Dear Editor and Reviewers,

On behalf of my co-authors, we thank you very much for giving us an opportunity to revise our manuscript, and we also appreciate reviewers very much for their positive and constructive comments and suggestions on our manuscript entitled “An optimized LSTM-based approach applied to early warning and forecasting of ponding in the urban drainage system”.

We have tried our best to revise our manuscript according to these comments and suggestions and provide the point-by-point responses. All changes were marked using the “Track Changes” function in the revised manuscript. Attached please find our responses to the referees’ comments.

Once again, thank you very much for your comments and suggestions. And we hope this revised manuscript has addressed your concerns, and look forward to hearing from you.

Thank you and best regards.

Sincerely,

The Authors

Reply to Reviewer # 1

Dear Reviewers,

Thank you very much for your time involved in reviewing the manuscript. We also appreciate your clear and detailed feedback and hope that the explanation has fully addressed all of your concerns. In the remainder of this letter, we discuss your comments along with our corresponding responses.

To facilitate this discussion, we first retype your comments in italic font and then present our responses to the comments.

Comment 1:

"It is suggested that the conclusion of the paper needs to be further revised to balance the volume of the three conclusions, and highlight the main feature of the paper, how to apply deep learning method in the simulation of urban flooding."

Response 1:

Thank you for comments. The conclusions have been revised in our paper. See L406-425 for details. They are also provided below for your quick reference.

"This work aims at promoting the application of deep learning in urban flood forecasting. Specifically, we have proposed an optimized LSTM-based approach in this study, which can quickly identify and locate ponding with relatively high accuracy.

According to the research results, the main conclusions of this study are summarized as follows:

1 The proposed model is constructed by two tandem processes (runoff process and flow confluence process) and utilizes a multi-task learning mechanism to achieve high accuracy. Over 15000 designed rainfall events were used for model training, which covers various extreme weather conditions. The median score of NSE for ponding forecasting is greater than 0.95, and the mean accuracy at any node to determine whether ponding occurs reaches higher than 0.98.

2 The superiority of the proposed model has been demonstrated by comparing with two widely used deep learning models: (traditional) LSTM and CNN models.

The superiority of the proposed model having two tandem processes is proved by comparing with LSTM and CNN structures with a single process. The mean NSE score for ponding volume forecasting of the proposed model is 0.9462, while that of LSTM and CNN structures with a single process is 0.7424 and 0.7391 respectively. Then, the superiority of the proposed model with a LSTM variant is demonstrated by a comparison with the conventional LSTM structure also with two tandem processes. As shown in Table 9, the mean NSE score of the latter is 0.8552.

3 An approach to model modification using real-life monitoring level and flow data is proposed in this paper. The proposed LSTM-based model is further calibrated to achieve better accuracy.

The LSTM-based model is corrected using two steps. First, the runoff process is corrected with the measured rain, level, and flow data referring to Parameter-based (Model-based) Transfer Learning. Then, the flow confluence process is updated using the updated lateral inflows at all nodes and the measured ponding volume. As shown in Table 8, the mean CC score at all nodes of the model with correction is 0.9309, while that of the model without correction is 0.1139."

We would like to take this opportunity to thank you for all your time involved and for this great opportunity for us to improve the manuscript. We hope you will find this revised version satisfactory.

Sincerely,

The Authors

Reply to Reviewer #2

Dear Reviewers,

Thank you very much for your time involved in reviewing the manuscript and your very encouraging comments on the merits.

Comments:

"I would like to thank the authors for taking the effort in revising the manuscript to address my comments. Though great revisions have been made, I have one more comment and some minor language revisions to suggest. I hope some of the edits would help the authors' future work."

We also appreciate your clear and detailed feedback and hope that the explanation has fully addressed all of your concerns. In the remainder of this letter, we discuss each of your comments individually along with our corresponding responses.

To facilitate this discussion, we first retype your comments in italic font and then present our responses to the comments.

