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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Stream flow simulation and verification in ungauged zones by coupling hydrological and hydrodynamic models: a case study of the Poyang Lake ungauged zone" *by* Ling Zhang et al.

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We are very grateful to the reviewer for reading the manuscript extremely carefully and forwarding the valuable suggestions for improvement. Point-by-point responses to the reviewers' comments are listed below.

1. General Comments

The reviewer's comment 1: However, the writing is very poor. Most of sentences are too awkward to be understood even though the grammar of the sentence is correct. After reading the whole of methodology, I could not proceed with the rest of the manuscript,

not only because of the poor English writing but also because of the confusing, conflict, and unclear technical details.

The authors' Answer: Thanks for the kind advice. We have invited a professional organization to modify the language. The confusing, conflict, and unclear technical details will be stated clearly.

The reviewer's comment 2: Based on my understanding, the methods in this study should be very clear: authors firstly simulated the streamflow of inlets for Poyang Lake using SWAT model; the parameters were calibrated using the observed streamflow from gauges located in the upper streams; then, the simulated streamflow were used as the inflows for hydrodynamic model to simulate the water level and other hydrodynamic characteristics of Poyang Lake; finally, modeled water level and discharge in outlet (Hukou) with and without SWAT simulated inflows were compared. If my understanding is correct. . .

The authors' Answer: The reviewer is almost right. The procedures of the manuscript are as follows. Procedure 1: we first calculated the streamflow produced by the Poyang Lake ungauged zone (PLUZ). Procedure 2: the modeled water level and discharge in outlet (Hukou) with and without PLUZ streamflow were compared. For Procedure 1, the Poyang Lake ungauged zone including two parts. One is the land cover area of PLUZ, the other one is water covered area (It has been revised as Poyang Lake). The water covered area is Poyang Lake. So in the next step, we calculate the streamflow for the land covered area and Poyang lake separately. The streamflow for the land covered are of PLUZ is simulated by SWAT model. The parameters were calibrated using the observed streamflow from gauges located in the upper streams. The streamflow in the land coved area of PLUZ is calculated as the difference value of simulated streamflow at inlets of Poyang Lake and the observed streamflow of the upper stream. The streamflow for the Poyang Lake is calculated by a simplified equation (Eq (1)). As the reviewer comments, the equation is not serious for not considering the lake storage change (This will be discussed in the reviewer's comment 4 in General Comments).

The steamflow of PLUZ is the summation of streamflow produced by the land coved area and Poyang Lake. For Procedure 2, the calculated streamflow in PLUZ were used as part of the inflows for hydrodynamic model to simulate the water level and other hydrodynamic characteristics of Poyang Lake. In this processing, two lake hydrodynamic scenarios (the Adjusted Scenario, the Original Scenario) are built. In Adjusted Scenario, inflows for hydrodynamic model is the summation of simulated streamflow in PLUZ and the observed streamflow from gauges located in the upper streams. In Original Scenario, inflows for hydrodynamic model is the observed streamflow from gauges located in the upper streams. The modeled results (water level and discharge of outlet (Hukou)) in Adjusted Scenario, Original Scenario were compared.

The reviewer's comment 3: ...I don't understand why authors used more than five pages to describe this simple procedure and the procedure hasn't been clarified ultimately. For example, I didn't see any coupling of hydrological and hydrodynamic models in sections 3.3

The authors' Answer: Thank you for the valuable suggestion. The coupling is in L197-252. The writing of manuscript may confuse you. In the manuscript, it is loosen coupling. In the Adjusted Scenario, the output of SWAT model is the input of Delft3D model. The streamflow of PLUZ is used as part of the upper inflows for hydrodynamic model. In the Original Scenario when the streamflow of PLUZ is not considered, there are 9 inflow points (d1, d2, d3, d4, d5, d6, d7, d8 and d9) for the lake (Figure 1(b)). Inflows to the points comes from the 7 gauging stations (Qiujin, Wanjiabu, Waizhou, Lijiadu, Meigang, Hushan and Dufengkeng). In the Adjusted Scenario, we should solve the problem: how to allocate the ungauged streamflow in to different inflow points. As the ungauged zone is usually in flat topography with turbulent flow, it is difficult to draw watersheds in the ungauged zone. What's more, allocating the streamflow in the ungauged zone to inflow boundary of hydrodynamic model is not an easy work. The the coupling sections describe the content: how to drawing watersheds in the ungauged zone and allocating the ungauged streamflow to the lake model properly. The section

may confuse you. We will reorganize the coupling section.

