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Combing geochemical knowledge and mathematical applications towards the computation of indexes aimed at a sustainable development and management of Earth resources

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The effects of climate change and the increasing anthropogenic pressure are depleting Earth resources, making their correct and sustainable management a crucial aspect that humanity has to face. Water resource protection and clean energy production are among the major challenges. Indeed, water is unsafe for drinking, in many places worldwide, due to the presence of toxic pollutants and at the same time, its overexploitation results in severe scarcity. On the other hand, the ecological transition requires the exploitation of clean and renewable energies and among them, geothermal energy represents one of the most eco-friendly solutions, especially low-enthalpy open-loop systems *(*OLS*)*.

Here, we present how combining the geochemical knowledge with mathematical applications may help developing (geochemical) indexes to (i) assess the quality of the water resource (*Chemical Water Quality Index*, CWQI) and (ii) evaluate the geothermal potential of an aquifer and the benefits of implementing an OLS (*Potential Geothermal Viability Index*, PGVI). The CWQI and PGVI provide one single values which summarizes the overall characteristics of the water resource or aquifers considering several variables, such as potential toxic elements (PTEs) contents for the CWQI and the hydrological features of the aquifer for the PGVI. Although they apply on different topics, both indices are based on the same mathematical principles. First, the variables are normalized to a common scale by assigning a score (*s*) depending on the measured value/reference value ratio. Consequently, a weight (*w*), directly proportional to the score (*s*), is assigned to each parameter and index is finally computed by combining the weights and the scores following a geometric aggregation. The index is included between ~1 and 10, for the CWQI, low values are indicative of good quality while for the PGVI, they imply favorable conditions for implementing an OLS; contrarily, higher values indicate poor water quality (CWQI) or unfavorable condition for geothermal energy production (PGVI). Both indexes are characterized by (i) simple mathematical computations, (ii) inclusivity of the variables, (iii) unbiased weightage method, (iv) accuracy of the outcomes and (v) they represent a useful and readily accessible tool for geochemical data treatment in environmental sciences.