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Unravelling the Influence of Geothermal Fields on Water Quality - A Case Study from Loutraki, Central Macedonia, Greece

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Extended Abstract

The village of Loutraki in the region of Pella in Central Macedonia, Greece, is known for its association with the 'Pozar' thermal baths. These thermal baths utilise geothermal hot water, which is a key attraction for tourists. Moreover, this geothermal resource plays an essential role in both the tourist attraction and the general socio-economic development of the region. The geothermal system in this region exhibits low enthalpy, with the temperature of the geothermal water typically being around 35°C. The thermal water from the Baths is mixed with cold water from the Agios Nikolaos River, and part of the resulting water mixture is used for irrigation. The main geological formations, apart from the Quaternary and Neogene sediments located mainly in lowlands, are carbonate formations (limestones), ultramafic/mafic rocks, schists, volcanites, pyroclastic rocks and lavas. The present study aims to investigate the deterioration of surface and groundwater associated with the geothermal fields by determining major ions, potentially toxic elements (PTEs) and other trace elements. A comprehensive dataset of physical and chemical parameters was analysed in a total of 81 representative water samples from the study area (10 surface and 71 groundwater samples). The data were processed, using statistical methods (descriptive statistics, Spearman correlation coefficients - CC, Factor Analysis-FA, Hierarchical Cluster Analysis-HCA) and thematic maps were created using ESRI's ArcGIS Pro software. The results of the chemical analyses indicate that the surface and groundwater are naturally enriched in As (from 0 μg/L to 382 μg/L), Li (from 0.36 μg/L to 300.7 μg/L), B (from 4.2 μg/L to 4745 μg/L), Cs (from 0.02 μg/L to 75.9 μg/L), I (from 0.7 μg/L to 29.5 μg/L), Rb (from 0.29 μg/L to 33.2 μg/L) and, Sb (from 0.02 μg/L to 2.81 μg/L) while increased levels of Electrical Conductivity (EC) (up to 1167 μS/cm) were recorded. Taking into account the geological formations, the multitude of faults in the area, and the data analysis of this study, it is concluded that the hot geothermal water and cold groundwater intermingle within the fractured zone, indicating a direct mixing of geothermal water with both surface and groundwater sources, and possibly posing a threat to the quality of drinking water. Finally, elevated groundwater concentrations of As that exceed the World Health Organisation's water standard (10 μg/L) raise significant health concerns [1]; all exceed values of As were recorded in irrigation wells and surface water which are associated with geothermal/geogenic origin. The potential bioaccumulation of As in soils, plants, and water poses a risk to human health as it facilitates transmission in the food chain. Concluding, the current study suggests systematic and long-term monitoring of water resources which is in hydraulic connection with geothermal fluids to mitigate potential health risks and to propose long term solutions that will utilize the existing geothermal field.

References

[1] World Health Organization (WHO), "Guidelines for drinking water quality (4th ed.)", Geneva: World Health Organization, 2017