Integrated Hydrological and Hydrogeological System Analysis of the Lake Tana Basin, North-western Ethiopia

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Hydrological, hydrogeological, hydrogeochemical and isotope hydrology studies have been carried out in the Lake Tana basin located in the north-western Ethiopian highlands. The basin is located in a subsided graben. Lake Tana is the largest lake in the Horn of Africa which is considered to be the origin of the Blue Nile river that contributes 85 percent of the Nile flow. The main objective of the study is to determine the groundwater recharge rate, surface waters and groundwater interaction and to assess the aquifer system aimed at mapping the groundwater potential zones. Based on three independent recharge estimation methods (soil water balance approach, chloride mass balance and base flow analysis) the average annual groundwater recharge in the basin is estimated at 251 mm. There is no groundwater inflow in to the basin. However, the basin looses around 3744 Mm^3 $year^{-1}$ as groundwater outflow mainly in the southern part. The lake leaks to the adjacent Beles river basin. The annual leakage from the lake in to the Beles river basin is 1391.1 Mm^3 $year^{-1}$. From hydrogeologiocal point of view the area is underlain by Quaternary and Tertiary volcanic rocks and lacustrine sediments. These rocks and sediments form multi layered stratified aquifers with high productivity in the centre of the basin surrounding the lake, Integrated hydrogeochemical and environmental isotope analysis revealed that there two groundwater flow systems. The first one is a shallow groundwater system with low salinity with relatively isotopically enriched (^{18}O and ^{2}H) waters with high tritium content. The deeper aquifer system forms multi-layered confined aquifers with isotopically depleted and higher salinity waters. The deeper system forms locally artisian aquifers with higher salinity. Hierarchical cluster analysis of hydrochemical data supported by principal component analysis have given seven clusters or subgroups of groundwaters indicating the complexity of the hydrogeological system of the basin. In general the groundwater system in the basin appears to be not simple as previously anticipated by different studies.

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