Application of WMS in flow discharge prediction for the ungauged Wadi Bougous, Algeria

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INTRODUCTION

Increasing demands for water supply and irrigation schemes due to population growth has encouraged the Algerian deciders to construct a reservoir in Wadi Bougous. Planning is used here to mean the determination of water resources required at the reservoir site to meet a given demand with a specified level of reliability (Adeloye, 1996). Operational difficulties arise from the fact that there is no hydrological data available for forecasting of water outflows and flood events. Facing this situation, a computer program called the Watershed Modeling System (WMS) was used to automatically delineate the drainage basins and determine water volumes (EMRL, 1998).

The objective of this work is to predict streamflow in the ungauged Bougous drainage basin (236 km^2), where a non-calibrated model is used. The Mellah drainage basin (551 km^2), controlled by a gauging station at Bouchegouf (Fig. 1), was used as a basin of reference to validate the rainfall–discharge model from the WMS.

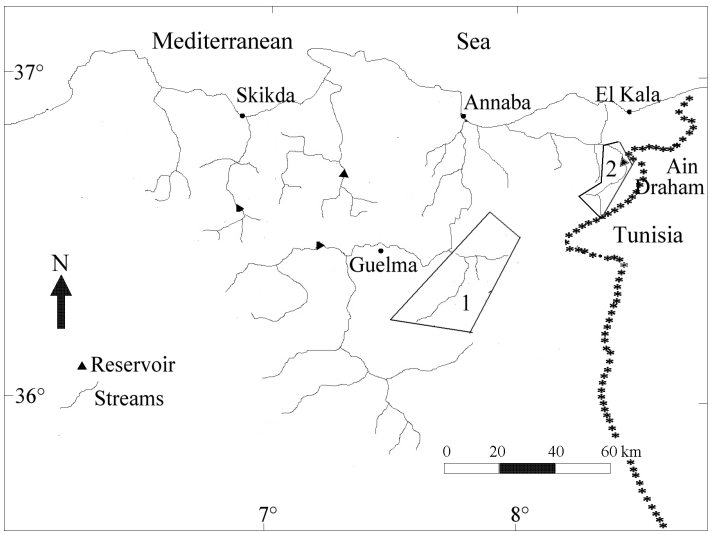

Fig. 1 Location map of the study area. 1, Mellah drainage basin; 2, Bougous drainage basin.

METHODS AND DISCUSSION

The extraction of the watershed divides and hydrographic networks were done using a Digital Elevation Model (DEM) and WMS. Satellite images were used to establish land use maps. Using ArcGIS, the land-use and soil types were digitized in order to make a classification and construct the tables of attributes (themes, perimeter and area). Then, codes were assigned to each theme in the tables of attributes that were later joined to WMS. The classification of themes was done according to the USGS Land Use and Land Cover Classification System, and Hydrologic Soil Group Descriptions.

The determination of the SCS-CN (Soil Conservation Service-curve number) was realized using the GIS module found in the WMS, and that by joining the land use and the soil type database files to shapefile tables. The CN calculated from the WMS model were equal to 71.50 and 82.3 for the Mellah and Bougous basins, respectively.

The simulation of the flow response was done for some storm events of Wadi Mellah using the HEC-1 model and the rainfall distribution type I-24 hours. After the simulation, the predicted water volume was computed using the following SCS runoff equations:

$$Qv\ (m^3) = 10 \times Q \times A;\ \text{with } Q = (P - 0.2 \times S)^2/(P + 0.8 \times S) \text{ and } S = (25400/CN) - 254$$

A, basin area (ha); Q, runoff (mm); P, daily rainfall (mm); Ia, initial retention (mm); S, maximum potential of retention after runoff starts (mm), and CN = curve number.

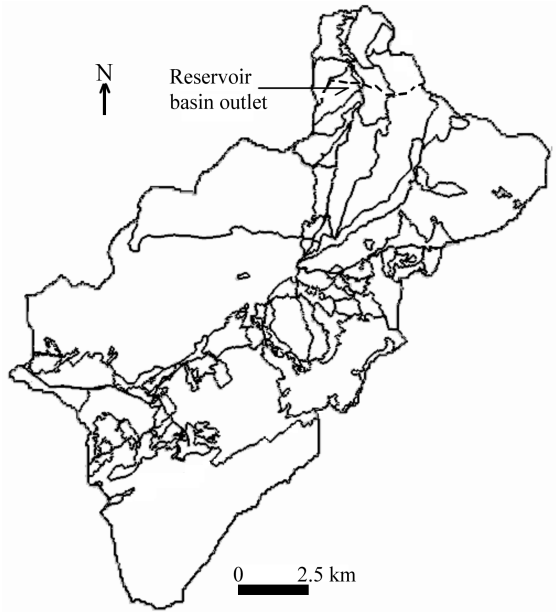

Fig. 2 Crossing of soil type and land-use layers in the Bougous basin.

The calibration done on the selected storm events using observed and simulated hydrographs has given a standard form of the curves where the time of the rising limb depends more on the chosen rainfall distribution function. The model has presented good results on the discharge peaks and volumes of the observed and simulated storm events where the values of the simulated volumes were close to those of the observed ones. As an example, the flood of 6–7 March 1980 had an observed volume of 3.35 Hm^3 and the simulated value was equal to 3.45 Hm^3.

Consequently, the measured and simulated mean annual volumes (1975/76–1998/99) in Wadi Mellah were equal to 104.24 Hm^3 and 100.18 Hm^3, accounting for an underestimation of only 3.89%. For the period 1975/76–2007/08, the predicted mean annual water volume in Bougous drainage basin was 40.69 Hm^3, equivalent to a mean annual water discharge of 1.00 m^3/s. Finally, these results show efficient water availability for reservoir reliability and give some encouragement that, once more data become available, regional estimation procedures might be developed for flow estimation at ungauged sites for use in improved water resources assessments of Algeria.

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