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EXTENDED ABSTRACT

Automatic Calibration of the Continuous HMS-SMA Rainfall-Runoff Model using the Metaheuristic Algorithm (Case Study: Kasilian Basin)

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Introduction

Rainfall-runoff simulation models can be used in many water resources applications such as flood control, drought management. Although modeling is both continuous and single-event, continuous modeling has been less important in our country. In continuous models, more hydrological parameters are involved in comparison with single-event models, although this leads to more complicated modeling, but instead of a more realistic conditions of the hydrological system of the watershed will be illustrated and, in continuous systems, the surface water status can be monitored over a long period of time. Single-event models simulate only one incident, hence the moisture content between rainfall events is not considered, in contrast to continuous models of longer periods for estimating the response of the hydrologic information of the basin considered throughout the length of the rainfall events and between them (Lastoria, 2008). The American Hydrological Engineers Center (HEC), along with continuous hydrologic modeling, added the Soil Moisture Accounting (SMA) soil moisture content algorithm based on the PRMS model to the HMS software (Bennett, 1998). In this research, the aim is to provide an automatic calibration model based on the anion colony for the HMS-SMA soil moisture model. In this continuous model, the multiplicity of the considered parameters of the model, in addition to causing the difficulty of calibration by the method of trial and error, which also allows the automatic calibration of the software package to fail. For this purpose, in this research, by selecting a continuous HMS-SMA rainfall-runoff model, an external optimization program (Anion Cluster Algorithm (ACOR)) was used to overcome the weakness.

Methods and Materials

Kasilian basin, the second most famous basin in the country, is between the latitudes of "45 ° 58 ° 35 'and' 45 '07 ° 36 'northern and longitude' 30 '10 ° 53 'to' 30 '17 ° 53' Eastern. For simulation and extraction of Thiessen Polygons from data of 16 years of precipitation (1360-1766), three rain-storm stations on daily scale as well as daily discharge data of Walik-Ben station as the only hydrometric station of the basin for observational discharges were used, also evaporation data of the Sangdeh station were prepared on a daily basis during the aforementioned statistical period. Since the searches are performed locally in these two ways, they have weaknesses such as being sensitive to the initial values of the parameters and are not able to find the optimal response. Therefore, the Metaheuristic algorithm (clone optimization algorithm for ants) has been used for calibration in this research.

Results and Discussion

In the calibration step, according to the results of Table 1, the Nash-Sutcliff and R coefficients for all the mentioned years are more than 0.6 and 0.7, respectively, where the magnitudes of the Nash coefficient -Statistics larger than 0.6 represent an appropriate agreement of observational and computational hydrographs, as shown in Figures 4 and 5.

Table1- Results of Calibration of the SMA Model in any Water Year

Water Year	E	RMSE(m^3/s)	R	PEV(%)
62-63	0/6	0/38	0/78	4/1
64-65	0/76	0/26	0/87	4
69-70	0/6	0/4	0/77	2/1
75-76	0/8	0/21	0/9	0/52

However, in the verification stage, according to Table 2, the Nash-Sutcliff and the R-coefficient for all years, ranging from 71-70, are in an acceptable range of 0.7, respectively. As can be seen from Figures (1) and (2), there is a good agreement between observational and computational hydrographs for all years ranging from 71 to 70 years.

Table2- Results of Validation

Water Year	E	RMSE(m^3/s)	R	PEV(%)
63-64	0/64	0/36	0/81	2/1
65-66	0/7	0/5	0/9	7/4
70-71	0/58	0/81	0/77	15/8
73-74	0/64	0/37	0/81	8/54

