«A Three-Dimensional Model to Evaluate the Water Resources of the Kufra and Sarir Basins, Libya»

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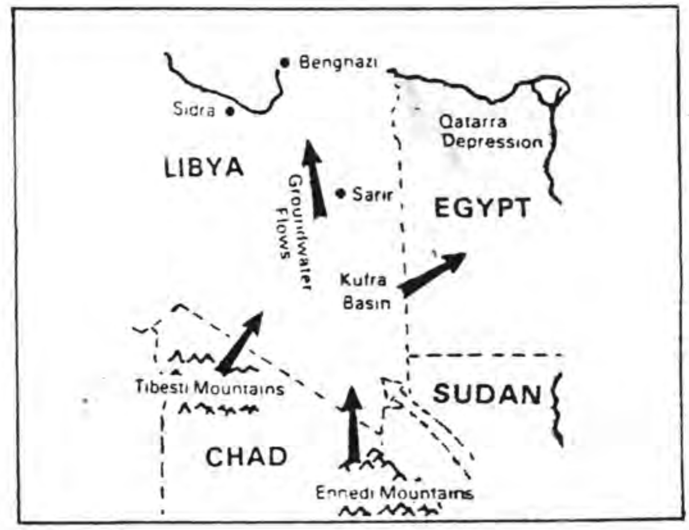
The Kufra, Sarir Tibesti, and Sarir Calanscio basins have huge ground-water reservoirs. The Kufra well fields (KPP and KSP) and Sarir Calanscio well fields (North Sarir, South Sarir, and Jalo) have been implemented for agricultural production. Tazerbo and West Sarir well fields are under construction to transport water to the coastal area. The existing well fields in Kufra and Sarir basins were designed to produce 26.62 m^3/sec, while Tazerbo and West Sarir well fields were designed to produce 23.2 m^3/sec. The wells in these well fields have tapped a small portion of the Nubian and post-Eocene aquifers. Kufra and Sarir Calanscio well fields have been pumped for several years. The behavior and the draw-down prediction is determined using the modified three-dimensional model. The model simulation of regional water-table aquifers is based upon the planning extraction of the existing and proposed well fields of 121 m^3/sec, while the model simulation of the Nubian aquifer in Kufra oasis is based upon the actual pumping of 4.16 m^3/sec.

The steady-state model for the Kufra, Sarir Tibesti, and Sarir calanscio aquifer indicates that the transmissivity ranges from 0.02 to 0.3 m^2/sec; the total ground-water inflow entering the system from Tibesti, Chad, and Sudan is 43.66 m^3/sec. The ground-water outflow discharging from the Sabkas north of Sarir basin is 9.25 m^3/sec, while the ground-water outflow towards Egypt is 15.08 m^3/sec. The total evapotranspiration from the oases is 19.32 m^3/sec.

The transient model of the same aquifer was constructed on the basis of the steady-state model parameters and the planning extraction of the five existing and nine proposed well fields of 121 m^3/sec. The storage coefficient obtained from the match of the actual and observed drawdown ranges from 0.07 to 0.15. This model indicates that the interference between the existing and proposed well fields is higher among the Sarir Calanscio and Tibesti well fields than it is in the Kufra well fields. The model also indicates that the draw-down in the Tibesti well fields is higher than it is in the other basins. Significantly, the model indicates that these well fields are feasible. The most promising area indicated by this model for water exploitation is the southern part of the Kufra basin.

Some of the previous studies of ground water reveal that recharge to the ground water occurred only during the Pluvial periods (about 8,000 to 10,000 years ago). In the present study, ground-water recharge has been tested using the numerical model. A fossil-water model was constructed by using the steady-state parameters (head, transmissivity, and evapotranspiration); the model permitted no inflow (recharge to the system from the southern boundary through the constant head nodes). A storage coefficient of 0.07 was used for Calanscio Basin, while 0.15 was used for Tibesti and Kufra basins. The results of this simulation indicate that the present head is about double the fossil-water head at the southern boundary. The fossil-water hydraulic gradient is 0.6×10^{-4},



while the observed one is 2.5×10^{-4}. The model also indicates that most of the existing Sabkhas would have dried up 8,000 years ago. Accordingly, the heads and the hydraulic gradient could not have been maintained unless recharge had occurred since the Pluvial periods.

A steady-state model was constructed for the Kufra aquifers using the prepumping water level maps and adjusted evapotranspiration and leakance. This model indicates that transmissivity ranges from 0.001 to 0.3 m^2/sec for the upper aquifer and from 0.01 to 0.5 m^2/sec for the lower aquifer. The area of high transmissivity indicates the existence of a buried channel south of KSP. Leakance ranges from 7.5×10^{-10} to 2.25×10^{-8} sec^{-1}, constant head outflow is 5.64 m^3/sec, leakage from lower to the upper aquifer is 1.54 m^3/sec, and total evapotranspiration is 2.4 m^3/sec which is best matched with the one obtained from the regional simulation (2.17 m^3/sec).

A transient model was simulated using the steady-state parameters. The model was calibrated using ten years draw-down for KPP and five years drawdown for the KSP well field. The actual pumping rate of 3.5 m^3/sec was used for KPP and 0.6 m^3/sec was used for KSP. The best leakance coefficient, which controls the difference in draw-down of the upper and lower aquifer, ranges from 7.5×10^{-10} to 2.25×10^{-8} sec^{-1}. The storage coefficient ranges from 0.05 to 0.2 for the upper aquifer and from 0.00002 to 0.0025 for the lower aquifer. The maximum drawdown in the KPP and KSP wells, including both the nodal drawdown correction and partial penetration correction after 50 years of pumping is 53 and 30 meters, respectively. The maximum leakage from the upper to the lower aquifer is 2.61 m^3/sec. The draw-down prediction and the transmissivity distribution indicate that the southern part of the KSP well field is the most promising location for future water exploitation.