GIS-Based Assessment of Groundwater Storage and Vulerability to Water Insecurity in Zimbabwe

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INTRODUCTION

- WASH are threatened by climate change, particularly in the Global South.
- Groundwater buffers against climate variability, especially in regions with unreliable surface water.
- Rapid population growth and uneven spatial development place pressure on groundwater resources.
- Understanding these dynamics is crucial for climate-resilient WASH planning.
- Satellite-based Earth Observations (GLDAS/GRACE) provide a scalable method to track groundwater storage (GWS).

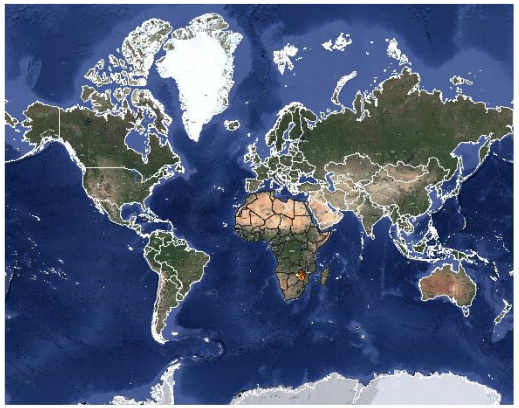
POLICY JUSTIFICATION

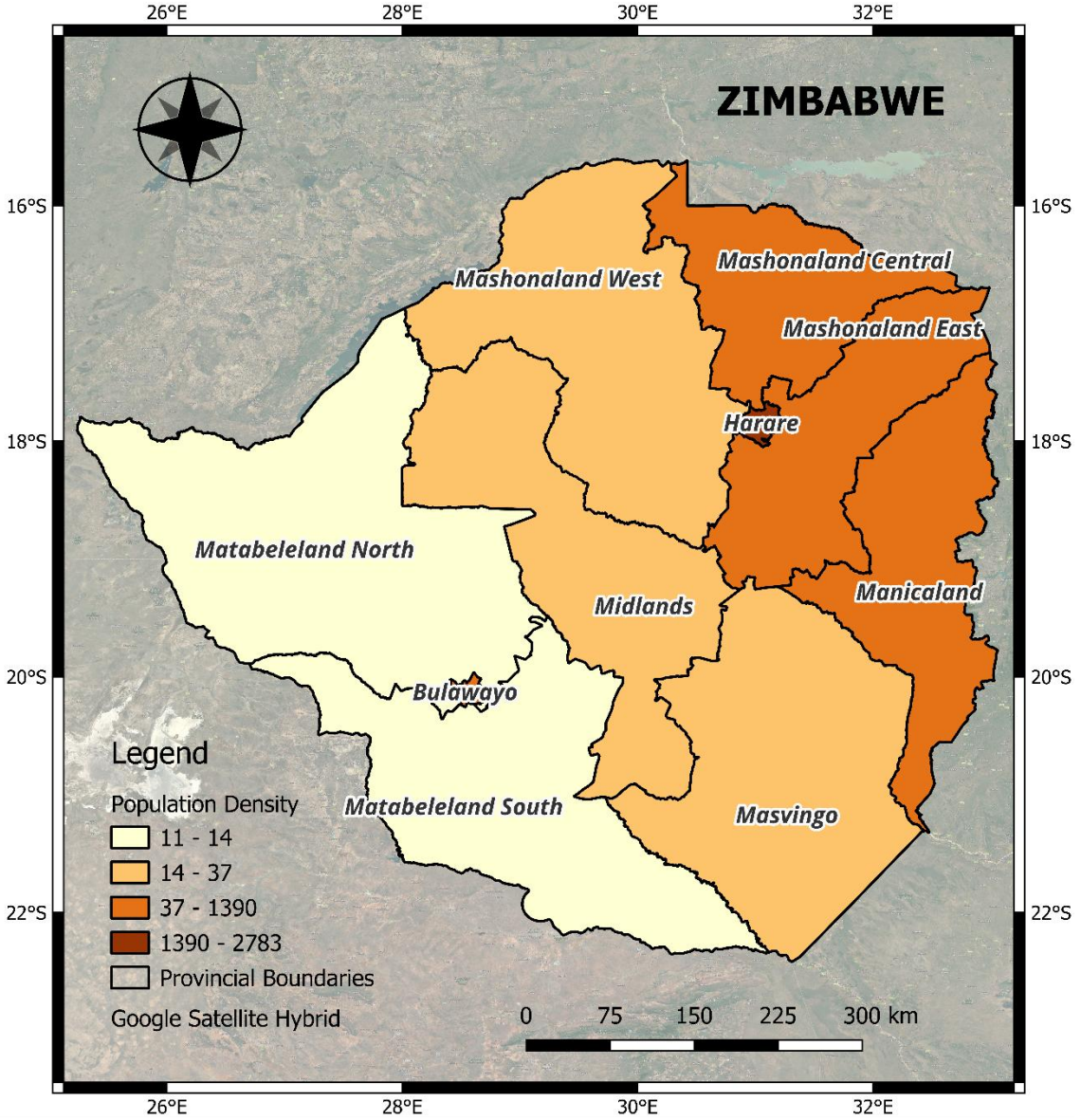
- Global SDGs 6(Clean Water and Sanitation) and 13(Climate Action).
- African Ministers' Council on Water - AMCOW's call for targeted groundwater governance interventions
- African Union (AU) Theme of the Year (2026): "Assuring Sustainable Water Availability and Safe Sanitation Systems to Achieve the Goals of Agenda 2063."
- SADC GMI – Groundwater Management Institute objectives and Revised Protocol on Shared Watercourses (including shared Transboundary Acquifers)
- National Development Strategy 2 NDS2 objectives on equitable, inclusive growth climate adaptation and evidence-based planning.

