



5TH SADC GROUNDWATER CONFERENCE

16 – 18 NOVEMBER 2022, WINDHOEK, NAMIBIA

GROUNDWATER: Making the invisible visible for socio-economic development



MAPPING THE EXTENT OF WATER SALINITY IN THE SHORELINE AQUIFERS: LAKE CHILWA BASIN, MALAWI.

Banda T^{1*}, Dulanya Z¹, Manda B¹, Larson T², Mwathunga E¹

¹ University of Malawi, P.O. Box 280, Zomba

* tbanda@habitat.mw

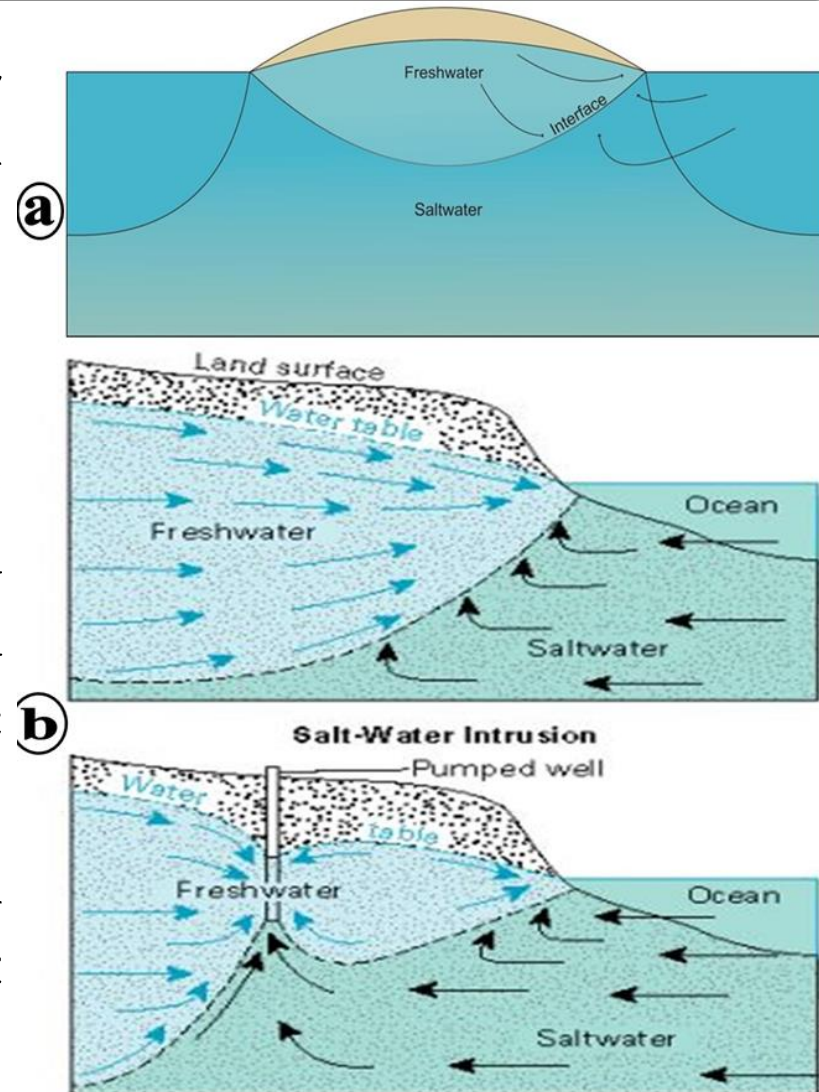
² Illinois State Geological Survey, University of Illinois, Urbana and Champaign

