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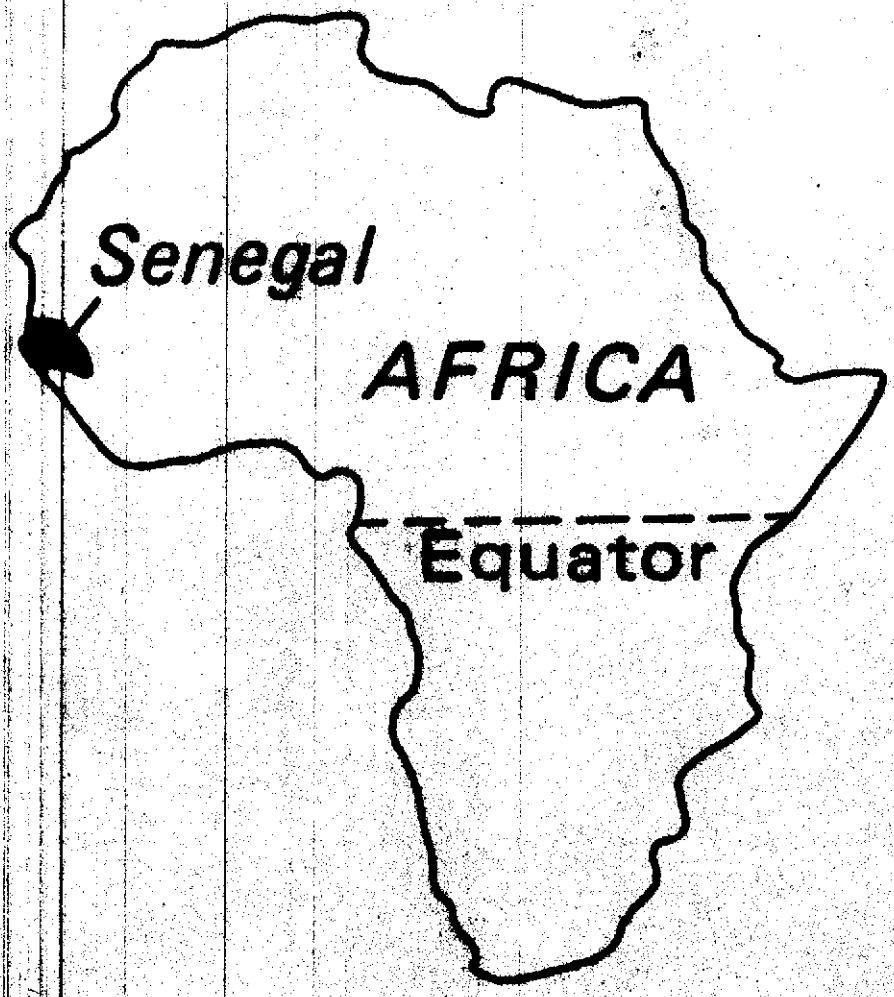
SENEGAL RIVER VALLEY GROUND-WATER MONITORING PROJECT: SUMMARY REPORT ON PIEZOMETER EVALUATION, FEBRUARY-MARCH 1989

U.S. GEOLOGICAL SURVEY
Open-File Report 89-411



Prepared for the
ORGANISATION POUR LA MISE EN VALEUR DU FLEUVE SENEGAL
and the U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

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ABSTRACT

In response to a request from U.S. Agency for International Development, the U.S. Geological Survey provided technical assistance to the Senegal River Valley Ground-water Monitoring Project in western Africa. The technical assistance consisted of evaluating approximately 600 piezometer wells, constructed near the Senegal River, to determine if the piezometers were installed in such a manner that accurate hydraulic data could be obtained from the wells. The hydraulic data will be used to determine the head difference between the shallow and deep aquifers in the Senegal River valley, as well as between the aquifers and the Senegal River.

