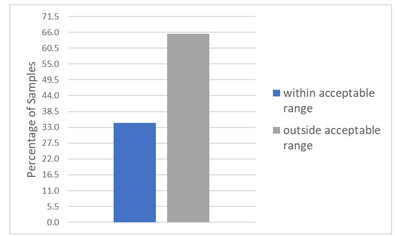
**The Umm Er Radhuma aquifer in Saudi Arabia has an extremely low estimated groundwater recharge flux of 0.4–0.6 mm/year.**



Location of Gomaah's (2021) groundwater samples that I used in my research.

## Methods:

- Owing to the infrequency of rainfall events in Saudi Arabia, we obtained only one sample, from a precipitation event in 2024.
- Ion chromatography was used in an Aramco laboratory to analyze the chloride concentration in the rainfall datum.
- Gomaah (2021) published fifty-five groundwater samples taken from the Umm Er Radhuma aquifer.
- These data include each sample's chemical analysis and coordinate location (see map)
- The electrical balance verified the ion analysis data, with a 5% error acceptance limit. Samples outside this range were excluded.




## Results and Future Work:

- The estimated groundwater recharge flux for the UER aquifer is significantly lower than that of the Tucson and Avra Valley basins, which receive approximately 11.6 mm/year.
- Future work can include more rainfall data to enhance the reliability of the CMB method, ensuring a more accurate long-term recharge estimate. Additionally, testing the water table fluctuation (WTF) method can provide a comparative approach to validate and refine recharge assessments.

## Reference:

Gomaah, M. (2021), Hydrochemistry of Umm Er Radhuma Groundwater, Journal of Geoscience and Environment Protection, 09(04), 128–146.

Pool, D. R., & Anderson, M. T. (2008). Ground-Water storage change and land subsidence in Tucson Basin and Avra Valley, southeastern Arizona, 1998-2002. Scientific Investigations