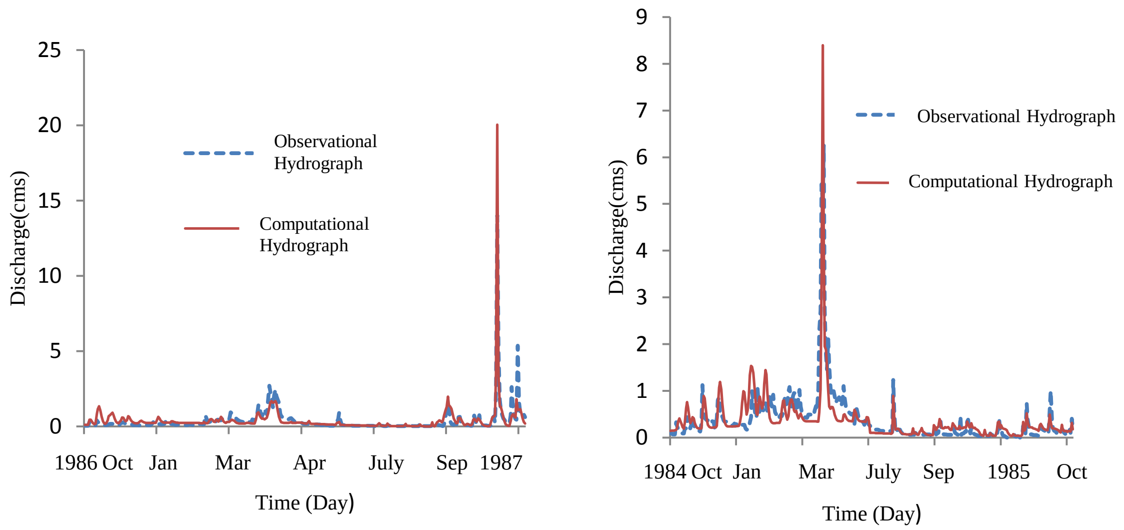

Fig 1- Comparison of Observational and Computational Hydrographs in the Period of Validation of the Years 1966-64 and 66-65

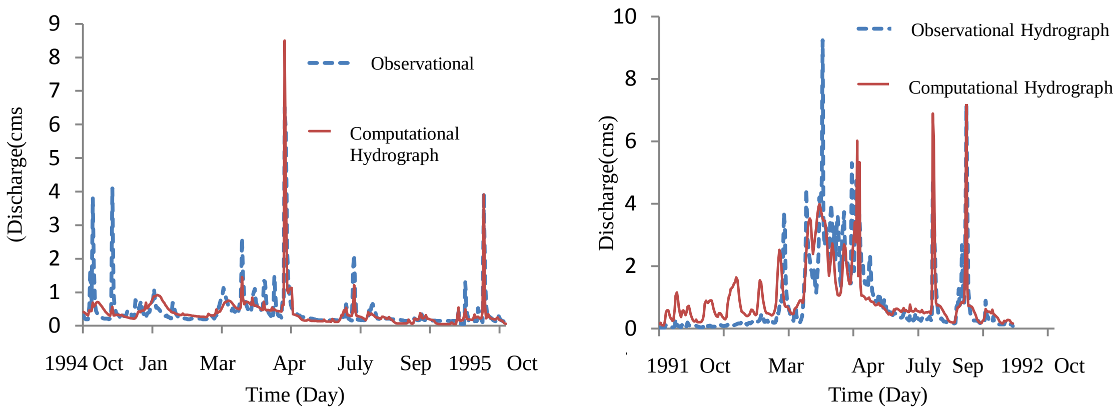

Fig. 2- Comparison of Observational and Computational Hydrographs. Validation Period of Water Years of: 71-70 74-73

The sensitivity analysis of the present study was carried out on a 75-76 year as an example. The value of each parameter was fixed by keeping other values in two values of ± 10% ±. The highest percentage of relative variations was observed in the parameters of maximum soil tensile storage, maximum soil reserves and maximum penetration rate. In other words, these three parameters are the most effective parameters. But for the rest of the parameters, the model has a relative percentage change of less than 1% and even close to zero, indicating the model's insensitivity to these parameters, relative to their variations.

In this study, due to the automatic calibration weakness of the HMS-SMA software and the time-consuming manual calibration, an ant colony optimization algorithm was used for calibration. Therefore, eight years of statistical analysis with different scattering were used to calibrate and evaluate the model. Simulations were performed for each year from about 10 November to 9 May for the first 6 months and from 10 May to 9 November for the second 6 months.

Conclusion

In the results of calibration model that was performed on four years of 63-62, 65-64, 70-69 and 76-75 in two half-years, it was observed that while in the first half of the year accumulation and melting of snow Occurs, a relatively good correlation between observational and computational hydrographs is achieved. In the second half of the year, due to the absence of this phenomenon and the presence of rainfall in the form of rain, better results were obtained. On the other hand, considering that the value of the Nash-Sutcliff criterion for all years is greater than 0.6, the calibration results can be well understood. The best condition in the calibration phase is the 76-75 water year, which has a magnitude of 792 Ns-Sutcliffe. In the validation phase, as well as the calibration of a fairly acceptable adaptation in each year, the Nash-Sutcliff assessment criterion confirms this. From this, the water year 66-65 with a Nash-Satchel content of 0.7 was in acceptable range. In the analysis stage, the sensitivity of the parameters to which the model is sensitive to the variation in their content is the maximum soil tensile strength, maximum soil storage, maximum soil infiltration rate and maximum penetration depth of the soil, while the rest of the parameters are about 1 to 2% or less of these values were affected by the percentage variation of the R and N-Sutcliff measurements. In other words, the model is not nearly sensitive to the changes in these parameters. At the end, the results of this study are compared with the results of other researchers. As it is stated, the results obtained in this study are appropriate and acceptable in comparison with other results.

Resources

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