OBJECTIVES

1. Analyze trends in groundwater storage in Zimbabwe from the inception of the GRACE mission (2003) to 2025
2. Examine the statistical association between precipitation and groundwater storage
3. Assess spatial patterns of population pressure and groundwater stress
4. Identify provinces vulnerable to water insecurity

STUDY AREA: ZIMBABWE





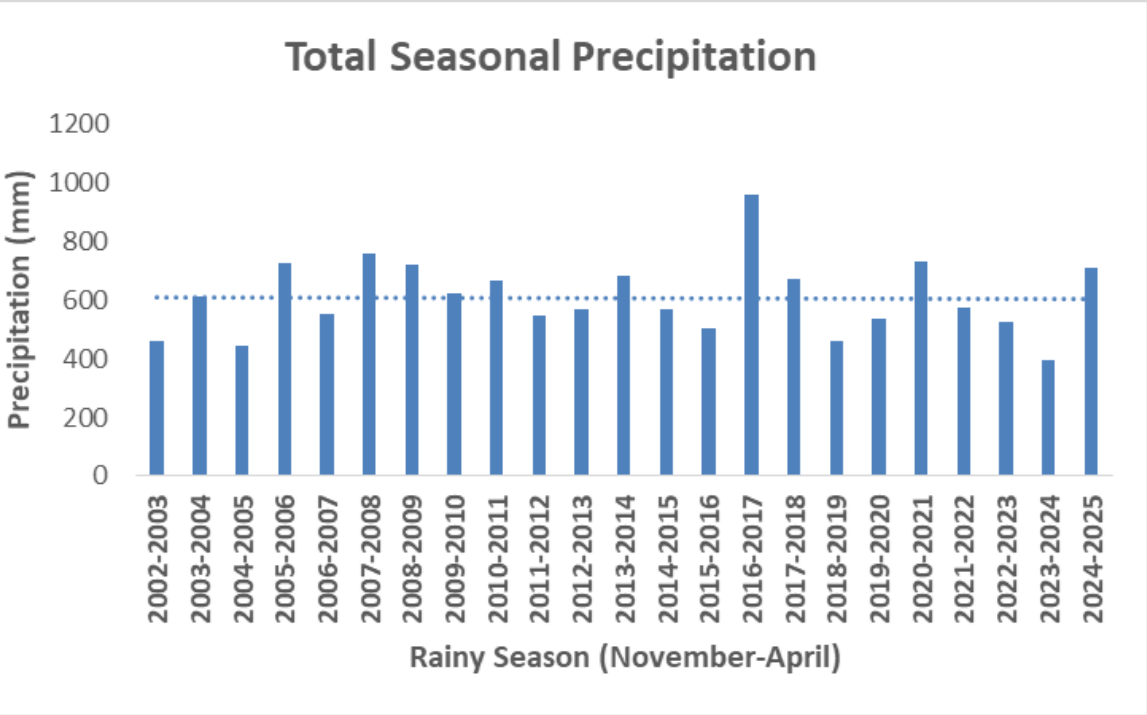
METHODOLOGY

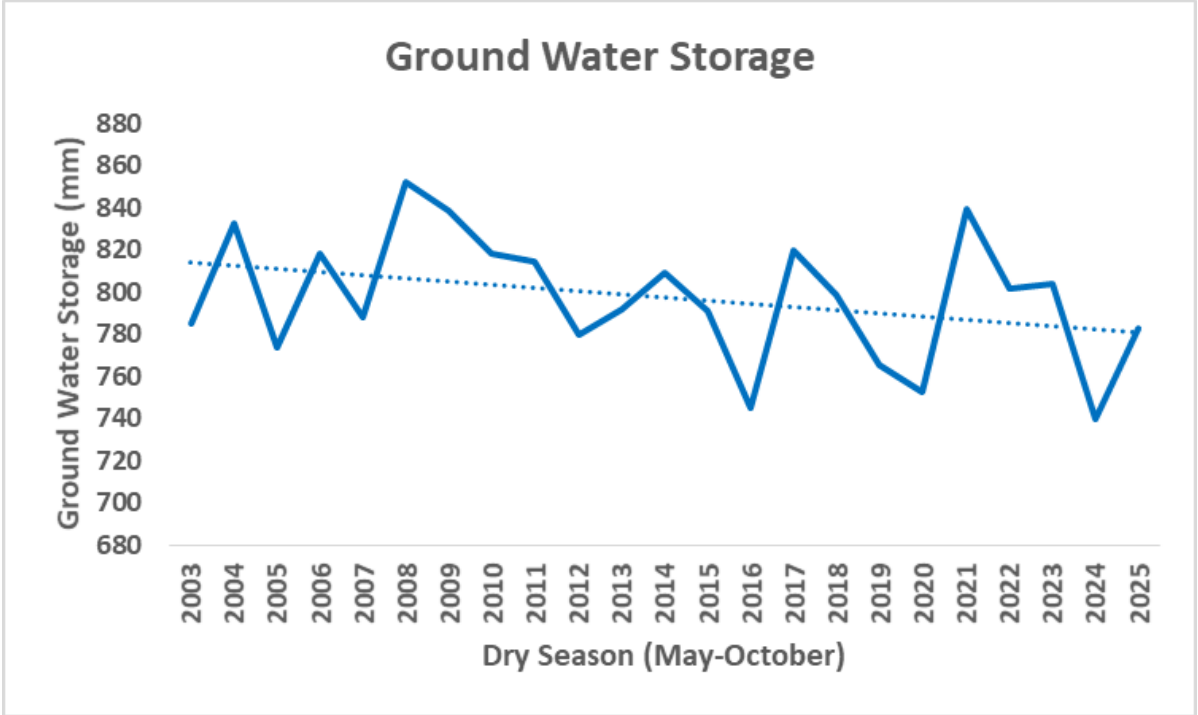
- Data: CHIRPS precipitation data, 2022 National Census data
- Analysis Tools: GIOVANNI, QGIS, Microsoft Excel, Climate Engine

- Analyses Conducted:

1. Linear Regression Analysis to assess the relationship between precipitation and groundwater.
2. Bivariate mapping to classify vulnerability zones.