The reviewer's comment 4: ...but a lot of confusing water balance equations (i.e., Equation (2-4)), especially for equation (3). Where is the water level change (i.e., surface water storage) in equation (3)? If the water level change is too small to be negligible authors may need to verify it and clarify it in the manuscript. In my opinion, all the Equation (2-4) can be written in one if considering the Poyang Lake as the control volume: QHukou = P+Qinflows-E-ΔSWSsimulated where QHukou is the discharge in the outlet of Poyang lake; P is the precipitating in Poyang Lake; Qinflows is the summation of the streamflow in all inlets of Poyang Lake; E is the evaporation in Poyang Lake; ΔSWSsimulated is the water level changes in Poyang Lake.

The authors' Answer: Thank you very for the valuable suggestion. The writing of manuscript may confuse you. In Section 3.3 (Equation (2-4)), we intended to calculated the inflow at different inflow points of the lake in the Adjusted Scenario. The inflow at the point was the summation of three parts: the streamflow in land covered PLUZ, the streamflow in Poyang Lake, and the streamflow from the upper gauged stream (the 7 gauging stations: Qiujin, Wanjiabu, Waizhou, Lijiadu, Meigang, Dufengkeng and Hushan). However, originally I was confused by the concept of STREAMFLOW in Poyang Lake. The streamflow in Poyang Lake should take the lake level change into consideration. However, the lake streamflow is estimated by the lake hydrodynamic model. In the hydrodynamic model, we modeled the changed lake level and streamflow in long time series. The streamflow of the lake should not be the upper inflow boundary of the Lake hydrodynamic model. So we revise the inflow to the lake inflow point as the summation of two parts: the streamflow in land covered area of PLUZ, and the streamflow from the upper gauged stream (the 7 gauging stations). As the lake hydrodynamic model can model the changed lake level and streamflow, we have decided not to take Poyang Lake as part of the ungauged zone. So the PLUZ is redefined the area inside the yellow line and outside the boundary of Poyang Lake (Figure 1(a)).

The reviewer's comment 5: ...Given the authors' methodology is correct, I have an-

other two concerns: has the hydrodynamic model been calibrated? If yes, the bias and error of the simulated ungauged streamflow can be corrected during the calibration of hydrodynamic model which means the verification of simulated streamflow in ungagged zone may be spurious;

The authors' Answer: Thank you very for the valuable suggestion. The writing of manuscript may make you confused. We construct two Scenarios (the Adjusted Scenario, the Original Scenario) for the lake hydrodynamic model. The Adjusted Scenario take the ungauged streamflow into consideration while the Original Scenario does not. The model in the Original Scenario has been calibrated and validated. The model in the Adjusted Scenario use the same parameter as that in the Original Scenario.

The reviewer's comment 6: the other concern is I don't think it's necessary to use SWAT simulation as the results shown in Figure 4 since the discrepancy of two scenarios with and without SWAT is relatively small which may be smaller than the uncertainties in SWAT simulations as shown in Figure 3.