Field examinations of 27 randomly selected piezometer installations revealed that construction and stability of well footings was satisfactory and that well depths and water levels were within 10 percent or less of reported values. Evaluation of water-level hydrographs for 36 randomly selected piezometer wells indicated that ground-water levels fluctuated seasonally in all wells, with highs in October-November and lows in May-June, corresponding, respectively, to peak- and low-flow stages of the Senegal River. Maximum annual fluctuations in ground-water levels ranged from a few tenths of a meter to about 3 meters. Hydraulic conductivities calculated from slug-injection test data collected by project personnel for 137 piezometers in the lower Senegal River delta ranged from 1.0×10^{-3} at wells in medium- to fine-grained sand to 8.0×10^{-7} centimeters per second at wells in silty clay.

The results of these evaluations indicate that the piezometers are properly installed and providing valid data.

INTRODUCTION

Several reports (for example, Illy, 1973; Audibert and Filippi, 1984) have been written on the hydrogeology of the Senegal River basin. These reports, useful as they are, lack sufficient data from which detailed hydrologic analyses can be made, although the reports provide adequate general background information on the hydrogeology of the area. Illy (1973, figs. III and IV) describes some anomalies as related to hydraulic gradient northeast and south-southwest of Podor, and indicates that the Senegal River is losing water all along its reach in this area. These water-table maps show two areas of large "sinks" or drains; the hydraulic head decreases to about 15 meters below sea level east of Podor and to about 25 meters below sea level northeast of Podor (Illy, 1973, fig. III, p. 51). Several questions arise: Are the data valid? Where does the water discharge? Are the land-surface elevations of the wells accurate? What, if any, hydraulic connection exists between the

