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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Using the nonlinear aquifer storage–discharge relationship to simulate the baseflow of glacier and snowmelt dominated basins in Northwest China" *by* R. Gan and Y. Luo

R. Gan and Y. Luo

luoyi.cas@hotmail.com

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Dear editors and reviewers,

The comments and suggestions are appreciated. Accordingly, we have revised the manuscript. Following are the point to point reply to the comments and suggestions.

Comments: First to the references:

- page 5536, line 20: Replace "Ferker" by "Ferket"! - page 5539, line 2: Replace "Neistch" by "Neitsch"! - page 5539, line 16: Replace "Morasi" by "Moriasi"! - page 5541, line 15: Replace "Morasi" by "Moriasi"! - page 5547, line 28: Replace "Paolo, V."

by "Villani, P."!

Response: They are typos. We made the changes in the revision, "Ferker" into "Ferket" (P2 L7, section1 in revised manuscript); "Neistch" into "Neitsch" (P4L10, section 2.1 in revised manuscript); "Morasi" into "Moriasi" (P5L24, section2.3 in revised manuscript); "Morasi" into "Moriasi" (P8L10, section3.2 in revised manuscript); "Paolo, V." into "Villani, P." (P17L24, References in revised manuscript).

Comments: As far as I see the following references are listed at the end of the paper but not used in the text: Chu and Shirmohammadi (2004), Eckhardt (2008), Essery (1992), Kirchner (2009), Peterson and Hamlet (1998), Rupp and Woods (2008), Samuel et al. (2012), Szilagyi et al. (2007), and Wittenberg and Sivapalan (1999).

Response: We forgot to remove the redundant references from the list while preparing the manuscript. The redundant references were removed.

Comments: Please clarify the following points: Baseflow is usually associated with groundwater discharge into a river. The baseflow modelled by SWAT is just this: groundwater discharge. The baseflow which is calculated with the filter algorithm is different: It is the low frequency component of the streamflow. As such, it will not only comprise groundwater discharge, but probably also the melting water, which plays an important role in the investigated catchments. Is it really meaningful to compare SWAT output and the results of the filter?

Response: Agree. The filter distinguishes the quick frequency and low frequency components of the streamflow. The low frequency component is believed to be related mainly to the groundwater discharge while it may be comprised of low frequency part of some other runoff components. It is not critically important to compare the SWAT output and the results of the filter. However, it might be helpful for assessing the baseflow simulated by SWAT model in case the baseflow measurements are unavailable.

Comments: page 5539, line 12-13: The parameters of the non-linear model are calibrated. Are the parameters of the other models calibrated as well? If yes, how? If no, the comparison of the different models is unfair.

Response: We compared the results of the non-linear reservoir approach with the two-linear reservoir approach (Luo et al., 2012). Parameters of these two approaches all were calibrated. Luo et al. (2012) incorporated the two-linear reservoir approach into SWAT model and calibrated the baseflow parameters through comparing the simulated and observed low flow assuming that the baseflow is the main component of the streamflow during low flow periods. For the non-linear reservoir approach, the parameters a and b were obtained by fitting the following time variable discharge rate curve by Eq. (1) (Wittenberg, 1999) to the streamflow records during the low flow periods of Manas River.

$$Q_t = Q_0[1 + (1-b)Q_0^{1-b}t/ab]^{1/(b-1)}$$

where Qt is the discharge rate at time t, and Q0 is the discharge rate at the beginning of interest.

Comments: page 5540, line 10: "the nonlinear relation performs much better" - this is not clearly visible from Fig. 2.

Response: The comment is highly appreciated. It was a pity that we pasted a wrong graph during preparing the manuscript. The correct graphs should be as in Fig. 1.

Comments: page 5542, line 25-26: The findings of Partington et al. (2012) are not very significant because they are solely based on model results.

Response: Agree. This reference is not serious significant to the manuscript and thus removed.

Comments: page 5543, line 2-3: "There is a good agreement in the baseflow patterns

of the SWAT and filter methods" - I do not agree with this statement.

Response: Agree. This statement is not accurate. We deleted this sentence. Results of the filter can be a reference for that of the SWAT model. Yet, comparison of them seems not critically important.

Comments: page 5543, line 4: "the direct surface runoff [...] ceases recharging the groundwater"- Direct runoff never recharges the groundwater.

Response: Agree. We rephrased this point as "when recharge to the groundwater from the upper soil layer ceases" (P11L21, section 3.3 in revised manuscript).

Comments: page 5544, line 3-4: "in the digital filter method, streamflow consists of surface runoff and baseflow" - This is wrong. The filter distinguishes direct runoff (streamflow component varying with high frequency, usually associated with surface runoff and interflow) and baseflow (streamflow component varying with low frequency, usually associated with groundwater discharge).

