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Reducing the uncertainty of the BBH water balance model using the Budyko framework

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Time distribution of soil moisture is simulated by BBH model on the daily scale time at catchment's level for a three years period. During this period, observations of climatic variables (temperature, humidity…) are available at the daily scale.

This model is applied assuming a one layer vertical column and coupled with the FAO Penman-Montheith.

The case study is an olive field area (30690 ha), alimented by rainfall inputs, in a semi-arid region. In the lack of soil moisture observations and giving the availability of fuzzy runoff observations, intervals of variation for parameters are derived in comparison with the literature and with reference to the soil and climate characteristics.

In a second stage, a calibration of the BBH parameters is undertaken adopting a rainfall-runoff transformation (SCS CN model). The parameters of the SCS CN model are estimated according to physiographic information (FAO 25). Hence, SCS model outputs are taken as reference data to reduce the interval of variation of the BBH parameters.

In fact, this lack of soil moisture observations introduces an important uncertainty about BBH model parameters. To take this uncertainty into account, an ensemble of twenty parameters sets is performed to simulate twenty different responses for the BBH model.

In the third stage, Budyko frame work is adopted to diminish the uncertainty about these parameters. Budyko relationships relate (a) average precipitation and runoff and also (b) average annual precipitation and annual actual evapotranspiration through a puissance model involving a single parameter k.

For this purpose, the twenty models are run for a long series of 17 years for which climatic data are available. Annual averages of the resulting BBH water balance responses are thus computed. Average precipitation, evapotranspiration and runoff are used to build the Budyko dryness index for each model. Conversely to Budyko assumptions, we include the groundwater, percolation and capillarity components resulting from BBH simulations, into the Budyko equation. Each BBH parameters set induce a single "observation" point in the derived Budyko curve (a and b) corresponding to the climatic data of the site study.

Finally, assumptions about k are adopted and the "observation" points are evaluated against the nearest k value considering curves a_k and b_k. This methodology led to retain two sets of BBH parameters corresponding to k=1.3.