



Groundwater Flow Patterns and Hydrochemical Facies Distribution Using Geographical Information System (GIS) in Damaturu, Northeast Nigeria

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ABSTRACT

The present study attempts to define the relationship between groundwater flow systems and the distribution of chemical facies with the aid of Geographical Information System (GIS). The study also identifies the different geochemical processes responsible for the chemical evolution of groundwater chemistry. Analytical results of 23 groundwater samples reveal mean values of cations as Na⁺ (84.2 mg/l), K⁺ (4.2 mg/l), Ca²⁺ (27 mg/l), Mg²⁺ (11.5 mg/l) and Fe²⁺ (0.6 mg/l). The anion mean values are HCO₃⁻ (4.5 mg/l), SO₄²⁻ (3.7 mg/l), Cl⁻ (22.5 mg/l) and NO₃⁻ (2.2 mg/l). Based on mean values, the cations are in order of abundance as Na⁺ > Ca²⁺ > Mg²⁺ > K⁺ > Fe²⁺ while the anions reveal order of abundance as Cl⁻ > HCO₃⁻ > SO₄²⁻ > NO₃⁻. The geographical information system (GIS) using Inverse Distance Weighted (IDW) delineate two groundwater zones into: Ca-Mg-SO₄-Cl and Na-SO₄-Cl water types. The Ca-Mg-SO₄-Cl constitutes about 35% of the chemical facies and its evolutionary trend is due to simple hydrochemical mixing between Ca-Mg-HCO₃ and Na-SO₄-Cl facies and reverse cation exchange. The Na-SO₄-Cl facies constitutes about 65% of the chemical facies and represents fossil groundwater. The Ca-Mg-SO₄-Cl facies is dominant in the recharge areas while Na-SO₄-Cl facies prevails in discharge areas. Rock-water interaction diagrams indicate precipitation induced chemical weathering along with dissolution of rock-forming minerals. The scattered plots among ions revealed geochemical processes as carbonate weathering, silicate weathering, cation exchange and sulphate reduction. HCA identified effects of rock-water interaction and anthropogenic effects as responsible for the modification of groundwater chemistry in the area.

KEYWORDS

Groundwater; Chemical Facies; GIS; Rock-Water Interaction; Cations and Anions

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References

- [1] A. Nur, J. M. Ishaku and A. Tayib, " Spatial Distribution of Chemical Facies Using Geographical Information System (GIS) in Michika, Northeastern Nigeria," *Research Journal in Engineering and Applied Sciences*, Vol. 1, No. 2, 2012, pp. 102-109.
- [2] A. Shahbazi and A. Esmaeili-Sari, " Groundwater Quality Assessment in North of Iran: A case Study of the Mazandaran Province," *World Applied Sciences Journal*, Vol. 5, 2009, 92-97.
- [3] D.U. Ophori and J. Tóth, " Patterns of Ground-Water Chemistry, Ross Creek Basin, Alberta, Canada," *Ground Water*, 1989, vol. 27, No. 1, pp 20-26. doi:10.1111/j.1745-6584.1989.tb00003.x
- [4] W. Back, " Hydrogeochemical Facies and Groundwater Flow Patterns in Northern Part of Atlantic Coastal Plain," *US Geological Survey Professional Paper*, Vol. 498A, 1966, p. 42.
- [5] J. M. Ishaku, A. Nur and J. A. Bulus, " Mapping of Groundwater Facies Using Anion Geochemistry in Angware Area, Jos Northcentral Nigeria," *Research Journal of Chemical Sciences*, Vol. 2, No. 6, 2012,

