NOVEL APPROACH TO ESTIMATE RUNOFF IN SEMI-ARID AREA. CASE STUDY OF THE BASIN OF OUED DJELFA-Melah (ALGERIA)

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Abstract

The critical hydrological situation in semi-arid area vs. the problem of availability of water resource , let us to think about application of new method to assess the surface runoff for purpose of establishment the hydrological water of a hydrological system.

The quantification of annual flows is paramount to assess the surface water resources. A new model was developed based on three parameters to the time of concentration, precipitation and the shape compactness index of the watershed.

We have simulate the average annual runoff for a random observed precipitations, the result obtained are compared to several empirical formulae used for the evaluation of runoff. Its performance is evaluated by the criteria of Nash, RSME, and MAE. This model has been tested and applied in the basin of Djelfa which characterized by a semi-arid climate, the average annual runoff calculated for the region for shape index of 1.41 and concentration time of 13.41 hours is about 9 mm. The high part of runoff was losted by the Eavpotranspiration and by the infiltration.

Keys Words: Runoff, water resources, time of concentration, shape compactness index, Djelfa basin

I. Introduction:

Surface runoff is an important parameter in the hydrological cycle (E.Berkaloff et all, 1954); the amount of annual flow is depending on lotof parameters that control the surface runoff. In semi-arid area the increases of temperature; decreases of relative humidity and the saturation vapor pressure reduce the permanent runoff. Semi-arid areas are characterized by a moderate rainfall and by continuous augmentation in average temperature and the vapor pressure, whose favorite the evapotranspiration. These areas were characterized by the lake of permanent water flow. Modeling of surface runoff is important in the water resources management (R.L.Kashyap et all 1976). The surface runoff is depending on two principle factors: climatic factors (Rainfall intensity and duration, direction and velocity of wind); and physiographic factors (the shape, the slope and land use of the watershed) (George Writer, 1903).

II. Study area:

The Basin of Oued Djelfa Melah (Fig.1) with an area of 1300 km², was located at 300 km from the capital of Algeria, the basin was located between 2° and 3° 5 East longitude and between 33° and 35° North latitude; it was characterized by a moderate rainfall (about 300 mm) an average annual temperature (about 16°C) (Ali Rahmani et al, 2015).

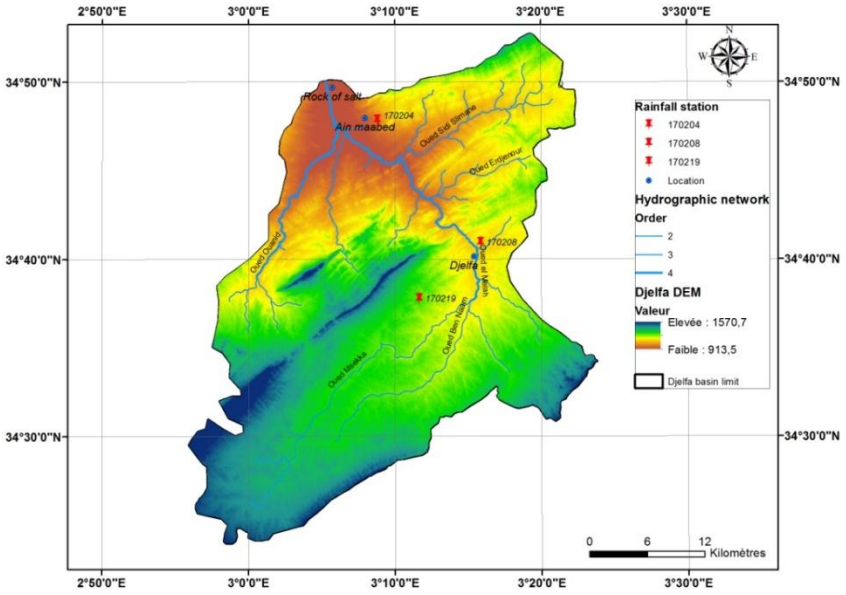

Fig.1 the basin of Oued Djelfa melah

III. Methodology:

Based on two formulae Chibane & al and Tixeront model; we have introduced two principle characteristics of the basin which the previous models don't tacked into account (the concentration time (tc) and the shape index of the watershed (Kc). We get simulate the model to obtain Runoff for tc varies between 1 to 15 hours. The general equation of this model was given by the equations (1 & 2)

$$\text{Runoff} = [\tau . \text{P}]^{0.78} \quad \text{(eq.1)}$$

$$\tau = \frac{1}{K_c \times t_c} \text{ (eq.2)}$$

With:

