STAHY2017-27
STAHY 2017 workshop,
21–22 September 2017, Warsaw, Poland

A new Budyko – ARMAX framework to simulate the water balance on monthly and annual scales: Application to Atbara and Blue Nile watersheds

Ayman Awadallah (1), Mohamed Mostafa (1), Mohammed Haggag (2), and Ahmed Abdelbaki (1)

(1) Fayoum University, Faculty of Engineering, Civil Eng. Dept., Fayoum, Egypt, (2) Cairo University, Faculty of Engineering, Irrigation and Hydraulics Dept., Giza, Egypt

A comprehensive assessment of the partitioning of precipitation (P) into evapotranspiration (E) and runoff (R) using a simple parsimonious model gained new interest with the climate change studies. For climatological averages, the Budyko Framework (BF) provides a simple first-order relationship to estimate water availability represented by the ratio E/P as a function of the aridity index (Ep/P, with Ep denoting potential evaporation). The Budyko Framework (BF) is an effective approach for investigating long-term water balance at large basin scale under steady state. The assumption of steady state prevents applications of the BF under unsteady state, such as the monthly time step.

In this study, we propose to englobe the Budyko framework within an AutoRegressive Moving Average with eXogenous variables (ARMAX) model to account for the inclusion of precipitation and evaporation of previous months to predict the current monthly runoff associated with an ARMA error term. The approach is more generalized than the modifications undertaken on the BF through the inclusion of new constant terms in the equation, as proposed recently by Greve et al. (2016) and Du et al. (2016). The proposed Budyko-ARMAX model is applied on the monthly and annual scales of Atbara and the Blue Nile. The inputs to the model are the areal averages of the precipitation and the potential evapotranspiration, available from the global datasets of the GPCC and CRU. The obtained results are satisfactory with Nash-Sutcliff Efficiencies (NSE) of 0.91 and 0.93, for monthly flows of Atbara and Blue Nile, respectively; and 0.61 and 0.73, for annual flows of Atbara and Blue Nile, respectively. These NSE are much higher than the ones obtained from either an ARMAX model alone without introducing the BF or with a BF alone, especially on the annual time scale.

Du, C., Sun, F., Yu, J., Liu, X. and Chen, Y. (2016) New interpretation of the role of water balance in an extended Budyko hypothesis in arid regions, Hydrol. Earth Syst. Sci., 20, 393–409, doi:10.5194/hess-20-393-2016

Greve, P., Gudmundsson, L., Orlowsky, B. and Seneviratne, S.I. (2016) A two-parameter Budyko function to represent conditions under which evapotranspiration exceeds precipitation, Hydrol. Earth Syst. Sci., 20, 2195–2205, doi:10.5194/hess-20-2195-2016.