The authors' Answer: Thank you for the comments. The writing may confuse you. If the writing is more clear, your comments is as follows: the other concern is I don't think it's necessary to use SWAT simulation as the results shown in Figure 4 since the discrepancy of two scenarios with and without ungauged streamflow is relatively small which may be smaller than the uncertainties in SWAT simulations as shown in Figure 3. The SWAT and Delft3D are two different models and applied in different specific fields. The acceptable simulation accuracies are different too. In general, SWAT model simulation can be judged as satisfactory if Ens (Nash-Sutcliffe efficiency) > 0.50 and -25% < PBIAS (percent bias) < 25% for streamflow (Van Liew et al. 2007), while for water level (or tide level) simulation by Delf3D model Ens can be larger than 0.90 (some can reach 0.99) and the absolute value of PBIAS can be smaller than 5% (Qi et al., 2016; Zhang et al., 2015). The Delf3D model is steady and the uncertainty is relatively small. Therefore, it is not easy to improve the simulation result of Delft3D model. If the simulated accuracy of Delft3D model can be increased, the increased range should

be small and may be smaller than the uncertainty of SWAT model. However, it is valuable to improve the Delft3D model, although the increased range is small. In the previous research for Poyang Lake dynamic model, the simulated streamflow at the outlet (Hukou) is smaller than the observed in average (Qi et al., 2016; Zhang et al., 2015). This may result from not taking the ungauged streamflow into consideration. So it is valuable and important to test if ungauged streamflow can increase the Poyang Lake dynamic model. And we are curious what the results would be. It is important to get the result: the ungauged zone improves the Delft3D model accuracy although the increase range of the accuracy is small. You comment means the discrepancy should be bigger than the SWAT uncertainty if we want to validate the simulation result of the ungauged streamflow by Delft3D model. That is because the increased discrepancy may be caused by the uncertainty of the SWAT model? If my understanding is right, what we should do is to demonstrate that the discrepancy (the increased accuracy) is not the random fluctuation result of the SWAT uncertainty. We separate the 10 years data into 10 segment. Each segment has one year data. If we can get the discrepancy (the increased accuracy) in all the 10 segment, then we can demonstrate that the discrepancy (the increased accuracy) is not the random fluctuation result. Then the SWAT simulation result can be valid. We are trying to redo the experiment.

2. Specific Comments

The reviewer's comment 1: Line 15: Is the water covered area of the ungauged zone the Poyang Lake? If yes, please revise or it is very confusing.

The authors' Answer: Yes. It will been revised in the manuscript.

The reviewer's comment 2: Line 18: how do you conclude "narrower discrepancy"? Please provide some quantification. The same for Line 23 "higher value"

The authors' Answer: Yes. It has been revised in the manuscript as flows. Experimental results show there was a narrower discrepancy (R2=0.81, PBIAS=10.00%) between the stream flows observed at the outlet of the lake and the simulated stream flows in

adjusted scenarioïijŇcompared to that in original scenario (R2=0.77, PBIAS=20.10%). Using our technique, we estimated that the ungauged zone of Poyang Lake produces stream flows of approximately 180 billion m3; representing about 11.4% of the total inflow from the entire watershed. We also analyzed the impact of the stream flows in ungauged zone on the water balance between inflow and outflow of the lake. These results, incorporating the estimated stream flow in ungauged zone, significantly improved the water balance as indicated by R2 with higher value (0.81) and percent bias with lower value (10.00 %), as compared to the results when the stream flows in the ungauged zone were not taken into account, R2 with lower value (0.41) and percent bias with higher value (18.88%). The method can be extended to other lake, river, or ocean basins where observation data is unavailable.

The reviewer's comment 3: Line 29-30: Please rewrite this sentence.

The authors' Answer: The sentence is revised as follows. In order to reduce the damage to the population, agriculture and economy, we should predict floods and droughts precisely. However, in watersheds there is an ungauged zone lacking stream flow observations. The streamflow of ungauged zone is difficult to estimate, which makes ungauged zones neglected in water yield estimation. Therefore, it is important to estimation the streamflow in the ungauged zone.

The reviewer's comment 4: Line 40: Please delete the second "stream flow".

The authors' Answer: It has been delete.

The reviewer's comment 5: Line 51-52: Please revise this sentence. Awkward.