Comment 1:

Section 2.3. -- Model correction: I still don't quite follow how the correction model has been developed, and there might be a miscommunication issue. Did you leverage an existing pre-trained model from Pan et al (2010) to perform the correction here (L143)? If yes, how applicable is this pre-trained model to this study? Also, the sentence 'the model CR is trained based on a pre-trained mapping from X to Y' (L151) is confusing. It doesn't tell whether the CR model uses a trained model from another study (for the purpose of transfer learning) or is trained separately in this work. If it is trained separately, which I suppose was after the development of the two LSTM modules, why did you call it 'transfer learning'?

Response 1:

Thanks for your comment. We have answered these questions one by one.

Did you leverage an existing pre-trained model from Pan et al (2010) to perform the correction here (L143)? If yes, how applicable is this pre-trained model to this study?

We did not leverage an existing pre-trained model from Pan et al (2010) to perform the correction here. We have adjusted the reference to L141.

"Transfer learning is mainly used to transfer the knowledge of one domain (source domain) to another domain (target domain) such that the target domain can achieve better learning effects (PAN, S J, et al., 2010)."

Also, the sentence 'the model CR is trained based on a pre-trained mapping from X to Y' (L151) is

confusing. It doesn't tell whether the CR model uses a trained model from another study (for the purpose of transfer learning) or is trained separately in this work.

'A pre-trained mapping from X to Y' (L147) is the trained model in the runoff process introduced in Section 2.1.1.

If it is trained separately, which I suppose was after the development of the two LSTM modules, why did you call it 'transfer learning'?

In the parameter-based(model-based) transfer learning, it is mainly assumed that some of the same parameters will be shared between the related tasks in the source and target domains, so that part of the network structure can be shared between the related tasks. In this paper, Y is the source domain, G is the target domain. The training process of the model CR between X and G introduces the network structure and the trained parameters in the runoff process between X and Y, which is called 'transfer learning'.

Comment 2:

Other minor edits in the introduction section:
L32: 'has-' --> 'has'

L33: I wouldn't call "deep learning as a form of training". Deep learning is a particular machine learning technique that leverages neural networks to learn nonlinear relationships from a dataset.

L38: 'some factors need to be improved' --> 'there are opportunities to further the application of deep learning ...'

L39: 'the dataset for training' --> 'the training dataset'

L39-40: 'There are studies utilizing deep learning algorithms for urban flood forecasting, but the developed model is trained on a small number of samples.' --> 'Many studies in urban flood forecasting only use a small number of samples to develop the deep learning models.'

L42-44: 'Secondly, monitoring equipment is expensive and thus not frequently available. Therefore, researchers have to rely on simulations produced from hydrodynamic models, however, often without considering the accuracy of the models.' --> 'Secondly, due to the high cost of monitoring equipment, researchers usually have to rely on unvalidated simulations produced from hydrodynamic models.'

L47-48: "Such as ..." --> "Example includes but not limited to ..."

L54: "we propose an optimized LSTM-based approach, which is applied to early warning" --> "we propose an optimized LSTM-based approach for early warning ..."

L57: "(LSTM, CNN)." --> ", i.e., LSTM and CNN."

L58: "to achieve higher accuracy" --> "to improve the emulation performance"

Response 2:

Thanks for your suggestion on improving the accessibility of our manuscript. These questions have been revised one by one.

Comment 3:

L34: 'And unlike' --> 'Like'. Please avoid using 'and' in the beginning of the sentence, which is informal. (There are multiple cases throughout the manuscript. Please double check)

Response 3:

Thank you for your comment. The related content have been revised in our paper. See L43, L135, L145, L173, L204, L209, L252, L398 and L428 for details. They are also provided below for your quick reference.

L43: , and compared ... --> , then compared the ...

L135: , and how to ... --> . Moreover, how to ...

L145: 'And add multiple fully connected layers after ...' --> Then, multiple fully connected layers are added after ...

L173: and the generated storms ... --> The generated storms ...

L204: and the ratios ... --> The ratios ...

L209: 'And if ...' --> Moreover, if ...

L252: 'And the subscript ...' --> The subscript ...

L398: 'And the other ...' --> Besides, the other ...

L428: 'And also, ...' --> Furthermore, ...

We would like to take this opportunity to thank you for all your time involved and for this great opportunity for us to improve the manuscript. We hope you will find this revised version satisfactory.

Sincerely,

The Authors