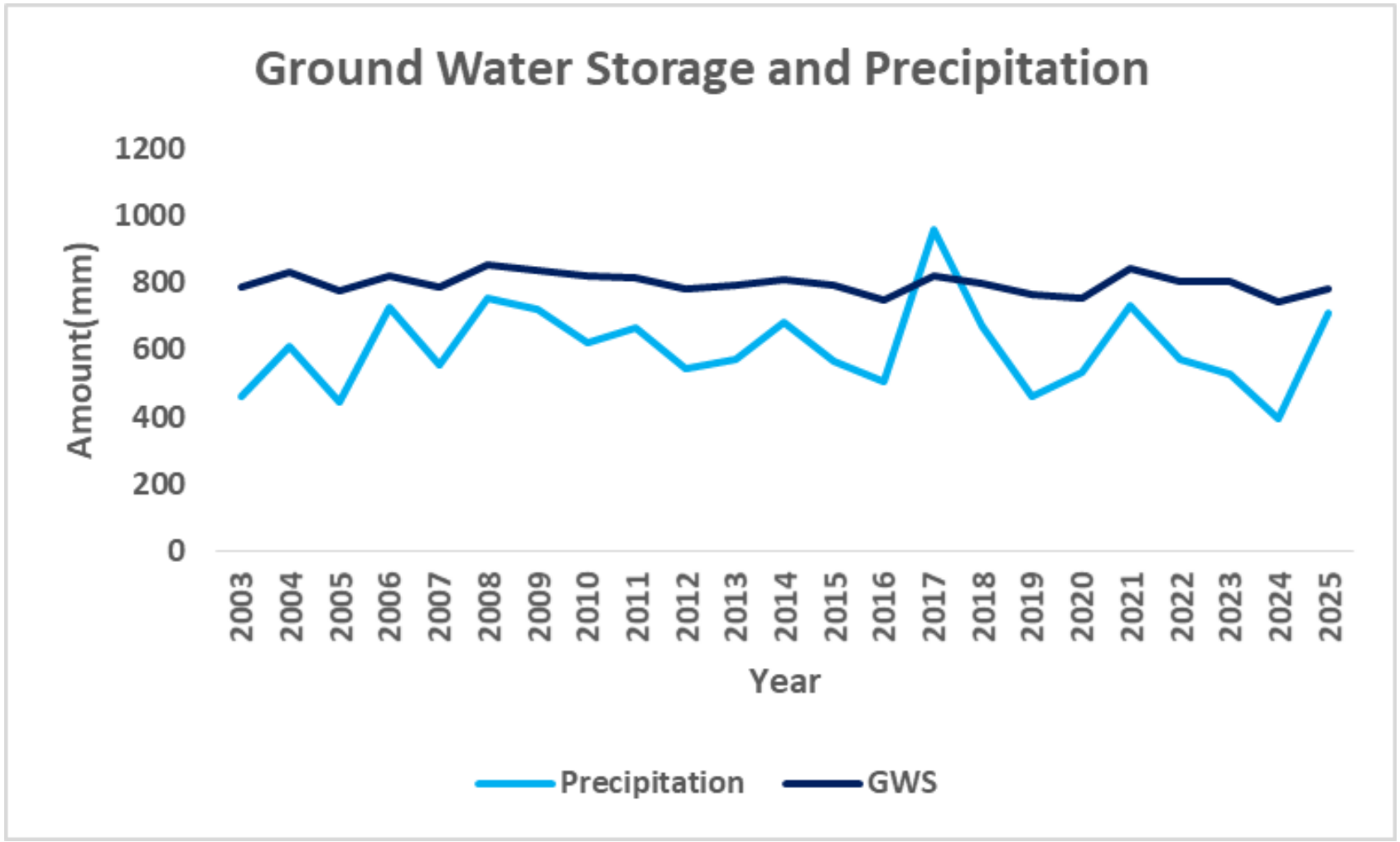
TRENDS IN GROUNDWATER STORAGE AND PRECIPITATION





Declining GWS reserves increase the risk of borehole failure directly impacting WASH services

