

# ***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 reviewers 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 comment

The reviewer's comment 1: ...but the poor writing make it hard to be understood well. ...However, the manuscript was not well written...

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

## 2. Specific comments

The reviewer's comment 1: The abstract was not well written. (1) 'To estimate streamflow without observation, the authors extend existing techniques . . .', but it is not clear what is the existing one and what is extended one? A simple 'coupling hydrological model with a hydrodynamic model' is not far clear. (2) L13-15: It is hard to understand. What is land covered area? (3) L15-17: I still did not get what the original and adjusted scenarios are. (4) it is not that convincing to say R2 with higher values and bias with lower values, it would be better to use numbers or a range (e.g., 0.7-0.8).

The authors' Answer: (1)The sentence may be not clearly written. It has been revised as follows: To solve the problem of estimating and verifying stream flows without direct observation data; we estimating stream flows in ungauged zones by linking a hydrological model with a hydrodynamic model, taking the Poyang Lake basin as a test case. To simulate streamflow of the ungauged zone, we build a SWAT model for the entire catchment area covering the upstream gauged area and the ungauged zone; then to calibrate the SWAT model using the gauged area. To verify the results, we built two hydrodynamic scenarios (the original and adjusted scenarios) for Poyang Lake using Delft3D model. In the original scenario, the upstream boundary condition is the observed streamflow of the upstream gauged area; while it is the summation of the observed streamflow and the simulated ungauged streamflow in the adjusted scenario. (2) Land covered area means the area which is not covered by water body. Seen in Figure 1, the land covered area of the ungauged zone is the area inside the yellow line and outside the boundary of Poyang Lake. Originally, the Poyang Lake ungauged zone includes two parts: the land covered area and the Poyang Lake. As the lake water level and streamflow is model by the lake dynamic model (Delft3D model), we do not need to calculate the streamflow of Poyang Lake and set the streamflow as the input

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of the lake dynamic model. So we redefined region of the ungauged zone as the area inside the yellow line and outside the Poyang Lake (Figure 1(a)). The area does not include the Poyang Lake. L13-15 is revised as the follows. To simulate streamflow of the ungauged zone, we build a SWAT model for the entire catchment area covering the upstream gauged area and the ungauged zone; then calibrate the SWAT model using the gauged area. (3) Thank you for the valuable suggestion. There may exist some writing problems here. The method should be described in details. 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: we compared the model result (water level and discharge in outlet (Hukou)) of the dynamic model with and without the ungauged streamflow. For Procedure 1, to simulate the streamflow in the Poyang Lake ungauged zone we build a SWAT model for the entire catchment covering the upstream gauged zone and the ungauged zone. The parameters were calibrated using the observed streamflow from the gauges located in the upper streams. For Procedure 2, the simulated 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 constructed. In Adjusted Scenario, the upper inflow boundary of hydrodynamic model is the summation of the simulated ungauged streamflow and the upstream gauged streamflow. In Original Scenario, the upper inflow boundary of the hydrodynamic model is the upstream gauged streamflow. The modeled results (water level and discharge of outlet (Hukou)) in Adjusted Scenario, Original Scenario were compared. In summary, the Adjusted Scenario take the ungauged streamflow into consideration while the Original Scenario does not. 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 model in the Original Scenario has been calibrated and validated. The model in the Adjusted Scenario use the same parameter as that in the

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Original Scenario. (4)The sentence has been revised as follows: Experimental results show there was a narrower discrepancy ( $R^2=0.81$ , PBIAS=10.00%) between the stream flows observed at the outlet of the lake and the simulated stream flows in adjusted scenario compared to that in original scenario ( $R^2=0.77$ , PBIAS=20.10%).

The reviewer's comment 2: L29- 33: it does not read well, the connection seems not logical.

The authors' Answer: The sentences are 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 3: L66-67: What does 'Usually, there are stream flow observation at the lower boundary of the ungauged zone.' Mean?

The authors' Answer: The sentence may not be written clearly. The sentence is revised as follows: Usually, the downstream of the ungauged zone exist a lake (or a river, an ocean). The lake is gauged by streamflow gauging stations at the outlet and water level gauging stations on the water surface.

The reviewer's comment 4: L72-75: Dargahi and Setegn combined a hydrological model (SWAT) with a 3D hydrodynamic model (GEMSS) .... Bellos and Tsakiris . . . However, . . . there is no clear and specific method of coupling hydrological and hydrodynamic models in space and time. It is really hard for readers to get what problems or drawbacks others have, and what the novelty of the authors' method is.

