Interactive comment on “Baseflow simulation of SWAT model in an inland river basin in Tianshan Mountains, Northwest China” by Y. Luo et al.

Anonymous Referee #2
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The paper is devoted to baseflow simulation in the Manas River, Tianshan Mountains, Northwest China, by using the improved SWAT with one and two reservoirs for modeling the deep aquifers. The approach is described clearly, and the results are so convincing. But the results interpretation seems “too simple” from recent point of view. After experience of few decades of using the flow simulation models in hydrology, after, say, the generalization of Beven (Beven K.J. Rainfall-runoff modelling. The Primer. Chichester: Ltd. John Wiley & Sons., 2000), we know that calibration of every complicated mathematical construction could provide flow simulation seem as “good results”. But the calibration result only couldn’t be a reliable proof of the model adequacy and conclusions correctness.

Say, it is very natural and expected that two-reservoir approach in paper discussed provide the better results than one-reservoir approach – it is rather mathematical effect. What it means from point of view of reality, what results are more realistic – from one reservoir or two-reservoir approach or from digital filtering? The automated digital filter is also king of a model. At least it asking for more detailed consideration in the paper and clear author hypothesis.

Response: the comment is highly appreciated.

Baseflow is an important component in hydrological simulation, which is primarily related to aquifer properties and mainly influenced by recharge to or extraction from groundwater storages. Conceptual modeling of baseflow has been studied extensively. Groundwater storage and discharge (S-D) relation is the basis of modeling the baseflow process and focus of disputes within the modeling community.

Is the S-D relation linear or non-linear? Wittenberg (1999) argued that the unconfined aquifer is unlikely a linear reservoir, instead, more likely a non-linear one and demonstrated the non-linearity that was found existing commonly through studies of approximately 100 basins in Germany. Samuel et al. (2011) demonstrated that a nonlinear storage–discharge relationship in deeper soil layer, a large range of possible model parameters, especially related to deep soil and slow flow parameters, and the inclusion of low flow criteria in the optimization procedure can improve baseflow estimation in Ontario basins. This can partly be attributed to the fact that heterogeneity of hydrological attributes linking groundwater storage and the existence of delayed storages in some of the natural basins might cause nonlinearity of groundwater recharges. On another hand, Fenicia (2006) confirmed that the linear storage-discharge relationship describes best of groundwater behavior through studies of tens of basins in Australia. Linear S-D relation has been also frenquently adopted by other researchers (Aizen et al., 2000; Fenicia et al., 2006; Eckhardt, 2008; Ferket et al., 2010), sometimes combined with analytical solutions of the simplified Boussinesq equation (Paniconi et al., 2003; Troch et al., 2004; Hilberts et al., 2004). As probably a compromise, multi-reservoir algorithms, linear, non-linear, or combined were used to generate baseflow by, e.g., Tallaksen (1995), Ferket et al. (2010), and Samuel et al. (2011).

We generally believe that non-linear S-D is a common relationship in the physical reality, super-composition of multi-linear reservoir may play an important and efficient role in approximating the non-linear

storage-discharge system, at least in a mathematical content. Our case study demonstrated that two-linear-reservoir combination can achieve very good results. This might have reflected the influences of aquifer properties upon aquifer discharge processes. Quick flow component of the baseflow may be attributed to higher groundwater table, portion of the larger pores, and recharge from the top layers, while the slow component may be attributed to the lower water-table, portion of the smaller pores, and absence of recharge during the dry season. These can be also inferred from theoretical formulation of the quick flow recession constant, α_{gw}, can be found in the theoretical documentation of SWAT2005 model (Neistch et al., 2005), which indicates that the constant is proportional to groundwater table and aquifer conductivity, and inversely proportional to the average flow travel length in the watershed.

Meanwhile, we are undertaking the following work. One is to incorporate the non-linear S-D relationship into SWAT model and test its performance in improving the baseflow simulation; another is to use the improved SWAT model (the two-reservoir or the non-linear one reservoir approach) in other watersheds in this region to test their validity. The work will try to answer if the S-D relation linear or non-linear, and to determine which approach is a better choice for baseflow simulation in for the snow and glacier melt dominated watersheds in this region.

Some technical errors occur in manuscript that asking for careful author's edition. The manuscript can be accepted for publication after a minor revision.

The following corrections/amendments are needed:

1. It is recommended to consider the modeling results in compare with real composition and properties of aquifers in the basin investigated more detailed and to formulate clearly the author position concerning to “reality” of different simulating results.

Response: the comment is highly appreciated.

We should have discussed the modeling results by comparing the baseflow processes and their quick and slow components to the aquifer properties, e.g., the stratification, the aquifer pore and conductivities, the fluctuations of groundwater table, and the soil properties overlying. We could not extend the discussion because of aquifer data unavailability. Lack of the aquifer data poses a great challenge for our baseflow study because aquifer data unavailability is a common situation in mountain watersheds in this region. In this case, what we can do is to try different baseflow modeling approaches in multi watersheds so as to find potential methods and proper parameter sets for regional scale baseflow simulation. The two-reservoir approach proposed in this study, although it might be an ad hoc for the SWAT model, showed a good performance. We hope that the approach can be published so that it can be applied and verified under broad range of watershed conditions by SWAT users.

2. Table 1 mentioned on p. 10404, l. 12 (Physical features) does not exist. Please add it.

Response:

The table of physical features of the watershed was thought to be trivial and the citation was deleted.

3. In spite of my own poor English (I'm sorry) I follow the Anonymous Referee #1 - language should be checked by a native speaker. Line 13, page 10411 - a capital letter in the start of sentence.

Response:

We have revised the manuscript according to the comments above and improved the English.

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