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The Application of Groundwater Recharge Estimation Methods in an Unconfined Aquifer within a Critical Zone Through Hydrogeophysics

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Introduction

Water security encompasses the stability and assurance of adequate access to water for multiple uses, including the maintenance of ecosystems, as well as the protection and conservation of water resources. As a result, there is a strong interdependence between water security and food security, particularly under scenarios of global climate change, which is increasing the frequency of extreme events.

A bibliographic review and the subsequent conceptual understanding of water movement within the hydrological cycle and its recharge processes in aquifers are essential for water risk management. This knowledge and its application aim to ensure water security, since extensive use of groundwater reduces its discharge into surface water bodies.

Therefore, this work proposes a characterization of the current state of the art regarding the concepts of existing methods used to estimate the groundwater recharge of the unconfined aquifer in the Ribeirão das Posses watershed, located in Extrema, Minas Gerais, a critical zone within the Center of Water and Food Security in Critical Zones.

Method and/or Theory

The first stage of the study involved a literature review of basic hydrogeology concepts and the main existing methods for estimating aquifer recharge. Concepts such as the hydrological cycle, characterization of unconfined and confined aquifers, groundwater flow, water balance and Darcy's law were examined.

In the following stage, existing potential data for recharge control were collected. Whit the available hydroclimatological and hydrogeological data from the study area, it was possible to determine which recharge estimation methods could be applied. The selected methods were: water balance method, recession curve method, baseflow method and the water table fluctuation method.

However, to apply the WTF method as a recharge estimation technique, knowledge of the aquifer's effective porosity is required. This value is usually obtained from previous studies in the same region of the project. Since this research is part of a larger pioneering project at the Ribeirão das Posses watershed, the parameters that characterize the aquifer have not yet been established. A proposed solution would be to use geophysical logging to determine this parameter, enabling the application of diverse techniques for recharge estimation in order to minimize uncertainties.

Results and Conclusions

The Ribeirão das Posses watershed's long-term hydroclimatological records and available dataset enable reliable recharge estimation. Moreover, integrating geophysical logging with existing datasets demonstrates the potential of hydrogeophysical methods to refine aquifer characterization, not only in Extrema but also in regions facing similar water-security challenges. These findings could inform sustainable groundwater management policies, particularly for agriculture-dependent areas vulnerable to climate extremes.