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Total coliforms, arsenic and cadmium exposure through drinking water in the Western Region of Ghana: Application of multivariate statistical technique to groundwater quality

Andrews Obeng Affum[1], Shiloh Osae Dede[1], Benjamin JabezBotwe Nyarko[1], Samuel Afful[1], Joseph Richmond Fianko[1,2], Akiti Thomas Tetteh[1,2], Adomako Dickson[1,2], Samuel Osafo Acquaah[5], Micheal Dorleku[3], Emmanuel Antoh[1], Felix Barnes[6] and **Enoch Acheampong Affum[4]**
[1]National Nuclear Research Institute, Ghana
[2]University of Ghana, Ghana
[3]Council for Scientific and Industrial Research, Ghana
[4]KAAF University College, Ghana
[5]Kwame Nkrumah University of Science and Technology, Ghana
[6]German Academic Exchange Service, Ghana

In recent times, surface water resource in the Western Region of Ghana has been found to be inadequate in supply and polluted by various anthropogenic activities. As a result of the above problem, the demand for groundwater by the human populations in the peri-urban communities for domestic, municipal and irrigation purposes has increased without prior knowledge of its water quality. Water samples were collected from 14 public hand-dug well's during the rainy season in 2013 and investigated for total coliforms, *E.coli*, mercury (Hg), arsenic (As), cadmium (Cd) and physico-chemical parameters. Multivariate statistical analysis of the dataset and a linear stoichiometric plot of major ions were applied to group the water samples and to identify the main factors and sources of contamination. Hierarchal cluster analysis revealed 4 clusters from the hydrochemical variables (R-mode) and 3 clusters in the case of water samples (Q-mode) after z-score standardization. Principal component analysis after a varimax rotation of the dataset indicated that 4 factors extracted explained 93.3% of the total variance which highlighted salinity, toxic elements and hardness pollution as the dominant factors affecting groundwater quality. Cation-exchange, mineral dissolution and silicate weathering influenced groundwater quality. The ranking order of major ions were $Na^{+}>Ca^{2+}>K^{+}> Mg^{2+}$ and $Cl^{-}>SO_4^{2-}>HCO^{3-}$. Based on Piper plot and hydrogeology of the study area, sodium chloride (86%), sodium hydrogen carbonate and sodium carbonate (14%) water types were identified. Although *Escherichia coli* were absent in the water samples, 36 % of the wells contained total coliforms (*Enterobacter* species) which exceeded the WHO guidelines limit of 0CFU/100ml water for microbes in drinking water. With the exception of Hg, the concentration of As and Cd in 79% and 43% of the water samples exceeded the WHO guideline limits of 10 µg/L and 3 µg/L for drinking water respectively. Reported values in some areas in Nigeria, Malaysia and United States of America, indicated that the maximum concentration of Cd was low and as high in this study. Health risk assessment of Cd, As and Hg based on average daily dose, hazard quotient and cancer risk were calculated. To conclude, multiple natural processes and anthropogenic activities from non-point sources contributed significantly to groundwater salinization, hardness, toxic element and microbiological contamination of the study area. The outcome of this study can be used as a baseline data to prioritize areas for future sustainable development of public wells.

Biography

Andrews ObengAffumworks at Nuclear Chemistry and Environmental Research Centre, National Nuclear Research Institute, Ghana Atomic Energy Commission, Ghana.

aaffum@yahoo.com

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