Analyzing Trends in Groundwater Storage and in Salt and Nutrient Concentrations in Surface Water and Groundwater Bodies in the United States from 1920-2020

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Groundwater is a vital source of water for agricultural, domestic, and industrial use in the United States, but quantifying fluctuations in groundwater storage over time is difficult, especially in large regions. In addition, few datasets exist of temporal changes in salt and nutrient concentrations for both surface water and groundwater bodies across the United States. Fortunately, a significant amount of groundwater storage measurement data is readily available through the United States Geological Survey, and an impressive number of salt and nutrient concentration measurements are made available through the National Water Monitoring Council's Water Quality Portal. In our study, we couple data retrieved from the USGS with ArcGIS geoprocessing methods to outline trends in groundwater storage using data from wells in unconfined aquifers. In addition, we investigate trends in the concentrations of eight salts (calcium, chloride, magnesium, potassium, sulfate, sodium, carbonate, and bicarbonate) and two nutrients (nitrate and phosphorus) in surface water and groundwater bodies across the United States. To determine whether each USGS well lies in an unconfined aquifer, well depth data and national raster maps of land surface elevation and unconsolidated sediment thickness are used, resulting in 356,785 wells with measurement data over the period 1920-2020. Groundwater head, aquifer saturated thickness, and water table depth measurements are averaged temporally, by decade, and spatially, according to the 2,139 8-digit hydrologic unit code (HUC8) subbasins in the conterminous United States. Salt and nutrient concentration data is filtered to contain measurements only for our eight salts and two nutrients of study, and measurements are then converted to units of milligrams per liter and sorted by year. Temporal averages for each individual salt and nutrient are calculated, and ArcGIS shapefiles are generated for each salt and nutrient according to the surface water or groundwater source type (e.g., springs, groundwater wells, and lakes and reservoirs). The results of our trend analysis depict spatiotemporal trends in water quality and groundwater storage. These trends can be used to guide surface water and groundwater remediation efforts and can aid in improving sustainable water management practices at a local, regional, and national scale.