

Assessing groundwater fecal contamination in a drought-stressed aquifer: a combined fluorescence, PCA, and irrigation-based vulnerability approach (Berrechid, Morocco)

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Abstract:

Groundwater quality is increasingly threatened in semi-arid irrigated regions, where recurrent droughts lead to intensified groundwater abstraction, reduced natural recharge, and increased contamination risks. This issue is particularly critical in the Berrechid aquifer (Morocco), where irrigation relies almost entirely on groundwater resources under severe water stress conditions. The objective of this study is to identify and analyze the main factors controlling groundwater contamination, with a specific focus on anthropogenic pressures and environmental conditions that facilitate contaminant transport. To achieve this, an integrated approach was adopted, combining multivariate statistical analyses with remote sensing and Geographic Information System tools. A set of environmental variables describing pollutant transfer conditions was considered alongside indicators representing potential anthropogenic contamination sources. The analysis relies on tryptophan-like fluorescence as a proxy for biodegradable organic matter, and includes methods such as principal component analysis, correlation analysis, and regression modeling. In addition, an irrigation-based vulnerability mapping approach was developed to explicitly account for agricultural practices and their influence on groundwater contamination risk. This approach aims to improve the understanding of interactions between contamination sources, environmental factors, and irrigation dynamics under drought conditions. It also provides a more comprehensive framework for assessing groundwater vulnerability in arid and semi-arid regions by integrating both intrinsic environmental characteristics and human-induced pressures.

Keywords: Tryptophan-like fluorescence; Groundwater; Vulnerability assessment; Irrigation; Drought stress