Response: We rephrased this point as "Additionally, the streamflow in the SWAT model is comprised of surface runoff, lateral subsurface flow, and baseflow (groundwater discharge), while in the digital filter method, streamflow is distinguished as direct runoff (streamflow component varying with high frequency, usually associated with surface runoff and interflow) and baseflow (streamflow component varying with low frequency, usually associated with groundwater discharge and probably also the melting water). This may be the reason for that the digital filter method gives a much larger baseflow volume than the model-based approaches. Direct comparison of the baseflow of SWAT model and the filter might not be proper. However, the result of the filter is still a reference for the SWAT model due to availability of and difficulty in measuring the baseflow data".

Comments: page 5546, line 5-7: "the nonlinear aquifer storage–discharge approach performs as well as the two-linear reservoir approach [...] and [has] only two parame-

ters that must be calibrated." - Two linear reservoirs have two parameters as well.

Response: According to Luo et al (2012), there are totally five parameters for the two-linear reservoir approach to be calibrated. The five parameters are list in Table 1

Comments: page 5546, line 8-10: "The parameters a and b in the exponential function that describe the aquifer storage–discharge relationship can be calibrated independently from the observed streamflow data." - On page 5539, line 12-13, it is said that "The parameters a and b can be optimized by fitting the calculated discharge curves to the observed recession curves" and I thought this was done so. How can a and b be calibrated independently from the observed streamflow?

Response: We did not express correctly. We ought to express it as "The parameters a and b in the exponential function that describe the aquifer storage–discharge relationship can be optimized through the observed streamflow data during the recession periods independent of the SWAT model."

Comments: Finally, some minor corrections: - page 5537, line 13: Omit "river"! - page 5540, line 22: Omit "to give"! - page 5541, line 3: Omit ""simulation"! - page 5561, Fig. 7: Omit "in" in the caption of the ordinate! Units are missing in the equation for S.

Response: We deleted the words "river"; "to give"; "simulation"; and "in" in the revised manuscript.

References:

Luo, Y., Arnold, J., Allen, P., and Chen, X.: Baseflow simulation using SWAT model in an inland river basin in Tianshan Mountain, Northwest China, Hydrol. Earth Syst. Sci., 16, 1259–1267, 2012.

Partington, D., Brunner, P., Simmons, C.T., Therrien, R., Werner, A.D., Therrien, R., Maier, H.R., and Dandy, G.C.: Evaluation of outputs from automated baseflow separation methods against simulated baseflow from a physically based, surface water-

groundwater flow model, J. Hydrol., 458–459, 28–39, 2012.

Wittenberg, H.: Baseflow recession and recharge as nonlinear storage processes, Hydrol. Process., 13, 715–726, 1999.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 5535, 2013.

Table 1 Baseflow parameter values for one reservoir and two reservoir approaches in SWAT and the automated baseflow filter program for Manas River basin, Tianshan, China

Model	Parameter	unit	Initial value	Calibrated value
One reservoir	$\delta_{gw,sh}$	day	10-30	15
	$\alpha_{gw,sh}$	-	0 - 1	0.4
	β	-	0	0
Two reservoirs	$\delta_{gw,sh}$	day	10 - 30	15
	$\alpha_{gw,sh}$	-	0 - 1	0.4
	$\delta_{gw,dep}$	day	10 - 300	127
	$\alpha_{gw,dp}$	-	0 - 1	0.05
	β	-	0 - 1	0.4
Filter program	λ	-		0.925
	α	-		0.018
	baseflow days	day		127.9

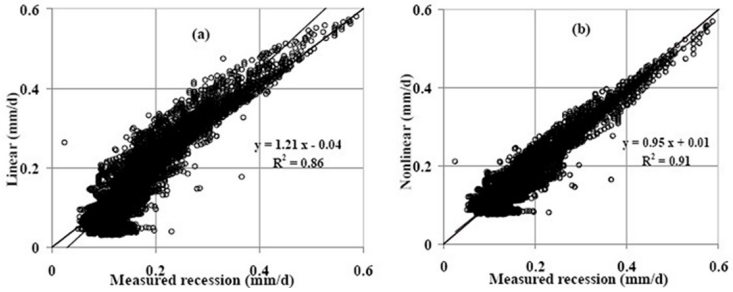

Fig. 1. Comparison of the fitted and measured recession data for 1961-1999 in the Manas River basin. (a) Using the linear aquifer storage-discharge relation; (b) using the nonlinear aquifer storage-discharge