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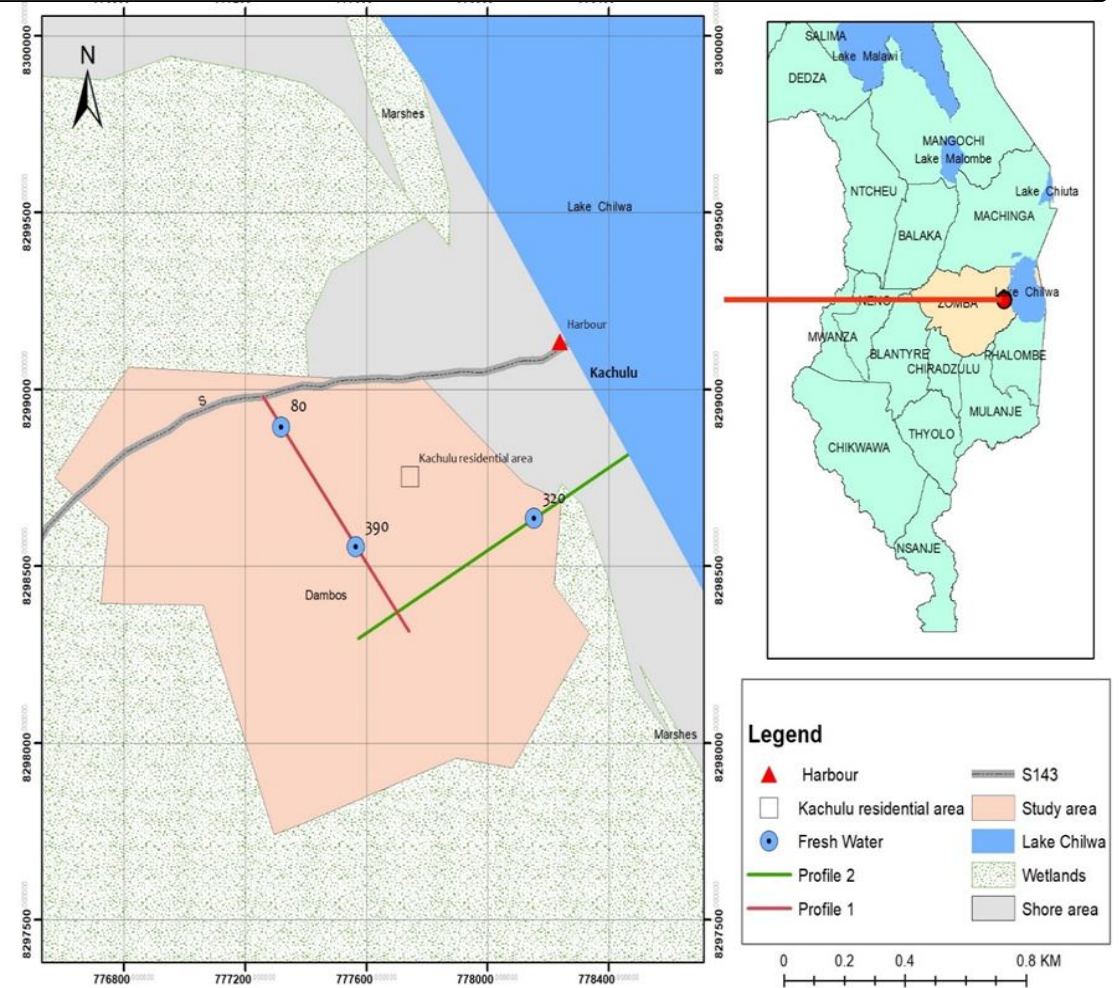
Introduction

- Groundwater resources are a dependable source of freshwater in many parts of the world.
- One of the significant problems of groundwater aquifer in shoreline areas is saltwater intrusion i.e. the migration of lake water to inland water caused by the natural and anthropogenic changes in hydrologic systems (Klassen et al., 2014)
- Saltwater intrusion results in salinization and can have significant economic and ecological impacts.



Study area

- The map shows The study area of Kachulu, located about 30 km from Zomba town in the south-east of Malawi. The map also shows the Lake Chilwa, Malawi.



- GPS points were ground truthed using a Garmin GPS receiver etrex 10. Other secondary shapefiles were sourced from the Malawi spatial data portal (MASDAP).

