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Evaluating the geochemical impacts of capturing high magnitude flow events for groundwater recharge

SARAH FAKHREDDINE[1]*, BRIDGET SCANLON[1], AND
MICHAEL YOUNG[1]

[1]Bureau of Economic Geology, University of Texas at Austin
*sarahfak@utexas.edu

Aquifer storage and recovery (ASR) is increasingly being applied as a method to augment local groundwater supplies. While ASR projects have the potential to alleviate water deficits, they can potentially alter the native geochemical and hydrological conditions of a groundwater aquifer resulting in the release of naturally occurring arsenic and subsequent degradation of groundwater quality. The release of arsenic has been reported at several ASR sites globally and threatens the viability of ASR as a water enhancement strategy.

The development of ASR projects in Texas, USA has greatly increased in the last few years due to regulatory changes aimed to promote the adoption of ASR throughout the state. Additionally, recent studies in Texas have shown that high magnitude flood flows (i.e., streamflows in the 95th percentile) during the three wet years from 2015-2017 have a volume equivalent to approximately twice the state water use over the same time period, potentially providing a large source of water for artificial recharge including ASR. However, recent, local pilot ASR wells have reported mobilization of low concentrations (<10 µg/L) of arsenic. The viability of capturing high magnitude flows (HMFs) for ASR depends on overcoming several limitations, including infrastructure capacity, community and ecosystem impacts, and degradation of groundwater quality by arsenic mobilization. Currently, there is no framework for incorporating potential arsenic mobilization into large scale ASR planning and site suitability studies.

Here, we use publicly available water quality datasets and geochemical modeling tools to evaluate the geochemical compatability of high magnitude flow waters with local aquifers within the Brazos River Basin in Texas. We analyze the chemical compositions of HMFs, including spatial and temporal variations in chemical composition. We compare the HMF chemistry to local groundwater with potential groundwater storage sites to determine if arsenic mobilization is likely to occur during ASR via either (1) a shift in redox environment, (2) increases in pH above values of ~8.5, (3) introduction of competitive ions (e.g., phosphate), or (4) combinations of these mechanisms. This work provides a framework for incorporating geochemical interactions into large scale ASR site suitability studies.

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