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Conceptual and mathematical models of the socle aquifer between the Plateau Mandingue and River Niger, southern Mali

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Groundwater resources are heavily relied upon in southern Mali, both for domestic and public supply. In the more recent past, irrigated agriculture has also become increasingly widespread in the region. This is largely because aquifers offer a reliable source of good-quality water at an accessible cost, thus protecting most users against droughts. Pressure on groundwater resources is expected to increase in the future owing to exponential population growth and to the likely effects of climate change. However, while groundwater plays de facto an important role in the livelihoods of millions of people, there are significant hydrogeological uncertainties that pertain to most aquifers in southern Mali. These need to be addressed in order to gain a better understanding of crucial water resources, as well as to underpin management practices. Within this context, we present a groundwater modelling study of the southwestern sector of the socle aquifer. The study area encompasses an area of approximately 3000 square kilometers between the towns of Siby, Bankoumana and Niarela. The conceptual model was developed based on thorough field surveys of springs and shallow and deep wells, as well as on extensive borehole records. Field work included readings on water table depths, as well as chemical and isotopic sampling. Flow patterns in the aquifer seem to follow a NW-SE gradient, from the Plateau Mandingue to River Niger. Monsoon-like rainfall recharge is observed to be extremely important for shallow wells, as well as for the long-term sustainability of human development in the area. Natural groundwater quality was found to be acceptable for most uses, although traces of arsenic were detected in the southwestern sector of the system. Mathematical modelling allowed for the development of a water balance, as well as to test future scenarios. Results suggest that groundwater pumping could deplete the aquifer in the coming years if recharge is reduced as a result of climate change and if the population continues to expand. This could pose a major future challenge to local communities. Strategies to cope need to be developed, which in turn implies that there is an urgent need to monitor all groundwater-related variables on a regular basis.