Quantifying Renewable Groundwater Stress (RGS) and Developing a Groundwater Quantity Stress Index (GWSI) for the Philippines Using Feature Importance Analysis

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Abstract

Groundwater underpins domestic supply, irrigation, and drought buffering in the Philippines, yet national-scale assessment is limited by sparse observation wells, dated baselines, and fragmented data systems. This study aims to (1) quantify Renewable Groundwater Stress (RGS) and (2) develop a composite Groundwater Quantity Stress Index (GWSI). Here, RGS is defined as the ratio of groundwater use to renewable availability—specifically, recharge (not total groundwater storage)—while GWSI integrates supply, demand, and vulnerability drivers at the provincial scale. Accordingly, we ask: How stressed are our provincial aquifers, which indicators matter most, and how do RGS and GWSI align to pinpoint actionable hotspots? We will compute RGS using GLDAS-2.2 Catchment with GRACE data assimilation (GRACE-DA) to derive groundwater storage (GWS) trends and a recharge proxy—baseflow/groundwater runoff (Qsb_tavg)—and compare these to RGS values computed with withdrawal estimates from national statistics. We will then construct the GWSI from satellite-based indicators (e.g., mean GWS and mean recharge from GLDAS-2.2 GRACE-DA), in situ rainfall data, and use metrics (e.g., NWRB permits per area, population density, irrigated share), together with vulnerability indicators (e.g., aquifer productivity, land cover, soils, slope). Indicators will be screened for redundancy via principal component analysis (PCA), and data-driven weights will be set using SHapley Additive exPlanations (SHAP) feature importance against RGS and available well levels and low-flow signals from streamflow records. The study will produce provincial RGS maps classified under UN/WMO/SEI stress thresholds, a GWSI map with driver attributions, and cross-validation plots relating storage signals to rainfall, baseflow, and groundwater-level trends. While the coarse resolution of GLDAS-2.2 GRACE-DA and variable indicator quality may constrain local precision, the framework will provide a reproducible, decision-oriented baseline to identify hotspots, diagnose dominant pressures, and prioritize monitoring and governance reforms.