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- [6] NPC, " Population of the Federal Republic of Nigeria, Yobe State Statistical Tables, National Population Commission Final Results of Population Census of Nigeria," National Population Commission.
- [7] J. W. Du Preez and W. Barber, " The Distribution and Chemical Quality of Groundwater in Northern Nigeria," Geological Survey of Nigeria, Vol. 36, 1965, pp. 1-93.
- [8] D. O. Emeka and O. M. Weltime, " Trace Elements Determination in Municipal Water Supply in Damaturu Metropolis, Yobe State, Nigeria," Bayero Journal of Pure and Applied Sciences, Vol. 1, No. 1, 2008, pp. 58-61.
- [9] T. Hess, W. Stephens and G. Thomas, " Modelling NDVIB from Decadal Rainfall Data in the North East Arid Zone of Nigeria," Journal of Environmental Management, Vol. 48, No. 3, 1996, pp. 249-261. doi:10.1006/jema.1996.0076
- [10] G. E. Oteze and E. O. Fayose, " Regional Developments in Hydrogeology of the Chad Basin Water Resources," Journal of Nigerian Association of Hydrogeologists, Vol. 1, No. 1, 1988, pp. 9-29.
- [11] E. A. Okosun, " A Preliminary Assessment of the Petroleum Potentials from Southwest Chad Basin, Nigeria," Borno Journal of Geology, Vol. 2, No. 2, 2000, pp. 4050.
- [12] M. S. Chaanda, N. G. Obaje, U. A. Lar and A. Moumouni, " Petroleum Geochemistry of Kuchalli-1 in the Nigerian Sector of the Chad Basin," Continental Journal of Earth Sciences, Vol. 1, 2007, pp. 18-24.
- [13] G. Matheis, " Short Review of the Geology of the Chad basin in N.E Nigeria," In: C. A. Kogbe, Ed., Geology of Nigeria, Elizabethan publishing Co., Lagos, 1976, pp 289294
- [14] M. E. Offodile, " Groundwater Supply and Development in Nigeria," Meco Geology and Engineering Services (Jos), 2002.
- [15] W. M. Barber and D. R. Jones, " Geology and Hydrology of Maiduguri," Records of Geological Survey, Borno State Province, 1960.
- [16] C. Raeburn and B. Jones, " The Chad Basin: Geology and Water Supply, Geological Survey of Nigeria," Geological Survey bulletin, No. 15, 1934.
- [17] C. A. Kogbe, K. Schoeneich and E. I. Ebah, " Hydrogeological Frame Work of Maiduguri Metropolis in the Chad Basin, Northeast Nigeria," 5th Conference of the Nigerian Association of Hydrogeologists (NAH), Minna, 1992.
- [18] M. O. Olugboye, " Revision Notebook on Hydrogeological Practices," World Meteorological Organization, 2008.
- [19] Y. N. Solomon, " Hydro-Geoelectrical Investigation of Damaturu Town, Northeastern Nigeria" , M.Sc Thesis, Department of Geology, Federal University of Technology, Yola, 2006.
- [20] J. Chilton, " Groundwater Water Quality Assessment—A Guide to Use of Biota; Sediments and Water in Environmental Monitoring," 2nd Edition, UNESCO/WHO/UNEP, 1992.
- [21] M. J. Barcelona, J. P. Gibb, J. A. Helfrich and E. E. Garske, " Practical Guide for Groundwater Sampling," ISWS Contract Report 374, Illinois State Water Survey Campaign, 1985.
- [22] Raynald Levesque and SPSS Inc., " SPSS 15.0," SPSS Inc., Chicago, 2006.
- [23] B. Banoeng-Yakubo, S. M. Yidama, Y. Anku, T. Akabzaa and D. Asiedu, " Water Quality Characterization in Some Birimian Aquifers of the Birim Basin, Ghana," Journal of Civil Engineering, Vol. 13, No. 3, 2009, pp. 179-187
- [24] J. H. Ward, " Hierarchical Grouping to Optimize Objective Function," Journal of the American Statistical Association, Vol. 69, 1963, pp. 236-244. doi:10.1080/01621459.1963.10500845
- [25] N. Kannan and S. Joseph, " Quality of Groundwater in the Shallow Aquifers of a Paddy Dominated Agricultural River Basin, Kerala, India," International Journal of Civil and Environmental Engineering, Vol. 2, No. 3, 2010, pp. 160-178
- [26] S. Naoum and I. K. Tsanis, " Ranking of Spatial Interpolation Techniques Using a GIS-based DSS," GLOBAL NEST: The International Journal, Vol. 6, No. 1, 2004, pp. 1-20.
- [27] C. G. Karydas, I. Z. Gitas, E. Koutsogiannaki, N. Lydakis-Simantiris and G. N. Silleous, " Evaluation of

Spatial Interpolation Techniques for Mapping Agricultural Top Soil Properties in Crete," *EARSeL eProceedings*, Vol. 8, No. 1, 2009, pp. 26-39.

- [28] P. A. Burrough and R. A. Mcdonnell, " Principles of Geographic Information Systems," Oxford University Press, Oxford, 1998.
- [29] WHO, " Guidelines for Drinking Water Quality," Geneva, 1996.
- [30] J. M. Ishaku, " Hydrochemical Evolution of Groundwater in Jimeta-Yola Area, Northeastern Nigeria," *Global Journal of Geological Sciences*, Vol. 9, No. 1, 2011, pp. 99121.
- [31] FAO WATER, " Adaptive Water Management in the Lake Chad Basin," Addressing Current Challenges and Adapting Future Needs, World Water Week, Stockholm, 2009.
- [32] S. Naseem, S. Hamza and E. Bashir, " Groundwater Geochemistry of Winder Agricultural Farms, Balochistan, Pakistan and Assessment for Irrigation Water Quality," *European Water*, Vol. 31, 2010, pp. 21-32.
- [33] A. F. Yousef, A. A. Saleem, A. M. Baraka and O. S. H. Aglan, " The Impact of Geological Setting on the Groundwater Occurrences in Some Wadis in Shlatein-Abu Ramad Area, SE Desert, Egypt," *European*