geoconvention
Calgary • Canada • May 12-14 2025

Effectiveness of Reverse Osmosis Technology for Groundwater Remediation in Coastal Aquifers: A Case Study of the Cape Flats Aquifer, South Africa

Jessie M Kanyerere-Amaechi[1,], Paschal Ogechukwu Amaechi[1]
[1]Department of Earth Science University of the Western Cape,

Abstract

Groundwater contamination in coastal urban areas poses a significant challenge to water security, necessitating effective remediation technologies. This study assessed the effectiveness of Reverse Osmosis (RO) technology in remediating groundwater contaminants in the Cape Flats Aquifer (CFA), South Africa. The research utilized data from the University of the Western Cape's groundwater treatment plant, focusing on key contaminants—iron (Fe) and manganese (Mn). Groundwater samples were analyzed pre- and post-treatment to determine contaminant concentration levels using standard laboratory techniques. The removal efficiency was calculated using the formula:

$$Removal\ Rate = \left(1 - \frac{post - treatment\ concentration}{pre - treatment\ concentration}\right) x\ 100\%$$

Results indicate that the RO technology achieved a removal efficiency of 96% for Fe and 78% for Mn, reducing the concentrations to within acceptable limits set by the South African National Standards (SANS 241:15). The system effectively improved water quality, with post-treatment levels showing a significant reduction in electrical conductivity (from 146.67 mS/m to 44.1 mS/m) and pH stabilization. However, seasonal variations and operational challenges were noted, emphasizing the need for continuous monitoring and optimization of the remediation system.

This study provides empirical evidence supporting the effectiveness of RO technology for groundwater remediation in coastal aquifers. The findings contribute to broader applications of ex-situ treatment technologies in urban water security initiatives and offer information for scalable models for other contaminated aquifer systems.

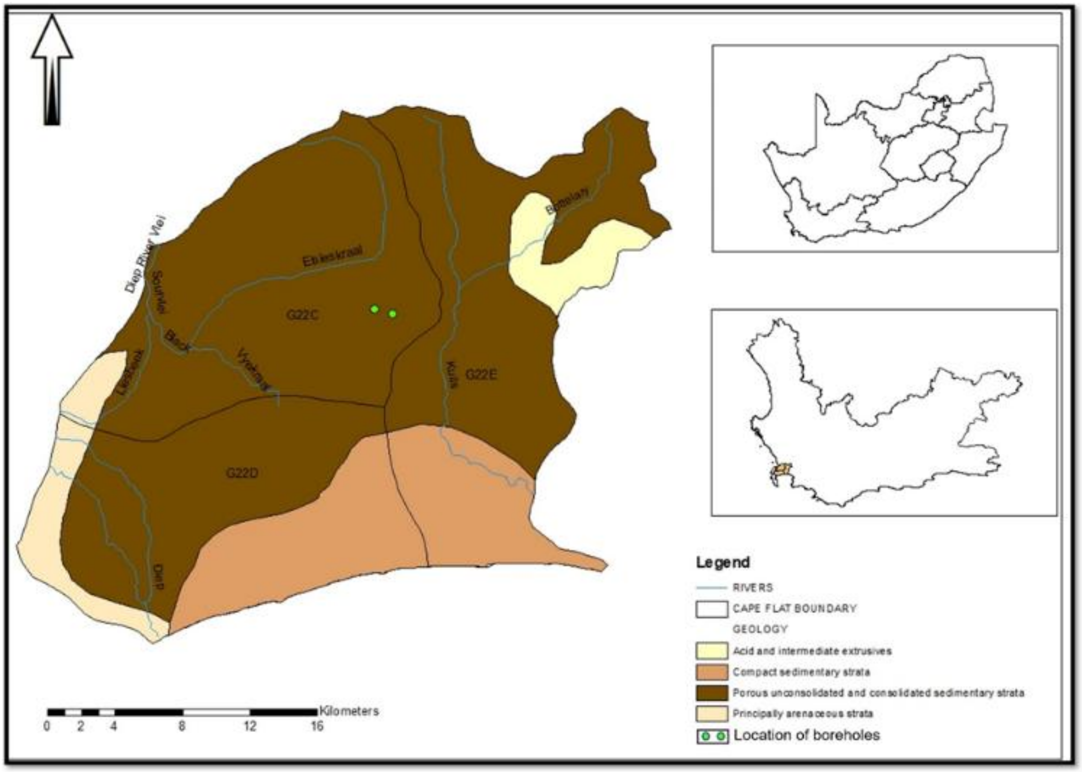

Figure showing Location area map including production boreholes

Acknowledgements

I wish to acknowledge my supervisory team at the University of the Western Cape. I also wish to acknowledge the South African National Research Fund providing me with financial support during my PhD program.

Consulted References

1. Khas Aza-Gnandji, R. W., et al. (2013). Hydrogeochemical characteristics of groundwater in the Cape Flats aquifer. *Water SA, 39(4), 567-578.*
2. Chen, J., et al. (2019). Groundwater remediation technologies: From past to future – A bibliometric analysis. *Environmental Science and Pollution Research, 26(24), 24676-24695.*
3. Gintamo, G., et al. (2021). Evaluating climate conditions affecting groundwater quality using hydrological modeling with GIS in Cape Flats Aquifer. *Hydrological Sciences Journal, 66(7), 1234-1250.*
4. Hunter, W. J., & Shaner, D. L. (2010). Permeable reactive barriers for in situ remediation of groundwater contamination. *Environmental Science & Technology, 44(6), 2396-2402.*
5. Pietersen, K., et al. (2012). Groundwater governance in South Africa: A status assessment. *Water SA, 38(3), 453-464.*
6. Reddy, K. R. (2008). Overview of pump-and-treat remediation technologies. *Environmental Geosciences, 15(2), 79-88.*
7. Shabalala, A. (2013). Managing and treating contaminated mine water through permeable reactive barriers in Krugersdorp, South Africa. *Journal of Environmental Management, 128, 618-626.*
8. Zhang, Y., et al. (2017). Groundwater pollution and contamination trends in urban environments. *Journal of Contaminant Hydrology, 204, 16-30.*