APPLICATION OF THE CROSS-SIMULATIONS METHOD TO THE ANALYSIS TENDENCIES IN THE RELATION RAINFALL-FLOW: CASE OF THE MEKERRA WATERSHED (ALGERIA)

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Abstract —This article presents the tendencies in the relation rainfall -flow starting from a global conceptual modeling of the flows annual and monthly. The identification of the tendencies was carried out by the application of the approach of the simulations crossed starting from the model GR. The results of the study and cross simulations made it possible to show thatmodel GR1A and GR2M was powerful androbust.showing that there was no stationary activity in the Mekerra watershed during the period 1960-2015, suggesting a downward trend in surface flows.
Keywords—GR, mekerra, trend, rainfall -flow.

1. Introduction

Conducted in the Greater Mekerra watershed show the importance of climate change marked by a drought trend that began in the early 1970s [1, 2, 3, 4, 5]. Exorcises of hydrological modeling global GR. on a local scale and the step of fine time are necessary to improve the forecast of the climatic impacts on the resource. Within this framework, the Studies hydrological response of a basin is influenced by the rainfall (space and temporal distribution of precipitations, intensity and duration). The objective here is the analysis and validation of the tendency of evolution connecting the data of rain and flow on a chronicle of almost 55 years old.

2. Materials and methods

The data used relate to the potential precipitations, evapotranspirations (ETP) (calculated with the method of Thornthwaite) and the flows. The rainfall data come from Sidi bell abbes stations. This station, which is located inside the basin, has been selected for the reliability and spatial and temporal representativeness of their data.

The general tendency to the fall of precipitations during previous periods (1960-1970). This one is estimated at more than 20% in the West, 13% in the central Algerian and 12% in the East of the country, as from the years 1970s, which worsened in the years 1980 and 1990s. The preceding ones in Algeria [2], [7], [8]. Interannual variations in water flows (figure 1), relatively show an important run out water blade, recorded at the measuring station in1972, when the area knew important precipitations.

Application of CEMAGREF's Rural Engineering (GR) models at annual time (GR1A) and monthly time (GR2M). In this work the GR1A version that we use is that proposed by [9], and [10], and for GR2M has known several versions, successively proposed by [11], [12], [13], [14], [9], [15], this final which appears to be the most effective.

The GR1A model has only one optimized parameter, the incremental parameter, which appears as a modulator coefficient of potential evapotranspiration. On a large sample of watersheds, the median of X is 0.7 and a 90% confidence interval is given by [0.13 - 3.5], [16].

Model GR2M is with two parameters optimisables: X1, capacity of the reserve of production (mm); X2, coefficient of exchange undergrounds (mm).

The model is with step of monthly time. It functions goshawks of two tanks, one of production (or ground tank) and the other of routing on the which adjustments and interceptions are done differently on the entries. The model uses in entries the mean rain and the ETP it provided in exit the flow. The median of X1 is worth 380 and one interval confidence at 90% is given by [140 - 2640],

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the median of X2 is worth 0.92 and one interval confidence at 90% is given by [0.21 - 1.31], [16].
Annual model GR1A: The period chosen for the study relates to the rainfall records and the flows of our station being spread out over the period of 1960 to 1990. The validation is used to compare the values which were not used for the calibration and relating to the period (1991-2015).
Monthly model GR2M: Data used for chock relate to the periods (between January 1953 at December 1971), until obtaining a better possible performance of the coefficients of determination, and criterion of Nash (value equal or higher than 70%).
Annual model cross GR.: We use for the chock the data which were used for the validation in the preceding part and for the validation we introduce the data having been used for the chock proceed.

