The paper deals with the possibility of predicting flow (depth) in a sewerage system using dynamic neural networks. Although the paper is interesting, I have few problems with it.

1. From the abstract, I read RNN allows "a signal to propagate in backward direction" (lines 4-5). That seems to imply that rainfall at time t can influence flow at time t-1, which makes no sense and I believe is not what the Authors wanted to say.

Response:

The meaning of this sentence should be that the signals at time t can influence flow at time t+1. In order not to confuse the readers, the sentence has been revised as "<u>The RNN allows signals to propagate in both forward and backward directions, which offers the network dynamic memories. Besides, the information at the current time-step with a feedback operation can yield a time-delay unit that provides internal input information at the next time-step</u> to effectively deal with time-varying systems."

2. Generally speaking, how can be possibly made a prediction on ungauged sites, when no data are available for training? I believe that - however - simulations have to be carried out (in the paper they are performed with SWMM). And therefore, if the Authors have to build a model (distributed and physically based), I do not understand why, afterwards, they want to have a model with RNN. What is the advantage in having both? Or, more generally, what is the advantage on the use of RNN model instead of SWMM? Consider the following advantages of an hydraulic model over the RNN: you can simulate a pump station, any variation in the system (and therefore real time control, where existing), and so on.

Response:

We appreciated very much for the referee's comment on this critical point. Indeed, one of the objectives of this study is to make predictions on ungauged sites by using the RNN. As pointed, the model could not be used to make predictions without data available for training. <u>To overcome such problem, a set of synthetic data generated from a storm water management model (SWMM) under cautious verification process of applicability are introduced as the learning target to the training procedure of the RNN.</u>

<u>The difference between RNN and SWMM is that, in general, a physically based simulation model such as SWMM can be used to model natural systems to gain insight into their functioning and to show the eventual real effects of alternative conditions. The SWMM model could generate the water level of time t by being fed with input data at the same time (time t). In this study, the calibrated SWMM model was fed with the whole series of input information to gain its</u>

corresponding series of estimation outputs. Consequently, it can only produce current water level because future rainfall pattern is not available at current time. Whereas the trained RNN can produce future water level (time t+n) by being fed with current data (time t) and can be executed through a step by step procedure. We like to note that the inputs of the RNN only include measurement variables (i.e. current precipitations and water levels at nearby gauging stations), consequently the trained RNN can be used to predict the future water level of ungauged station based on the current measuring variables at nearby gauging station.

Frankly speaking, the calibration procedure of SWMM is complex, for example, the optimization of parameters usually takes time and have to be calibrated event by event in order to obtain accurate estimation of water levels. Moreover, to our best knowledge, most of the studies demonstrate that the SWMM model needs to be fed with the whole series of input information to gain its corresponding series of estimation outputs. Therefore, the advantages of have both SWMM and RNN in this study are (1) to use SWMM to generate data at specific ungauged site as the learning targets of RNN; (2) to use RNN fed with the SWMM outputs as learning targets for the purpose of water level prediction at an ungauged site. Based on such integration process with the inclusion of ungauged sites, it makes the whole prediction system more solid and complete for the following operations of sewerage systems.

3. Page 2319 line 7: I believe "A surface inundation will occur as the surface runoff DISCHARGE (not volume) is larger than..."

Response:

Thanks! The wording has been changed in our revised version.

4. Same page, lines 10-12. It is quite obvious that a storage tank is more effective if it is empty. Therefore, people usually want to pump as much as possible - we do not need to have the depth forecastings. An exception may be when the system is very complex: in that case an optimization procedure may be needed.

Response:

We agree with the reviewer’s statement that, in general, people usually want to pump water as much as possible. This is true especially in the case of typhoon period. In fact, the operation procedure of pumps is highly dependent on the experience of local operators even though there are rules for the guidance of pumping operations, such as warm up the pump when water rises up to the warning level (1.8m) and start pumping when the water level is higher than start-out level (2.4m). In other words, the information for pumping operations can be referred by rainfalls and water levels. Compared with rainfalls, the water level has higher relation to the operations of pumps and is therefore selected as the target in this study. Besides, the reason for the need of water level predictions is that the information from predictions provides more time for the operators to make more suitable real-time operating strategies than current observation.

5. Page 2325. A comprehensive catchment description is missing. Especially the time of concentration, which I believe plays a role of paramount importance in the simulations, and which seems to be almost neglected in the paper (page 2326 line 25 Authors say "it is very short").

Response:

More description of the catchment and the pumping station are added in the text (lines 255-265 & 309-319).

6. Page 2327 lines 20-22: Authors say "Even if the SWMM is able to produce an accurate set of water level values, the outputs, however, are not predictions but simulations". I can't see the difference (see below).

Response:

Please refer to Response 2.

7. Page 2329 lines 9-10 and later on. Predictions are good up to 20-min-ahead. Again, I believe this depends on the time of concentration. I see very difficult a level prediction for times larger than the time of concentration, but if the Authors claim to be able to predict also the (future) rainfall pattern (which is not in the paper and which I find difficult to believe).

Response:

This is, in part, related to comment 5 mentioned above. The time of concentration of this catchment is about 70 minutes. The sewage system, however, is a complex one, and it is hard to estimate its variability. Time of concentration is a critical factor; however it highly varied with events. There is a trade-off between the accuracy and the lead time of model predictions. To ensure good accuracy of water level prediction, the outputs of the constructed model are designed for a lead time up to 20 minutes which is required by local operators. Twenty minutes is enough for reliable and effective operations of pumps to drain runoff water away and reduce the risk of flooding if the water level prediction is precise.

In conclusion, apart minor problems, I do not understand why there is a need to build an RNN model of a sewerage system, where the geometry can be known with very good detail and the behaviour can be understood and simulated with hydraulic models (like SWMM). I think this is the main problem with the proposed paper.

Response:

The major goal of this study is to **predict** the water level at both gauged and ungauged sites of the sewerage system by using the dynamic neural networks. <u>The purpose of predicting the water levels at the select gauged site is to provide upcoming information for the following operations of pumps at Yu-Cheng station</u> (the largest pumping station in Taipei metropolitan). The selected gauged site is the outlet of the sewerage system and its water level is highly related to the operation of pumps. We expect that information from water level predictions could give more contribution to pumping operations than observed water levels. <u>Because the future rainfall pattern is not available at current time, the SWMM could only be used for simulation, not for prediction. Concretely speaking, the output of SWMM is suitable for hydraulic planning and design after a storm event because the model requires complete rainfall pattern of an event; whereas the output of RNN is suitable for real-time operations of pumps because the model can be executed through a step by step procedure.</u>

Regarding the ungauged sites, "<u>Due to the limited number of water level gauging stations in the sewerage system, the data and predictions of water levels at ungauged sites become important issues of flood prevention. One of the advantages of predicting water levels at ungauged sites is to reduce the expensive engineering and maintenance costs.</u>" For the prediction of water level at ungauged site, we attempt to construct a reliable model in case where observations are not available. We agree that <u>a well calibrated SWMM is able to generate suitable estimation of water level and can be applied to any ungauged site if **estimation** is required.</u> The RNN, a data-driven approach, can produce precise predictions when sufficient data are provided. In order to obtain suitable predictions of water levels at ungauged sites, it is necessary to apply SWMM to generating a number of water level estimations at specific ungauged site as the learning targets of RNN. We are confident that the strategy proposed in this study could be easily extended to other ungauged sites.

The authors are grateful to receiving the reviewer's comments which makes the revised manuscript more readable and clearer (especially on the issue of simulation and prediction). Parts of the responses (underlined) to comments mentioned above have been added to this manuscript.