Problem Statement

- Most of the groundwater sources on the shores of Lake Chilwa (Kachulu Village) are saline. This has largely been attributed to the arid climate in the region.
- The extent to which groundwater interaction processes including saltwater intrusion from the lake are not well understood.



Objectives

Main Objective

- To investigate the extent of ground water salinization in the Kachulu area

Specific Objectives

- Use geophysical techniques (resistivity method) to map the aquifers in Kachulu area.
- To analyze the extent of water salinity in the aquifers of Kachulu area.
- Examine the factors responsible for water salinization in the area

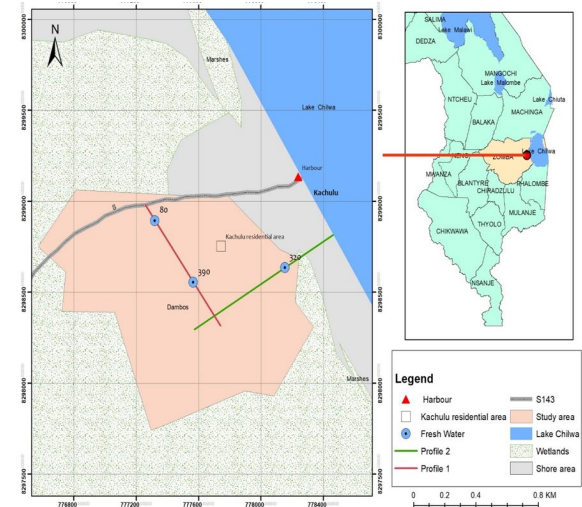
Data collection and analysis

• Data collection

- We conducted a 2D Electrical Resistivity Tomography (ERT) using ABEM SAS 1000 terameter and a Wenner electrode configuration array (Baharuddin et al, 2013)
- Data was collected from two profile. Profile one measured from north-west going south-east at 520m and profile two measured progressing into the mainland from north-east going south-west at 720m
- The data was processed using a Res2DINV software and the ERT inversions was produced.
- Arcgis - used for map preparations



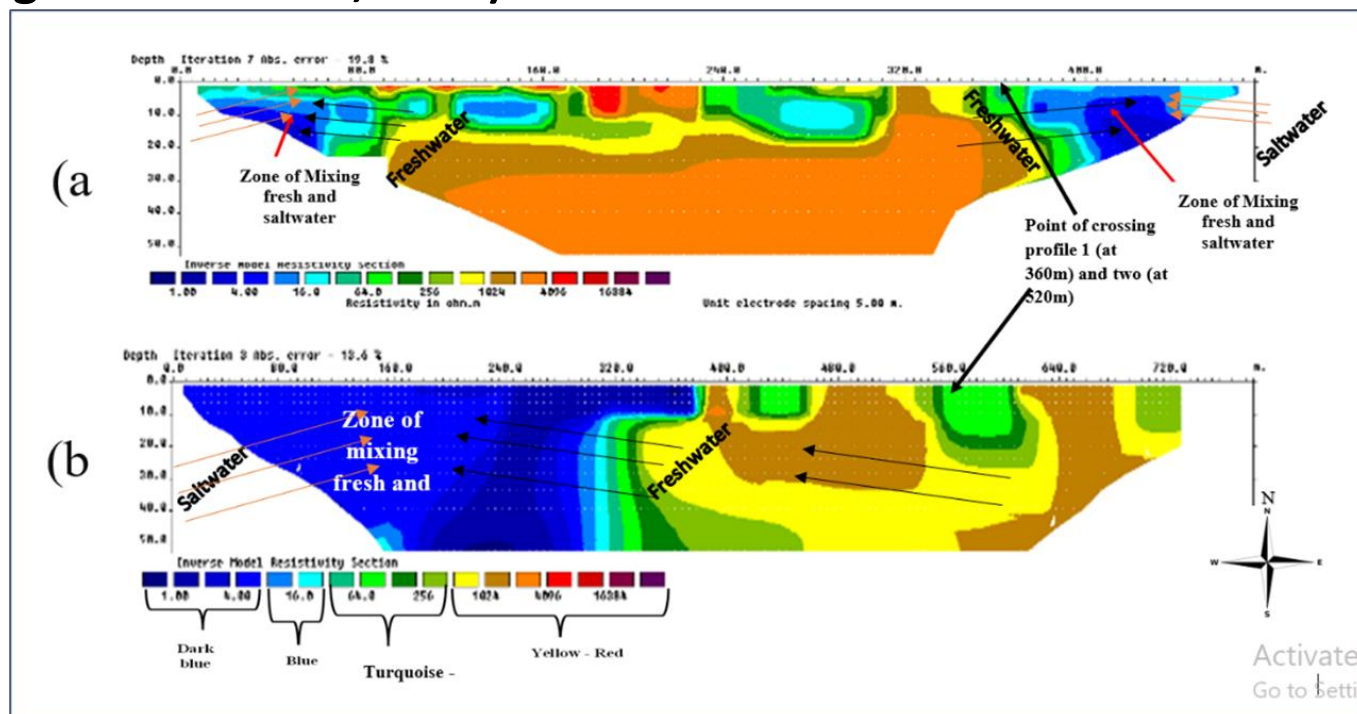
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Results and Discussions