The authors' Answer: Some researchers use regionalization methods to simulate streamflow in ungauged zones. The parameters in the gauged areas are calibrated. Then the parameters are transformed from gauged to ungauged areas.

The reviewer's comment 6: Line 60: Where is the citation for Ma's study?

The authors' Answer: It is an article in Chinese. The reference is as follows: Ma,

X., Liu, D.: Modeling of interval runoff in the region of Dongting Lake[J]. Journal of Hydroelectric Engineering, 30(5):10-15, 2011.

The reviewer's comment 7: Line 124: Please provide the spatial resolution for DEM.

The authors' Answer: The spatial resolution for DEM is 90 m.

The reviewer's comment 8: Line 131: Please provide some examples about the topographic data.

The authors' Answer: The following examples of topographic data have been added. The reference is as follows: Qi, H., Lu, J., Chen, X., et al. Water age prediction and its potential impacts on water quality using a hydrodynamic model for Poyang Lake, China. Environmental Science and Pollution Research, doi:10.1007/s11356-016-6516-5, 23(13):13327-13341, 2016. Zhang, P., Lu, J., Feng L., et al. Hydrodynamic and inundation modeling of China's largest freshwater lake aided by remote sensing data. Remote Sensing, doi:10.3390/rs70404858, 7(4): 4858-4879, 2015.

The reviewer's comment 9: Line 134-135: Please provide the temporal scales for water level and discharge.

The authors' Answer: Daily scale. The sentence has been revised as follows: The daily observation for water level (at stations of Xingzi, Duchang and Kangshan), and outflow discharges (at Hukou) from 2000 to 2011 were got from Web of hydrological information in Jiangxi.

The reviewer's comment 10: Line 142: What does "sing" mean here?

The authors' Answer: It is a spelling mistake. It should be "using".

The reviewer's comment 11: Line 163: Where is the water level change (i.e., surface water storage change) in equation (1) and (3)? If the water level change can be negligible please verify it and clarify it. (???)

The authors' Answer: The lake water level change has been taken into consideration

in the lake hydrodynamic model. As there are observed stations gauging the water level and lake hydrodynamic model can model the streamflow in Poyang Lake, Poyang Lake is not considered as ungauged zone. (more details in Comment 4 in General Comments)

The reviewer's comment 12: I didn't read the Result section word by word please carefully read it and revise it based on the revised methodology.

The authors' Answer: Thank you for the suggestion. We will modify it based on the the methodology.

The reviewer's comment 13: Line 440: Please delete Table 3.

The authors' Answer: We delete Table 3 in the revised version.

The reviewer's comment 14: Line 444: Please switch the Figure 1a and 1b; put figure 1a in left hand side; delete the "Meteorological stations" in legend of Figure 1b since there is no meteorological station; add the scale bar in Figure 1b.

The authors' Answer: There is a meteorological station of Boyang. And the rest will be revised in Figure 1.

The reviewer's comment 15: Line 450: Figure 2 is confusing, and please revise it. (???)

The authors' Answer: It will be revise as the comment (Figure2).

The reviewer's comment 16: Please provide the line number for figure 3 and also the captions for the subfigures.

The authors' Answer: We will provide the line number for Figure 3. The added captions is as follows: Subfigures (a),(b),(c),(d),(e) and (f) are the calibration and validation result for stations at Wanjiabu, Waizhou, Lijiadu, Meigang, Hushan, and Dufengkeng separately.

The reviewer's comment 17: Based on Figure 4, I don't think it's necessary to use

SWAT simulation. The discrepancy of two scenarios is relatively small which may be smaller than the uncertainties in SWAT model as shown in Figure 3.

The authors' Answer: We are trying to make more analysis (more details in the reviewer's comment 6 in General Comments).

The reviewer's comment 18: Please delete the figures 5-7.

The authors' Answer: We delete the figures 6-7. Figure 5 shows the long time series of ungauged water yield, which is the simulation result of the ungauged zone. So I think it may be valuable.

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