Runoff: average total annual runoff given in mm; τ: [hours^{-1}] ; P: average annual precipitation in mm; tc: concentration time in hours; Kc: shape index of the watershed (compactness coefficient)

IV. Results and discussion

The primary results of the application of this model were presented in this section, the contour plots in figures (Fig.2, 3, and 4) represent the variation of the runoff estimated by the three model (Romantchok, 1974), (Chibane & al, 2015) and the new model; vs the average annual temperature and the annual rainfall. We have seen that the model of Romantchok and Chibane, can't tack the watershed settings who control really the flow and surface runoff in these kind of basin, it tack only the annual precipitation as primary input. These models overestimate the surface runoff in semi-aride region, which characterized by large area, and the complicated soil classification and the high temperature who reduce the amount of runoff. In the other side, we observe that runoff

is not depend only on the precipitation, the dimensions and physical settings of the basin, also play a role in the runoff generation (Bernard N. Lenz &all, 2003); the example tacked in this study have a tc of 14 hours which mean that the water flow tack 14 hours to get arrive at the embouchement of the basin, where a lotof processes (infiltration, Evapotranspiration) reduce the runoff portion along the way of the streams.

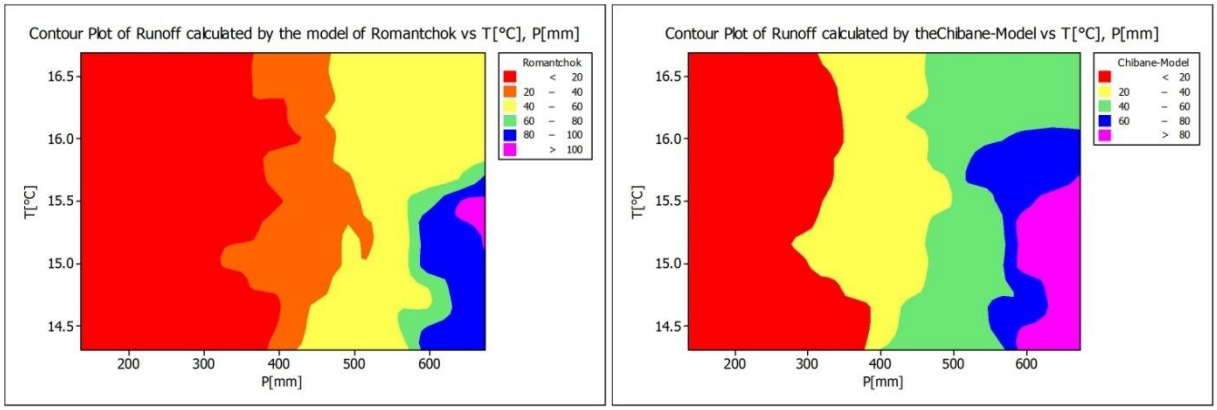

Fig.2: Runoff variation in function of annual rainfall and the average annual temperature, calculated by the model of (Chibane & all, 2015) and model of (Romantchok, 1974) for the region of Djelfa.

