

## Assessment of Groundwater Storage Depletion Using Grace and Land Surface Models in Mzimba District, North Malawi

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**Abstract :** Climate change and over-exploitation are imposing unprecedented threats to the groundwater resource. Globally, groundwater reserves have depleted to the extent that well yields have decreased, pumping costs have risen, and land has irreversibly subsided. As groundwater depletion continues worldwide, its impact worsens portending the need for objective analysis and its possible solutions. In Malawi, groundwater quantity is a national problem, specifically in Mzimba district, due to severe droughts. In this study, groundwater vulnerability to depletion was evaluated using the DRASTIC model, and the spatial and temporal trends of groundwater depletion were assessed using Gravity Recovery and Climate Experiment (GRACE) data and Land Surface Models (LSM) from Global Land Data Assimilation System (GLDAS) and Global Surface Water Explorer (GSWE). The results show that 1. 604.77 km<sup>2</sup> of the aquifer in the study area is vulnerable to depletion for the Standard Version (SV) of the DRASTIC model, whereas 108.11 km<sup>2</sup> is vulnerable to depletion for both the Drought Version (DV) and Abstraction Version (AV). 2. Groundwater storage is depleting at an average rate of  $-1.0 \pm 0.06$  cm yr<sup>-1</sup> ( $0.1043$  km<sup>3</sup>yr<sup>-1</sup>) in the study area with a high rate of up to  $-1.2$  cm yr<sup>-1</sup> ( $0.12516$  km<sup>3</sup> yr<sup>-1</sup>) in the western side and as low as  $-0.4$  cm yr<sup>-1</sup> ( $0.04172$  km<sup>3</sup> yr<sup>-1</sup>) in the eastern part. 3. Groundwater storage increases from  $-13$  cm in November up to  $15$  cm between May and April. 4. Drought is the primary cause of such depletion trends, with the correlation between active evapotranspiration and groundwater depletion and downward surface shortwave radiation and groundwater depletion, at  $-0.577$  and  $-0.678$ , respectively. The results from the study reveal the need for the scientific community and the general public to consider groundwater recharge strategies, specifically by mitigating climate change to reduce prolonged droughts. The study suggests the need to establish a stand-alone groundwater assessment and monitoring authority for enhanced conservation efforts of the water resource.

**Keywords :** grace, land surface model, groundwater, storage, depletion

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