This paper proposes a new method to estimate the spatial distribution of soil water storage capacity in catchments based on DEM and long-term water balance data. The shape parameter of the distribution is estimated based on HAND values derived from DEM. The average storage capacity over a catchment is estimated, by the MCT method, from climatological and vegetation data (i.e., long-term precipitation, runoff and seasonal NDVI). This method is evaluated in an experimental catchment and MOPEX catchments. This paper provides a novel method to estimate the spatial distribution of soil water storage capacity, which is an important feature for catchment hydrology but is usually not available. I have some comments for the authors to consider before the publication.

Comments:

1. As shown in Figure 2, saturated area and runoff coefficient is dependent on the initial soil moisture condition ($\frac{S_u}{S_{uMax}}$). However, within a time step (daily in this paper), rainfall in the early time causes the increases of $\frac{S_u}{S_{uMax}}$ and runoff coefficient. Therefore, the runoff coefficient during a day is also affected by rainfall, and runoff coefficient is a function of $\frac{S_u}{S_{uMax}}$, β, and $\frac{S_{uMax}}{P_e}$ (Moore, 1985; Wang, 2018). Given the values of $\frac{S_u}{S_{uMax}}$ and β, equation 12 in Table 2 underestimates $\frac{R_u}{P_e}$ in a day, and this underestimation increases with increasing rainfall depth. Similarly for HSC module, if A_s is determined by $\frac{S_u}{S_{uMax}}$ at the beginning of a day, the effect of P_e on runoff coefficient is not considered.

2. For HSC and HSC-MCT modules: the relationship $A_s = f(S_u/S_{uMax})$ is obtained from the HAND values (Figure 2d). This relationship can be obtained by fitting a distribution function to the CDF of normalized HAND values (e.g., Figure 2b). For example, if the distribution used in Xinanjiang (Zhao, 1992) and VIC (Wood et al., 1992) is applied, the CDF of storage capacity is:

$$F(C) = 1 - \left(1 - \frac{C}{C_m}\right)^{\beta} \quad (1)$$

The mean value of storage capacity is:

$$S_{uMax} = \frac{C_m}{\beta+1} \quad (2)$$

Substituting C_m from equation (2) into equation (1), we obtain

$$F(C) = 1 - \left(1 - \frac{1}{\beta+1}\frac{C}{S_{uMax}}\right)^{\beta} \quad (3)$$

$\frac{C}{S_{uMax}}$ is the normalized HAND values (HAND values divided by its average) in Figure 2b. The value of β is estimated by fitting the distribution. Then the relationship $A_s = f(S_u/S_{uMax})$ is obtained:

$$A_s = 1 - \left(1 - \frac{S_u}{S_{uMax}}\right)^{\frac{\beta}{\beta+1}} \tag{4}$$

The curve for $A_s \sim \frac{S_u}{S_{uMax}}$ is concave since $\frac{\beta}{\beta+1} < 1$. $A_s \sim \frac{S_u}{S_{uMax}}$ for HBV is concave or convex. The distribution corresponding to the SCS curve number method is another alternative (Wang, 2018), and the CDF is written as:

$$F(C) = 1 - \frac{1}{a} + \frac{\frac{C}{S_{uMax}} + 1 - a}{a\sqrt{\left(1+\frac{C}{S_{uMax}}\right)^2 - 2a\frac{C}{S_{uMax}}}} \tag{5}$$

Where a is the shape parameter. The $A_s \sim \frac{S_u}{S_{uMax}}$ relation for equation (5) is:

$$A_s = 1 - \frac{1}{a} + \frac{\frac{C}{S_{uMax}} + 1 - a}{a\sqrt{\left(1+\frac{C}{S_{uMax}}\right)^2 - 2a\frac{C}{S_{uMax}}}} \tag{6}$$

Where $\frac{C}{S_{uMax}} = \frac{\left(2 - a\frac{S_u}{S_{uMax}}\right)\frac{S_u}{S_{uMax}}}{2\left(1 - \frac{S_u}{S_{uMax}}\right)}$. It is interesting to test the goodness-of-fit of these two distributions (equations 3 and 5) to the empirical $A_s \sim \frac{S_u}{S_{uMax}}$ from the HAND-based values.

3. Line 167: I guess that "SEF" represents "saturation excess flow". But spell out "SEF" which is not defined before. Same for SOF and SFF.
4. It may be good to add a map to show the spatial distribution of S_{uMax}.
5. For figures with subplots, it is better to add "(a)" and "(b)", e.g., Figure 7 and Figure 8.
6. In the comparison of Figure 7a, is it possible to convert the distribution of TWI information to $A_s \sim \frac{S_u}{S_{uMax}}$ and add it to Figure 7a?
7. In Figure S4 (catchment 08171000), the calibrated β for HBV is about 1.8. $\beta = 1.35$ is very close to the curve of HSC. But it seems that the performance of HSC is better than HBV (lines 500-501 and Figure S3). Since β of HBV is calibrated, why is the calibrated value of β not around 1.35? Is this due to the effect of other calibrated parameters? Discussion on this may be helpful.
8. This comment is related to the previous one. For the comparison between HSC and HSC-MCT, is the calibrated S_{uMax} for HSC similar to the estimated S_{uMax} by MCT method? How about the other calibrated parameters (e.g., D, K_f, K_s, T_{lagF}) among the models (HBV, TOPMODEL HSC, and HSC-MCT)?

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