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Statistical technique evaluates the levels of heavy metal in groundwater across the Jhansi district, Bundelkhand area, India

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Abstract: For human use, groundwater is a critical resource. Because of natural and anthropogenic activities, groundwater pollution is reducing water quality across the Jhansi district, Bundelkhand area. The Bundelkhand Gneissic Complex (BGC) and granite terrain in the southern part of Achaean to recent era, and alluvial plains or highly eroding composite plains in the northern part of the district of the Quaternary period, make up this area. As a result, the aim of this study was to use a multivariate statistical technique like factor analysis (FA), Pearson

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correlation coefficient (r), and cluster analysis to investigate heavy metal concentrations using an inductively coupled plasma-mass spectrometer (ICP- MS) and to analyse water quality and contamination source in groundwater using multivariate statistical techniques like factor analysis (FA), Pearson correlation coefficient (r), and cluster analysis (CA). The results of the ICP-MS were compared to WHO (2017) and BIS (2017) criteria (2012). The concentration of Al was within reasonable limits, and the range of As, Cd, Cu, Pb, and Zn were lower than acceptable limits, while the concentrations of Fe, Mn, and Ni in the rest of the groundwater samples were higher than allowable limits. Furthermore, the PCA findings revealed three factors that were responsible for the data structure, accounting for 77.416 percent of the overall variance of the dataset, which was specified by three variables: 37.954 percent, 23.331 percent, and 16.132 percent. Whereas the results of factors 1, 2, and 3 indicated that (Cu, Pb, Zn), (Al, Mn), and (As, Ni) showed strong positive loading, indicating that the sources of these metals were naturally occurring and over-application of pesticides and fertilisers in agriculture, respectively. Furthermore, the obtained results of (r) revealed a strong positive correlation of Cu with Pb (r = 0.921), a moderate relationship of Mn with Al (r = 0.619), As with Ni (r = 0.496), Cr with Co (r = 0.556), Cu with Zn (r = 0.700), Fe with Pb (r = 0.541), and Pb with Zn (r = 0.709), as well as a negative correlation of Cd with Zn (r = -0.502), Cr with Cu (r = -0.528), Zn (r = -0.522) and (r = -.0923). The finding of (r) revealed that the positive correlation was a common source and the negative association was a separate source of groundwater, as well as that this relationship between heavy metals means that one variable increase while the other decreases and inversely. Furthermore, CA results revealed three clusters: A, B, and C, each of which suggested low to high emissions due to weathering and anthropogenic activities. Overall, 50% of groundwater samples were suitable for drinking and irrigation, while 50% of samples were not suitable for people use. In addition, this study suggests that groundwater be treated before it is used for human use.

Keywords: Groundwater, water quality, heavy metal concentrations, ICP-MS