The authors' Answer: The sentences should be far clear. They has been revised as follows: Dargahi and Setegn combined a hydrological model (SWAT) with a 3D hydrodynamic model (GEMSS) .... Bellos and Tsakiris . . . However, the method combing

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hydrological model and hydrodynamic model is scarcely applied in the ungauged zone for streamflow simulation and validation. 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. How to drawing watersheds and allocating the streamflow are not mentioned in the previous researches. The detail of linking hydrology and hydrodynamic models in the ungauged are presented in the study.

The reviewer's comment 5: L101-103: 'We established . . . model was established to . . .' Grammar issue.

The authors' Answer: The sentences has been revised as follows: We established two lake hydrodynamic scenarios to further verify the streamflow simulation results.

The reviewer's comment 6: L103-106: It is strange the end of Introduction was repeating the abstract.

The authors' Answer: The related sentences has been deleted.

The reviewer's comment 7: L121-124: It reads awkward, and it seems SWAT doesn't need temperature? Were all the data downloaded from Jiangxi hydro info website?

The authors' Answer: (1) The sentences may be confused. They has been revised as follows: Data required by the SWAT model include the forcing elements of daily rainfall, evapotranspiration, temperature, relative humidity and wind from 1980 to 2014 collected at 16 national meteorological stations. The stations are distributed uniformly across the area (Fig. 1a). This data was downloaded from China Meteorological Data Sharing Service System (<http://data.cma.cn/>). (2) No. Daily rainfall, evapotranspiration, temperature, relative humidity and wind data were downloaded from China Meteorological Data Sharing Service System. Streamflow data at 7 gauging stations (Qiujin, Wanjiabu, Waizhou, Lijiadu, Meigang, Hushan, and Dufengkeng), daily observation for water level at water surface stations (Xingzi, Duchang and Kangshan), and outflow

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discharges at Hukou were downloaded from Jiangxi hydro info website.

The reviewer's comment 8: Methodology section is too short and lack details.

The authors' Answer: The section should be clearer. We will add more details and reorganize the methodology section clearly.

The reviewer's comment 9: SWAT and Delft3D are the two major approaches of the study; however, there was no description of the two models.

The authors' Answer: The descriptions for the two models have been added in the manuscript. The part described for SWAT is as follows: We used SWAT (Soil and Water Assessment Tool) (Arnold et al., 1993) model to simulate stream flows in PLUZ. SWAT was physically-based, semi-distributed and river basin-scale hydrological model. It was developed to assess the impact of land management practices on stream flow, sediment and agricultural yields in complex basins with changing soil type, land use and manage over long time. For purpose of modelling, an entire watershed is divided into subwatersheds based on rivers and DEM data. Subwatershes are portioned into Hydrological Response Units (HRUs), the minimum research units. Water balance is the driving force of hydrological processes. Hydrological cycle including two division: runoff producing on land and flow routing in channel. Surface runoff volume is calculated using SCS method (USDA Soil Conservation Service, 1972). Flow routed through the channel is calculated by variable storage coefficient method (Williams et al., 1969). SWAT has already been applied to watersheds widely in the world for stream flow simulation (Douglas-Mankin et al., 2010;Arnold et al., 2012;Luo et al., 2016). The part described for Delft3D is as follows: Delft3D simulates the hydrodynamic pattern via the Delft3D-FLOW (Roelvink and van Banning, 1994) module. Delft3D-FLOW is a multi-dimensional (two dimension or three dimension) hydrodynamic and transport simulation programme. The programme can calculate unsteady flow by building linear or curvilinear grid suitable for water boundary, which is forced by tidal and meteorological data. Delft3D-FLOW is based on the Reynolds-Averaged Navier-Stokes

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(RANS) equations, which is simplified for an incompressible fluid under shallow water and Boussinesq assumptions. The RANS equations are solved by alternative direction implicit finite difference method (ADI) on spherical or orthogonal curvilinear grid. Delft3D has ability to simulate water level variations and flows on surface water bodies in response to forcing elements of inflow discharges and climate factors. It has been proven by application on many surface water bodies around the world. Delft3D is considered appropriate for the wide and shallow characteristics of Poyang Lake.

The reviewer's comment 10: L146-147: to simulated ?

The authors' Answer: As the PLUZ does not include Poyang Lake. The sentence has been revise as follows: We used SWAT model to simulate stream flows in the land covered area of the PLUZ.

The reviewer's comment 11: The results and discussion seems just result description and no discussion was provided.

The authors' Answer: We will revise the discussion part. The application of the method and the influence factors on the simulation results will be discussed, as well as the impact of climate change on the hydrodynamic characteristics on the Poyang Lake.

The reviewer's comment 12: There are many grammar issues here and there, and I believe they need a professional editing service before resubmission.

The authors' Answer: We have invited a professional editing service to revise the grammar issues.

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