- Various areas of different groundwater quality were found, including zones of fresh saline and mixed groundwater.
- Freshwater sources exist up to 50 m in depth.
- Four ranges of Electrical Resistivity Value (ERV) have been identified, ranging from 0 – 16,384Ωm. For the interpretation, this value has been divided into four ranges based on established references (e.g Hazreek et al., 2018)

Resistivity Value	Material	Mark on inverse model
< 5 Ωm	Lakewater	Dark blue colour
5 – 15 Ωm	Brackish	Blue colour
50 – 256 Ωm	Freshwater	Turquoise – green colour
> 400 Ωm	Hard layer (rock)	Yellow – red colour



Results and Discussions Cont..

- Profile one at 360m crosses profile two at 520m. At the point of crossing, the resistivity value larger than $400 \Omega\text{m}$ has been detected, indicating the possibility of a hardened layer (rock) marked as yellow-red colour in both ERT profiles. The hardened layer is the basalt type of igneous rock that exists in the area
- On profile one(a), the saltwater has been mapped at 0-80 m on the survey line at 20 m depth and 435m on the survey line at 35m.
- Freshwater with a $64 \Omega\text{m}$ has been detected at 80m on the survey line at 25m and at 390m on the survey line at 25m.
- On profile two(b), the brackish water has also been delineated from 1-240m and an extension at 380m on the survey line indicating a possibility that the brackish water percolation may have polluted the shallow aquifer in this area through saltwater intrusions. Saltwater has been mapped from 240-320m on the survey line at 50m depth and 435m at 35m. This is attributed to the excessive withdraws from the nearby boreholes.
- On profile two the fresh water has been registered at 320m of the survey line at 50m

Conclusion and Recommendations

- The study proves that the uneven spatial distribution of various aquifers with different water quality parameters exist in the area.
- Three categories of fresh, mix and saline waters were identified based on the resistivity values
- Zones of low ERV of ($< 5 \Omega\text{m}$) have similar characteristics to the water from the open waters of Lake Chilwa. We interpret these zones as areas where saltwater intrusion process may be taking place
- The groundwater in Kachulu area is saline, thus there is need to provide the water to the area through a reticulation system(mechanisation)

Acknowledgements

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Reference

- Baharuddin et al., (2013). Use of Timelapse Resistivity Tomography to Determine Freshwater Lens Morphology. Measurement: *Journal of the International Measurement Confederation*.
- Hazreek et al., (2018). Seawater Intrusion Mapping using Electrical Resistivity Imaging at Malaysian Coastal area. *International Journal of Civil Engineering and Technology (IJCIET)*.
- Klassen et al., (2014). *Chemical Indicators of Saltwater Intrusion for the Gulf Islands, British Columbia*



Tryness Banda
tbanda@habitat.mw

THANK YOU

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