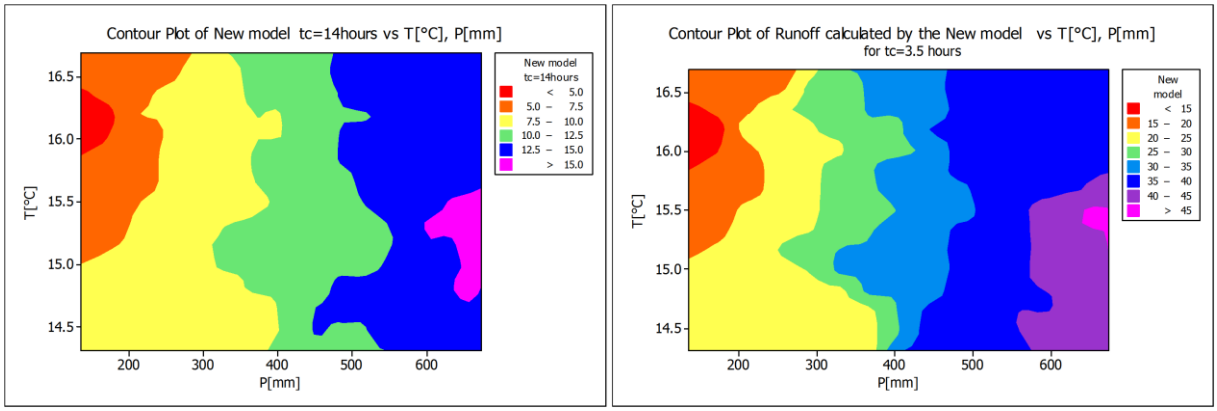

Fig.3: Runoff variation in function of annual rainfall and the average annual temperature, calculated by the new model for the region of Djelfa Kc=1.42 with two cases (tc ≈14hours, and tc ≈3.5hours)

The model of Romantchok and Chibane give the same value independently to the configuration of the basin (compactness coefficient and concentration time), also it is clear that the response of our new model is the same with the other model if (tc=3.5 hours). Which have a coefficient of fitness of 0.99.

In this case we have calculate the error of modeling by tacking the model of Romantchok as reference and the concentration time equal to (3.5hours).

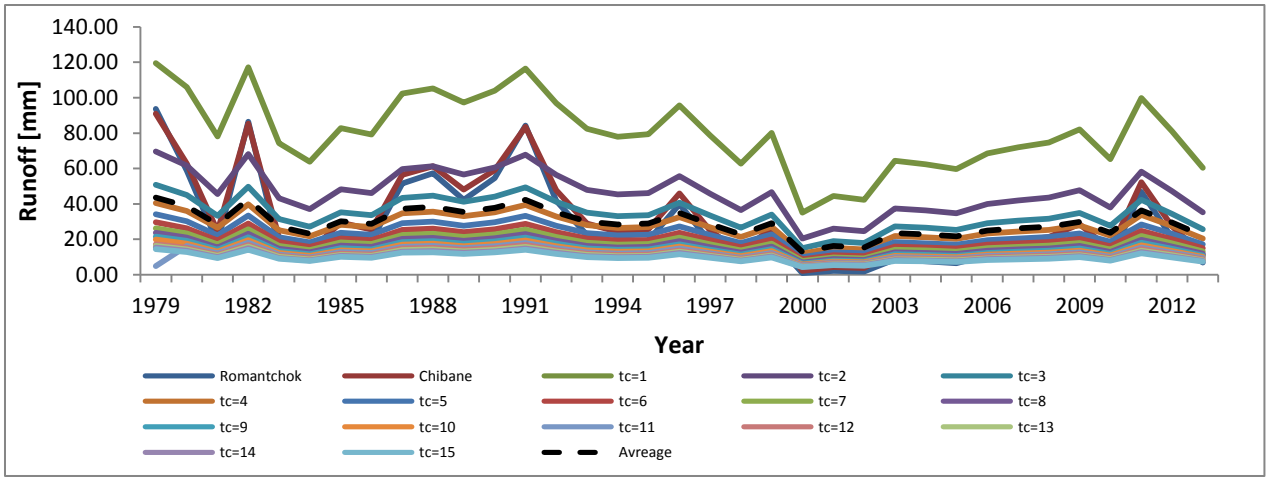

Fig.4: annual variation of runoff estimated by the three models (Romantchok 1974, Chibane 2015 and the new model, tc is the concentration time given in Hours).

Table-1 Performance of modeling vs the model of reference of Romantchok

	New model vs Romantchok	Chibane vs Romantchok
Nash	0.747	0.979
MAE	15.045	4.882
RMSE	17.801	5.166
AME	54.175	17.578

V. Conclusion

A new model to quantify the annual runoff was developed in this work; this model is based on three parameters; the rainfall as primary input, the shape index of the catchment (Compactness coefficient) and the concentration time as secondary inputs. The results of this model were compared to the model of Chibane and the model of (Romantchok, 1974).We has applicated this model to assess the surface runoff in semi-arid area.

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