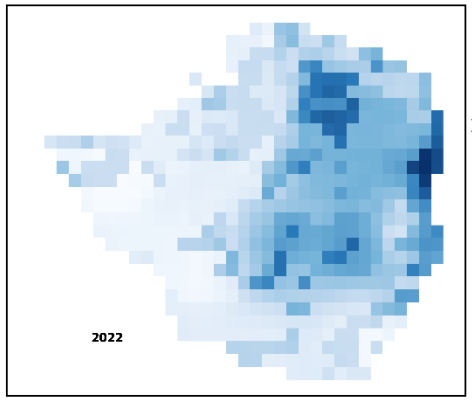
THE ASSOCIATION BETWEEN GROUNDWATER AND PRECIPITATION

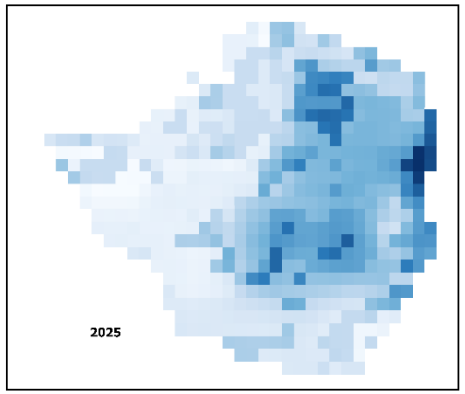


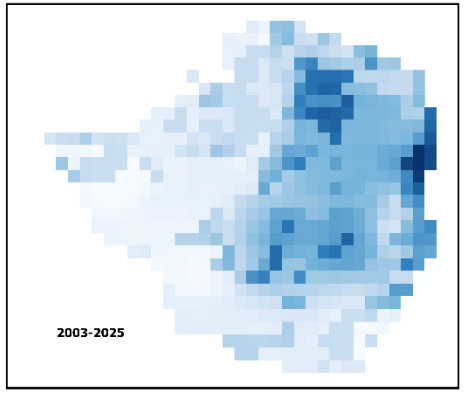
Regression Statistics

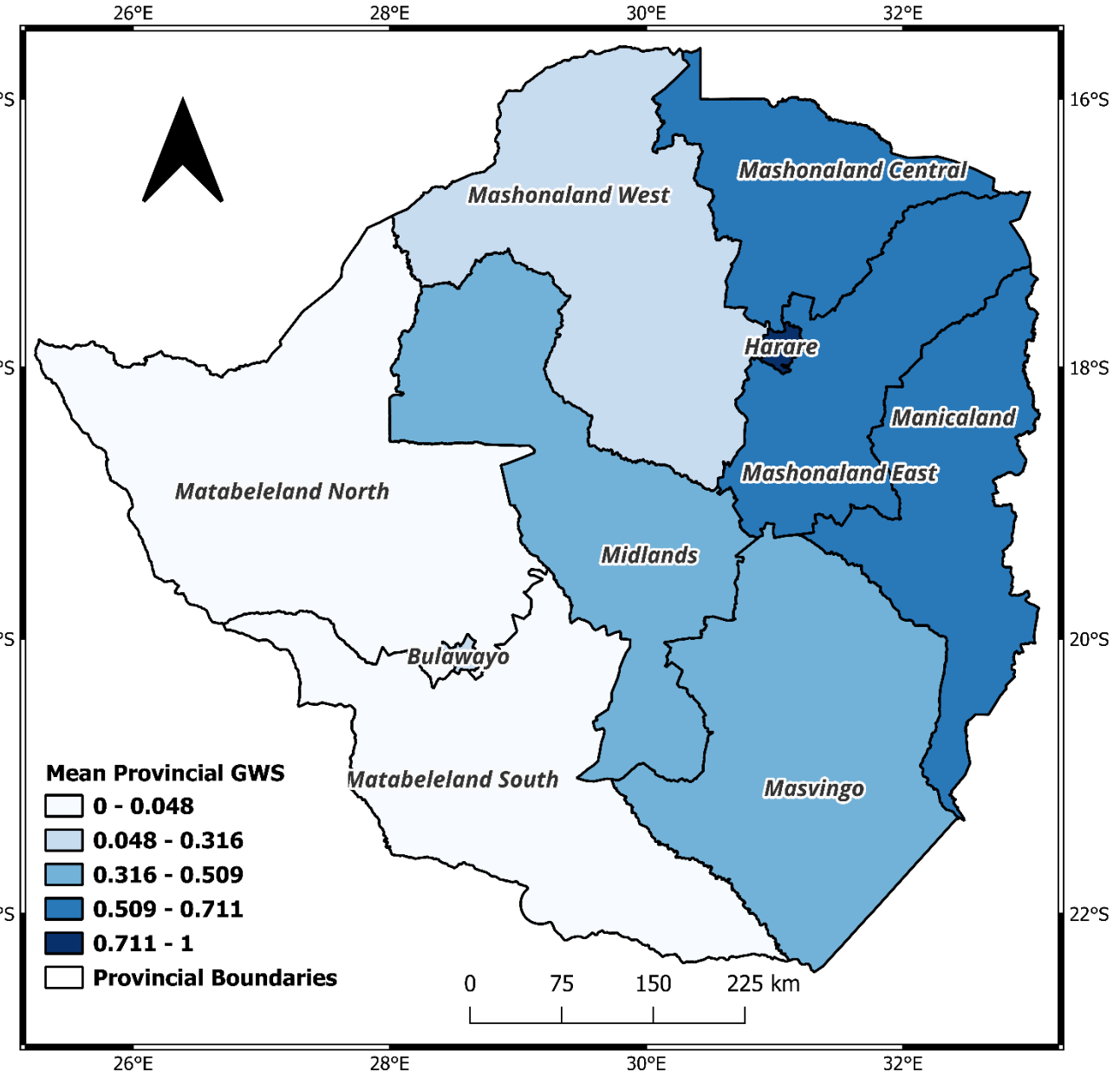
Multiple R	0.728053144
R Square	0.53006138
Adjusted R Square	0.507683351
Standard Error	21.18385273
Observations	23