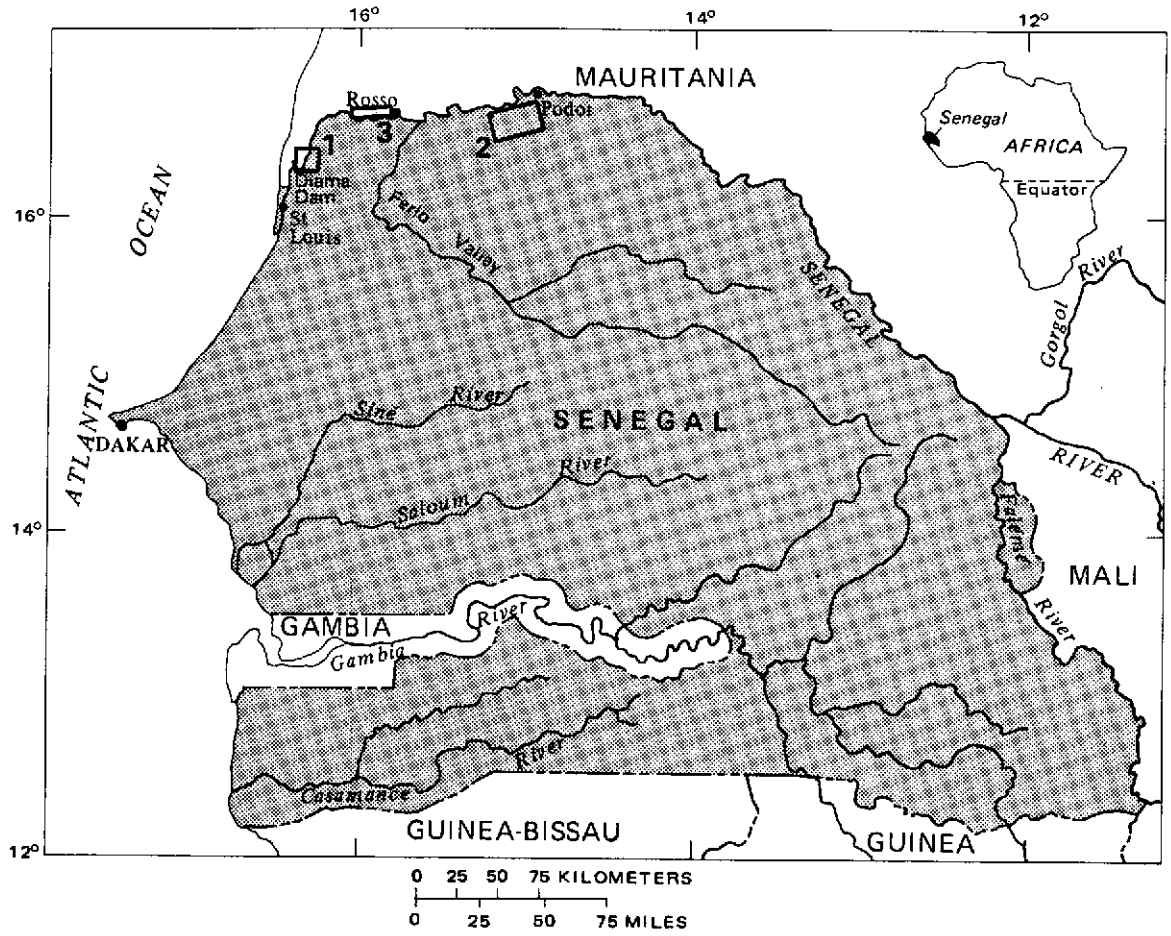

Figure 1. – Location of Senegal area (Numbers refer to areas cited in text where field evaluations were conducted).

EVALUATION OF PIEZOMETER DATA

Because of the large quantity of information available and time constraints, tasks identified to evaluate the piezometer network were as follows.

- o Review overall project goals as related to piezometer placement and installation. This includes review of the Project Paper, associated documents, and findings by earlier consultants.

- o Review the data collected from piezometer wells to date. These data include plots of well locations, lithologic logs, screened intervals, and water levels of randomly selected wells. The wells having plotted water-level hydrographs were randomly selected from both banks of the river, principally along established section lines. The hydrographs are used to determine the relation, if any, among water-level fluctuations, changes in river stage, irrigation practices, dam construction, changes in precipitation patterns, and tidal effects. Wells in which water levels do not fluctuate probably are inoperative and may need cleaning, conditioning, or replacement.

- o Visit randomly selected wells for comparison of constructed depth and actual depth, as well as observation of techniques used for water-level measurements.

combination of sand, silt, and clay. Nearly 80 percent of the piezometers are finished in the fine- to medium-grained sand. Values of hydraulic conductivity given in published technical journals and papers (see Morris and Johnson, 1966 and Ghislain de Marsily, 1986) for these lithologies range from about 1.0×10^{-3} centimeters per second for fine sand to about 1.0×10^{-7} centimeters per second for silt and (or) silty clay. Thus, the results obtained from the project piezometers are reasonable and consistent with accepted values.

Because water levels in the piezometers respond to changes in hydraulic stress, it can be concluded that they are functional. Most of the piezometers visited were within about 4 percent of their designed depth. A few are within 10 percent of the designed depth, but these placement differences are not significant because of the heterogeneous nature of the alluvial material and the difficulty of obtaining representative samples and subsequent definition of the lithology. In summary, the random selection of piezometers for analysis and the favorable results obtained therefrom attests to the reliability of the piezometer installations and operation of the network.

OTHER WORK NEEDED

The objectives of the Senegal River valley project require a system analysis of the entire Senegal River valley. The ultimate objective of the project is to present a method to the Organisation pour la Mise en Valeur du Fleuve Senegal (OMVS) for managing the resource. The large amount of reliable ground-water data available in the valley is suitable for simulation of the flow system by using a digital computer model. The model, once it is properly constructed and calibrated, could be a useful tool for fulfilling this objective. Manual methods of analysis of the data would be tedious, time consuming, and might not be adequate for describing the total flow system. The generalized report outlines that follow indicate the work that is needed in each of the three planned project phases.

PHASE I -- BASIC DATA COLLECTION AND COMPILATION

Work currently (1989) is being completed.

PHASE II -- INTERPRETIVE REPORT ON HYDROLOGY OF SENEGAL RIVER BASIN

Introduction
- Location
- Purpose
- Geography
- Population
- Economy
- Climate (precipitation, temperature, evaporation)
- Geologic setting
- General description, age, and structure of rocks

Hydrology
- Surface water
  - Location of dams, completion dates, and stage
  - Location of stream gages and period of record
  - River-bottom profile
  - River-stage profile
  - Surface-water statistics