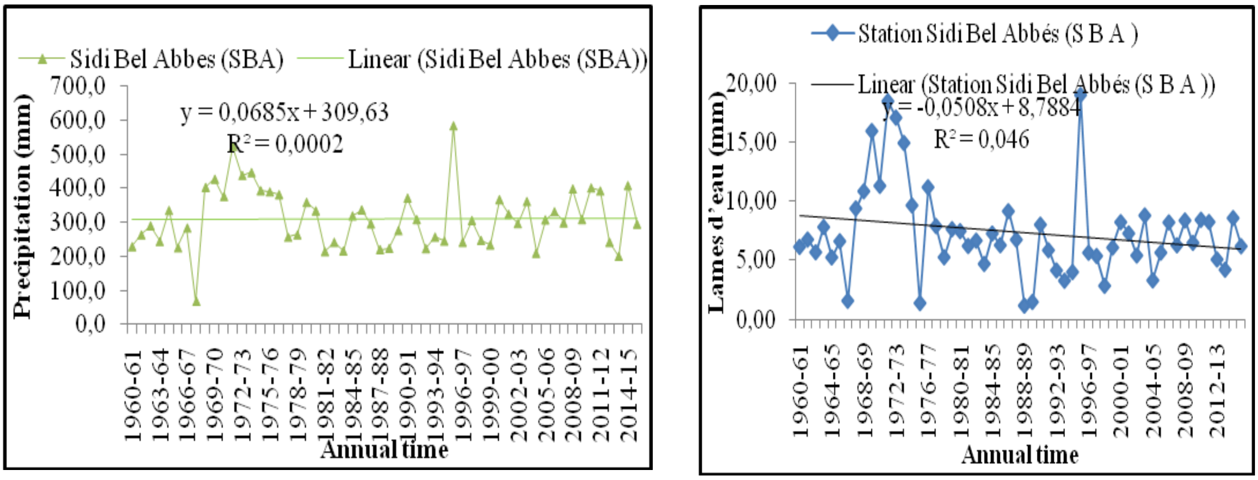

Figure 1. Interannual trend of precipitation and water flows.

3. Results and discussions

Summarize all results of the GR model application based on the time used in the table below.

Table 1: Comparison of results of GR application

		GR1A		GR1A Cruciate		GR2M		GR2M Cruciate	
		Turc	Thorn thwaite	Turc	Thorn thwaite	Turc	Thorn thwaite	Turc	Thornthwaite
Calage	Nash Critère(%)	87,5	87,9	85,2	93,6	87,3	90,1	97,5	98,3
	R^2	0,98	0,93	0,95	0,97	0,95	0,97	0,96	0,98
	X	1,25	0,97	0,79	0,84	0,89	0,90	0,89	0,91
Validation	R^2	0,97	0,97	0,89	0,92	0,78	0,83	0,67	0,73
	X	0,99	0,99	0,94	0,96	0,86	0,87	0,72	0,75

Table 1: Comparison of results of GR application

		GR1A Wet season		GR1A Dry season		GR1A Wettest month		GR1A Drier month	
		Turc	Thornthwaite	Turc	Thornthwaite	Turc	Thornthwaite	Turc	Thornthwaite
Calage	Nash Critère (%)	89	90	87,1	89	91	92,6	91	91,3
	R2	0,93	0,95	0,94	0,96	0,89	0,85	0,97	0,98
	X	0,95	0,97	0,96	0,97	0,90	0,87	0,94	0,96
Validation	R2	0,78	0,83	0,79	0,69	0,65	0,65	0,98	0,97
	X	0,82	0,89	0,80	0,72	0,97	0,79	0,9	0,9

The observations of the values of the criterion of Nash-Sutcliffe in table 1 show that the performed well on the Mekerra watershed. Indeed, the values of the Nash-Sutcliffe criterion obtained are higher than 70%, the correlation coefficient is significant in calage (97%) as in validation (83%), the robustness of the model is acceptable. The hydrograms obtained are also good quality as a whole. The dynamics of the flows being well respected. In general, the peak output is well located in time but is underestimated in the validation phase. . The low water levels are reproduced better than the points of risings.

For the model annual and monthly, chock and validation are significant for all the applications of the model. They vary according to the step of time used. The coefficient of correlation varies between 0,65 and 0,98.

The result of the cross calage is good, confirmed by the values of the criterion of Nash obtained which lie between 97,5 and 98,3%, as well as the good superposition of the curves of the blades of water observed and those calculated and the value of the coefficient of correction of the X1 evapotranspiration which remains rather stable close to 1.

This suggests that evapotranspiration is important. He also explains the interaction with deep water, wi ch leads to underground infiltration and the feeding of the water table throughout the wadi.

The crossed validation, relates to the period (1991-2015). The results of this validation are worse than those found previously during the first simple chock.

The application of the GR. over the seasons, wet and dry gives good results for timing and validation. For the wet season the criterion of Nash varies between 89 and 90% and the assessment are balanced, ranging enough between 70,1 and 83,4. For the dries season the criterion of Nash varies between 87,1 and 89% and the assessment are balanced ranging enough between 73,4 and 78,6.

The application of the GR model for the basin confirms that it is well adapted for semi-arid and aridclimate regions. However, the resulting evapotranspiration of the Thorntwaite formula yields bette r results than that of Turc. This reinforces the work already carried out on several basins in Algeria[17]

4. Conclusion

The present study consisted in analyzing the synchronous tendency of the relation rainfall -flow observed in the zone of study attests that the mode of the courses depends on the precipitated water blade. The application of the model GR. and the method of cross simulations were considered it able to detect changes in the tendencies of the relation rain-flow of the catchment area of Mekerra.

These results validate the assessment of the impact of climate change on the scale of small watersheds, thus ensuring effective decision-making by local water management actors and climate projections for future generations.

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