Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2020-353-AC1, 2020

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Diagnosis toward predicting mean annual runoff in ungauged basins" *by* Yuan Gao et al.

Yuan Gao et al.

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Received and published: 8 September 2020

Dear Reviewer: Thank you for your comments. Our responses to the comments are listed below: (1) How the soil water storage is determined? It varies at seasonal scale. How does it will affect your analysis? It is worth to highlight following article that developed a three parameter streamflow elasticity model as a function of precipitation, potential evaporation, and change in groundwater storage applicable at both seasonal and annual scales. https://hess.copernicus.org/articles/20/2545/2016/

Soil water storage capacity in this study is referred to as the maximum storage capacity from the land surface to the bedrock; therefore, it is considered as a static variable. The effective storage capacity or the remaining storage capacity could vary temporally due

to the dynamics of groundwater storage as shown in Konapala and Mishra (2016). The definition of the soil water storage capacity will be clarified in the revised manuscript.

Konapala, G., and Mishra, A. K. : Three-parameter-based streamflow elasticity model: Application to MOPEX basins in the USA at annual and seasonal scales., Hydrol. Earth Syst. Sci., 20, 2545-2556, https://doi.org/10.5194/hess-20-2545-2016.

(2) What do mean by Climate variability in your study? does it mean distribution of climate variables, for example, distribution of rainy days with in the season. This type of analysis are important and they have a direct influence on the soil water storage. This can be discussed as a scope of the future work. The magnitude and seasonality of the climate variables affects water availability (storage). This may be included as a future scope of the work. Please see this article: https://www.nature.com/articles/s41467-020-16757-w

Following Yao et al. (2020), the climate variability in this study is defined as the temporal variations of the precipitation (P) and potential evapotranspiration (Ep), including their intra-monthly, intra-annual, and inter-annual variations. For example, the deviations of daily P or Ep from its monthly mean values are defined as the intra-monthly variations. The definition of the climate variability will be included in the revised manuscript. In addition, we totally agree with you that the distribution of rainy days, the magnitude and the seasonality of climate variables have direct impacts on the soil water storage. In the revised manuscript, we will include the discussion on quantifying the climate variabilities, e.g., the distribution of rainy days, the mean and the seasonality of climate, and exploring the impacts of these characteristics on soil water storage capacity as a scope of our future work. Yao, L., Libera, D. A., Kheimi, M., Sankarasubramanian, A., and Wang, D (2020).: The roles of climate forcing and its variability on streamflow at daily, monthly, annual, and longâĂŘterm scales. Water Resour. Res., 55, e2020WR027111. https://doi.org/10.1029/2020WR027111.

(3) Are you using SCS method to find the infiltration loss? Does this loss is connected

to shallow water storage?

Yes. Infiltration loss is computed by Equation (2) which leads to the proportionality relationship of SCS method. The value of infiltration loss is dependent on the shallow water storage condition, which affects the remaining storage capacity. The “normal antecedent moisture” in the SCS curve number method is treated as the storage at the long-term steady-state condition. Therefore, the maximum storage capacity is the sum (Equation (5)) of storage capacity computed by the SCS curve number (Equation (4)) and long-term average storage.

(4) Baseflow plays an important role in the runoff analysis. Are you including this factor in your analysis. Can addition of the seasonal baseflow characteristics will improve the results?

We agree that baseflow plays an important role in total runoff which includes baseflow and surface runoff. But this research is focused on total runoff; therefore, baseflow is not explored separately in this study. One the other hand, the seasonal characteristics of baseflow are results of climate seasonality, which is implicitly included in the daily climate input. This will be clarified in the revised manuscript.

(5) How the curve numbers are derived? Did you derive the composite curve numbers, i.e., one value for a watershed?

Yes, each watershed has one curve number, which is the average curve number over the grid cells within the entire watershed. For each grid cell, the curve number is obtained based on land use and land cover and hydrologic soil group as introduced in Section 2.2.1. The composite curve number for each watershed will be clarified in the revised manuscript.

(6) How the bedrock topography are determined?

The bedrock topography data of the study catchments are not available from observations in this study; therefore, we used a hypothetical bedrock topography obtained

through Height Above the Nearest Drainage (HAND) method which assumes that the bedrock of each hillslope is horizontal and the bedrock elevation equals the elevation of the drainage point.

(7) I assume the shape parameter is kept constant for a given watershed, and it is calculated based by creating a time series based on the spatial (gridded) soil water capacity values. How the shape parameters are calculated? For example, Maximum Likelihood methods?? Do you think the parameter uncertainty (range) will affect the mean flow?

Yes, the shape parameter is kept constant for a given watershed. While, it is calculated by creating the spatial soil water capacity values at the long-term averaged antecedent soil moisture condition. A nonlinear programming solver using derivative-free method, i.e., Matlab function “fminsearch”, was used to calculate the optimal shape parameter by minimizing the root mean square error (RMSE). The method will be clarified in the revised manuscript. Yes, the parameter uncertainty will affect the mean annual runoff which can be seen by comparing Figure 5a and 5c. For each catchment, the value of the average soil water storage capacity is same between these two figures, and the different simulation performance is only caused by the shape parameter. Clearly, the shape parameter could affect the mean annual runoff. In the revise manuscript, the sensitivity analysis of the mean annual runoff to the shape parameter will be conducted.

(8) Line 98-100: Can be revised to make it simple.

Thanks. This sentence would be revised as: The mean of the distribution is estimated from curve number and climate because the soil water storage capacity consists of the antecedent soil water storage and the potential maximum soil moisture retention which can be calculated through SCS curve number method.

Please also note the supplement to this comment:
https://hess.copernicus.org/preprints/hess-2020-353/hess-2020-353-AC1-

supplement.pdf

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