Groundwater assessment in the transboundary Tuli Karoo Basin

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Introduction

- Groundwater is the biggest and most widely distributed store of liquid fresh water available for human use.
- Quantitative estimates of amount and quality of groundwater resources are required in the transboundary Tuli Karoo basin.
- Little or no reliable and current quantitative information on groundwater resources
- Relevant in water development policy, water-related development aid, community planning and technical decision making
Objectives

Main objective:
To map groundwater potential zones and model groundwater recharge as well as groundwater flow in Tuli Karoo basin.

Objective 1
To map the spatial variability of groundwater potential in the Tuli Karoo basin.

Objective 2
To determine the spatial and temporal distribution of recharge in the Tuli Karoo basin.

Objective 3
To determine the groundwater flow of Tuli Karoo Basin.
- Total area is about 12166 km²
- Characterized by shallow water table aquifer systems (Gomo and Vermeulen, 2017)
Materials and methods
Methods

Objective 1
- Data sourcing
  - Pre-processing (Subsetting, Projection)
  - Thematic layer processing (e.g. DEM hydropocessing, lineament extraction)
  - Weight overlay (AHP)
  - Borehole yield and depth data
  - Groundwater potential zone (Class map)
  - Statistical analysis

Objective 2
- Climatic data
- Landscape characteristics
- Soil water retention table
- Soil water balance model
- Groundwater recharge

Objective 3
- BGS tool inputs
  1. Aquifer layer
  2. Transmissivity
  3. Digital elevation model
- BGS tool
- Groundwater heads
- GW flow direction
Data sources

- STRM Digital elevation model – USGS earth explorer
- Landsat 8 – USGS earth explorer
- Precipitation - CHIRPS
- Processed landcover image - ESA
- Tuli Karoo boundary
- Transmissivity
- Tuli Karoo boundary
- Transmissivity
- Portals
  - Soils – ISRIC
  - Geology – World Geologic Maps
  - Borehole yields and depth – SADC-GIP
  - Ground truthing points

Institutions
- Borehole locations – ZINWA
- Borehole yields - ZINWA
Results and discussion
GWP Inputs

- Lineament density
- Drainage density
- Slope
- Topographic Wetness Index
- Geology
- Soil texture
- Landuse/landcover
- Rainfall
- Soil lithology
High groundwater potential is found in areas like Tongwe and Mazunga.

Some places like Thuli and some parts of Shashe have very high groundwater potential.
Validation of GWP map

- Percentage for low groundwater potential class decreases as the borehole yield increases.

- Statistical test was highly significant (P value <0.0001).

- Map looks to be a reasonable reflection of the situation.
Groundwater recharge using rainfall analysis

- Groundwater recharge calculated as 3.5% of annual rainfall.

- Groundwater recharge is high in the North eastern parts of the basin and low in areas like Shashe.
Estimating recharge using SWB

1. Climatic data
2. Landuse Look-Up table
3. Soil Water retention table
Groundwater flow using BGS

- Groundwater flows towards rivers
- In some parts of the basin, groundwater flows from North West towards south east where there is Limpopo River
Conclusions

1. Tuli Karoo basin has high groundwater potential indicated by the dominance of high groundwater potential classes which covers 57.8%.

2. Tuli Karoo basin has low groundwater recharge with a maximum of 13.21 mm per 10 year average.

3. The general groundwater flow in the Tuli Karoo basin is South east.
1. Reliable hydrogeological data should be provided to promote better understanding of groundwater as a resource.

2. Further studies should be done in the basin using other groundwater recharge and flow estimation techniques that uses field based data.

3. Use of numerical models such as MODFLOW to determine groundwater flow.
Thank you