Application of the Hydrological Model MGB-IPH at the Seridó River Basin (Brazil)

Beatriz F. M. Negreiros*[1,2], Joana Darc F. de Medeiros[2]

1 Institute for Modelling Hydraulic and Environmental Systems, Stuttgart, Germany; 2 Universidade Federal do Rio Grande do Norte, Natal, Brazil.

*Correspondence YP: beatriz.negreiros@iws.uni-stuttgart.de

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Abstract

Hydrological modeling is a powerful tool for ensuring sustainable water resources management. The present study applied the large-scale rainfall-runoff model MGB-IPH (the acronym for Large Basins Model and Institute of Hydraulic Research) for modeling a river basin named Seridó. The Seridó river basin is located in the semi-arid Northeast region of Brazil, where water shortage is a frequent problem. The model is calibrated for the period between 1990 and 2000. The model successfully simulates the seasonality of the basin and the contrast between dry and rainy years. However, the discharge values are not adequately predicted by the model. One of the possible reasons for that difference is the presence of many reservoirs in the basin, which are not considered by the model. In conclusion, the present study reveals future research needs in the scope of hydrological modeling of river basins in semi-arid regions.

Keywords: Hydrological modeling, semi-arid region, MGB-IPH, calibration.

Methods

The methods for the present case study involved:

- Generation of the drainage system from the Digital Elevation Model (DEM).
- Pre-processing of the Seridó River Basin using the plugin IPH-Hydro Tools coupled with the geoprocessing software MapWindow.
- Discretization of the basin in sub-basins.
- Manual calibration against observed discharge.
- Assessment of model performance with the Nash-Sutcliffe coefficient NS (Nash et Sutcliffe, 1970).

The study area:

- Drainage area: 10,080 km².
- Low precipitation rates and high temporal variability.

Results

The results of the present case study are:

- The model reproduces the seasonality of the river basin and the contrast between dry and wet years.
- The overall trend suggests that the model overestimates the discharge.
- The model obtains acceptable performance in only one stream gauge (NS = 0.246), while in the other two gauges the NS values indicate unsatisfactory efficiency (NS = -0.127 and -0.42).
- The obtained parameters reflect the physical system: low soil depth and low groundwater flow.
- The lack of sufficient rainfall and stream gauge data are additional challenges that may have hindered the calibration.

Conclusions

- The presence of reservoirs, which are not considered in the MGB-IPH, is believed to be one of the causes for the inadequate model performance. The reservoirs account for, in total, more than 250,000,000 m³ of storage capacity.
- The implementation of reservoir operation in the MGB-IPH model is suggested.
- For future research, automatic calibration may produce better results.
- The present study conveys knowledge for further hydrological modeling of river basins with similar characteristics.

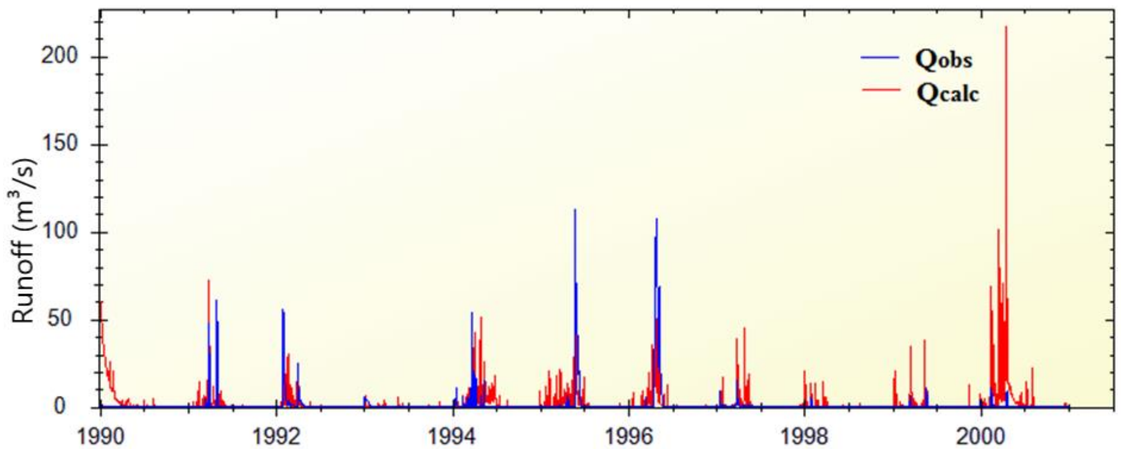

Figure 1: Calculated and observed hydrographs for the gauge station 37559000.

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