ST/ESA/13

Department of Economic and Social Affairs

Natural Resources / Water Series No. 2

GROUND-WATER STORAGE AND ARTIFICIAL RECHARGE

UNITED NATIONS
New York, 1975

DAKHLA AND KHARGA OASES, EGYPT*

The background information for the Dakhla and Kharga oases is as follows:

(a) Region: north-eastern Africa;

(b) Geography: extensive depressions (oases) in desert plains;

(c) Climate: arid: mean annual rainfall in the Dakhla oasis, 1 mm; in the Kharga oasis, less than 1 mm. Rainy season, if any, in the winter. Temperature, over 50°C during the summer;

(d) Reservoir type: sedimentary basin, artesian aquifer;

(e) Methods of investigation: geological mapping; geophysical exploration (gravimetric, aeromagnetic); drilling; age-dating by carbon-14. An electric analogue model is under construction

Ground-water reservoirs

The Nubian sandstone (Cretaceous) uniformly underlies a vast region of the north-east of Africa several millions of square kilometres in area. The outcrop area of this formation is as far as 1,000 km to the south of the oases in Sudan and Chad. Maximum thickness is 2,500 m. Faults, anticlines, synclines and deep channels exist, and influence ground-water occurrence and flow.

Sandstone constitutes the principal reservoir rock. Interbedded shales of low permeability make the aquifer heterogeneous and highly anisotropic. Eight water-bearing zones have been distinguished. However, the aquifer may be considered one hydrological unit with vertical leakage. Temperature of the water increases with depth.

Two analogue models have been designed. The model of the two oases simulates an area about 270 x 180 km. A general model of the Western Desert simulates an area about 700 x 1,000 km.

Water in deep aquifers is fair to good in quality. Water in shallow aquifers, in some places, is poor in quality owing to high evaporation and salt deposition. Principal recharge of the ground-water reservoir took place during the Pleistocene period. The age of the water determined by carbon-14 dating, varies from 20,000 to 30,000 years. Abundant precipitation evidently took place in the Pleistocene period. Currently, recharge by precipitation is practically nil. The waters of the Nile River contribute locally, but their over-all effect is negligible.

The hydraulic conductivity coefficient (*K*) varies from 2 to 5 m/day.

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* Case study No. 16 prepared by R. De Wiest (United States of America).

DAKHLA AND KHARGA OASES,
EGYPT

WESTERN DESERT (UAR)
HYDROGEOLOGIC CHARACTERISTICS
RELATED TO ANALOGUE MODEL
(After M. BORELI–1968)

CASE STUDY Nº 16

EXPLANATION

BOUNDARY OF GENERAL RC ANALOGUE MODEL

125 — CONTOUR LINE OF PIEZOMETRIC HEAD (Metres above MSL)

2000 — TRANSMISSIVITY CONTOUR LINES (m^2/day)

BASEMENT OUTCROPS

At Kharga Oasis, coefficient of transmissivity (T), averages about 1,400 m^2/day. At Dakhla Oasis, T averages about 4,000 m^2/day; coefficient of storage (S) varies from 0.002 to 0.005 in the deeper zones.

Discharge is mostly through wells. Shallow wells (also called "native" or "Roman" wells) produce from the uppermost artesian zone; deep tube-wells produce from the lower artesian zones.

In the Kharga oasis shallow wells discharged 100,000 m^3/day in 1961; 130 deep wells discharged 450,000 m^3/day in 1962, but only 130,000 m^3/day in 1966. The principal reason for the decrease was the decline of artesian pressure. In the Dakhla oasis, shallow wells discharged 190,000 m^3/day.

The ground-water balance for the Nubian sandstone aquifer in the Western Desert will be computed with the aid of the analogue model.

Utilization of ground water

Almost all wells are self-flowing at the time of construction. They flowed freely without control. As a result, the piezometric head declined, and many wells ceased to flow. Pumps were installed in some, but the construction of others did not permit pump installation. Efficiency of most wells was also reduced considerably owing to corrosion of casing and screens. Various kinds of casing and screens have been installed in an attempt to find the most suitable material and design. Water is used principally for human consumption and small-scale irrigation.

The economical-technical problems are: (a) The great depth of drilling, exceeding 1,000 m in some places; and (b) The anticipated lowering of the water level by future exploitation (1 m/year) will require deep-well pumps and a power supply. The hydrological problems are: (a) Inadequate spacing of wells, resulting in over-exploitation of the same water-bearing zone in the same area; and (b) Uncontrolled water flow.

Proper development of the ground-water reservoir is essential for the continued social and economic well-being of the region. It is hoped that the analogue models will simulate conditions accurately; and thus be utilized to determine either safe yield or the rate of mining and head decline, so that proper provision for suitable well-construction and pumps can be made.

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