PROVINCIAL MEAN GROUNDWATER STORAGE

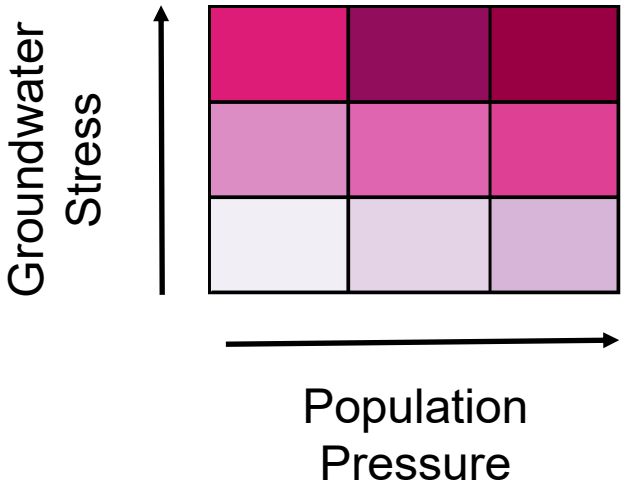


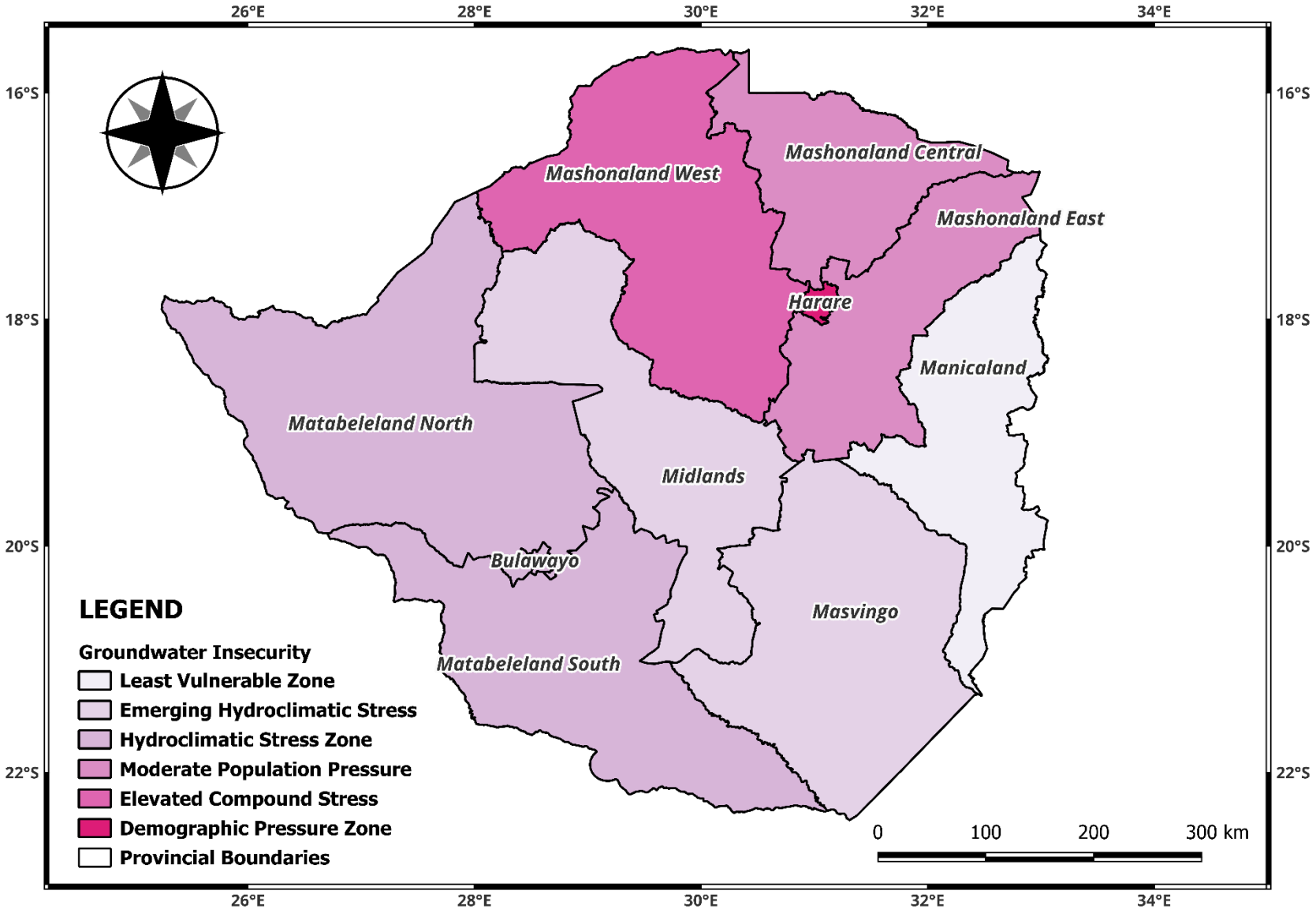






BIVARITE SPATIAL VULNERABILITY TO WATER INSECURITY MAP





LIMITATIONS

- Groundwater storage derived from satellite-based proxies, not direct borehole measurements
- Intra-provincial variability in groundwater conditions and population pressure not fully captured
- Population pressure indicators assume constant growth trends
- Bivariate mapping identifies relative vulnerability, not absolute water scarcity thresholds
- Excluded key factors: Groundwater abstraction rates; Land use / land cover change; Governance; Infrastructure

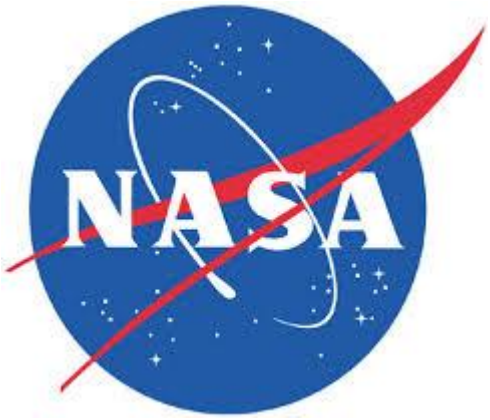
CONCLUSION

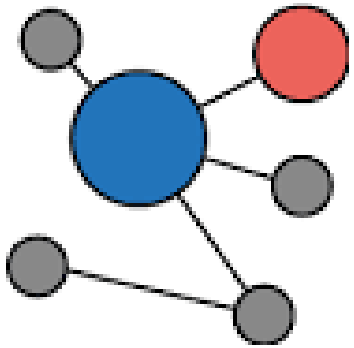
- Zimbabwe is experiencing significant spatio-temporal variability in groundwater storage, heavily influenced by precipitation and population pressure.
- Satellite remote sensing is a cost-effective tool for mapping water security in the Global South.
- Bivariate mapping provides a powerful tool for identifying water insecurity hotspots, giving a clearer picture of vulnerability.
- Results support evidence-based policy and sustainable groundwater management in Zimbabwe.

RECOMMENDATIONS

- Harare and Mashonaland West should be prioritized for integrated groundwater management, e.g. abstraction monitoring
- Matabeleland Region requires climate-resilient groundwater strategies, such as protection of recharge zones
- Integrate satellite GWS anomalies and population dynamics into the National Water Authority (ZINWA) resource planning.
- Invest in training local WASH officers in GIS to monitor ward-level water security.
- Invest in climate-resilient water infrastructure

ACKNOWLEDGEMENTS





Thank You

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