

**Dynamic versus static neural network model for rainfall forecasting at Klang River
Basin, Malaysia**

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We would like to thank the editor-in-chief for his objective and thorough review of our paper. We have addressed all the reviewers' comments in the following point-by-point response. All changes made to accommodate the reviewers' comments are underlined in the revised manuscript.

General Comments:

The reviewers have provided some suggestions on how to improve the paper. I would like to add more to this:

1. Logic of introducing any (new) approach/method is this: first, show the deficiencies of an existing method; second, introduce the new one; third, compare the new one to the old one and demonstrate the advantages. The suggested ANN model for weekly (monthly) RF forecast is purely autoregressive, so a comparison to a traditional autoregressive model is required. How does it compare to other traditional RF forecasting models? I think it is really necessary to provide such comparison.

Reply

The authors thank the editor for this comment. This comment introduces two points. The first is in the introduction section. The introduction section has been re-arranged and split into three sub-sections to include background, problem statement and objective to match the sequences proposed from your side. The existing comparison has been modified to include the traditional autoregressive model.

While the second point is to develop a traditional autoregressive model in order to provide a comparison analysis with the proposed AI-based model. In this context, owing to the editor feedback, the authors provide the procedure for developing the autoregressive model and provide the comparison in table 1.

2. It is advisable to test yet another model structure with the input data from the last year: typically a certain month/week is similar to what was observed in the same week/month in the past. There is enough data to do it. This will move the model from the class of autoregressive models and may improve the results.

Reply

In fact, the proposed architecture “yearly basis” (forecast the certain month/week (m) at year (n) utilizing same month/week (m) at the previous year (n-1)) was the first model structure to be developed. Considering that the data length for weekly/monthly is 12 and 24 years respectively,

then model will be developed based on 12/24 records (for training and testing). Such structure has two weak points:-

1. The data is very short (12/24 records) to develop time series model
 2. From the hydrological point of view YEARLY BASIS, the available 12/24 years is short to experience all the rainfall patterns to make sure of the reliability of the model.
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3. It is recommended to explain what will be the use of the suggested ANN-based predictor.

Reply

Owing to the reviewer feedback, additional paragraph at the beginning of the introduction section has been added to include the use of the proposed ANN-based rainfall predictor.

4. Use of various types ANN in various forecasting problems is not new. It is necessary to demonstrate the novelty of the suggested method. What does this work bring to science and how will it improve water management?

Reply

Owing to the reviewer feedback, in the IDNN sub-section under the methodology section has been modified to stress on the novelty of the proposed ANN method.

1. Some references are cited but do not appear (Noureldin et al, 2011 and Elshafie and Noureldin, 2011) in the References section.

Reply

Both references have been added in the references list and all the references list have been reviewed.

2. Usually using the third order model (i.e., the rainfall at time t-3, t-4 and t-5 still has impact on the rainfall at time t) is physically probable for this problem, especially for the wet period months.

Reply

Basically, the proposed neural network model in our study is NOT mainly rely on the physical and/or hydrological behavior of the system in the study area, it is conceptually a time series forecasters with consideration of the rainfall pattern of consecutive months. To predict the time series of different systems' behavior that uses the previous and most recently behavior of a system to predict its future changes. The major advantage of this method is the ability to predict the behavior of systems without fully consideration or analytical prediction rules (hydrological/physical). As a result, within this concept, any month could be forecasted as long as the previous data records could help enhancing the forecasting skills and are available in the time series.

3. Some justifications should be provided on using the back-propagation algorithm, which has the drawbacks of local convergence and slowness.

Reply

The authors fully agreed with the referee in this point. The back-propagation algorithm experienced several drawbacks such as, local optima, slowness. There are many advanced methods offered by researchers to overcome these drawbacks such as Particle Swarm Optimization (PSO) and Genetic Algorithm (GA). In fact, the authors preferred to use back-propagation algorithm method at this stage of this study on to introduce the dynamic neural network at the classical stage. However, the other algorithms could be applied and re-adjusted to be included in more advanced neural network types whether static (radial basis function or self-organizing neural network or probabilistic neural network) or dynamic neural network (recurrent, input delay and NARX neural network) with different types of training algorithms PSO and GA.

4. Many assumptions are stated in various sections. More justifications should be provided on these assumptions. Evaluation on how they will affect the results should be made.

Reply

It is true that there are some assumptions in our research. Hereafter, we will try to highlight the major ones.

- Assume the input pattern only 1 to 5 previous months/weekly.

The findings of the cross-correlation analysis between two consequences months shows that the cross-correlation is relatively poor if go more than 5 months/weeks behind the one under study to be forecasted for most of the months.

- The performance indicators

Actually, in developing such forecasting model using Neural Network, the model could perform well during the training period and might provide higher level of error when evaluating during either validation or testing period. In this context, in this study the authors used these performance indices to make sure of that the proposed model could provide consistent level of accuracy during all periods. The advantages of utilizing these two statistical indices as a performance indicator of the proposed model are as follow:-

- 1- Using the maximum error is to make sure that the highest error while evaluating the performance is within the acceptable error for such forecasting model.
- 2- While utilizing the Root Mean Square error is to ensure that the summation of the error distribution within the validation period is not high.
- 3- Consequently, using both indices is guaranteed consistent level of errors which is providing a great potential for having same level error while examining the model for unseen data in the testing period.

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5. The key ANN parameters are not mentioned. The rationale on the choice of the particular set of parameters should be explained. Have the authors experimented with other sets of values? What are the sensitivities of these parameters on the results?

Reply

In fact, there is no formal and/or mathematical method for determining the appropriate “optimal set” set of the key parameters of Neural Network (number of hidden layers, number of neurons with each hidden layer and the type of transfer function between two consequence layers). Accordingly, the authors decide to perform this task utilizing trial and error method. The authors experimented several sets and examined each experiment but we report only the best trial.

However, the authors reported some observations about the proposed model performance and sensitivity analysis under different set of key parameters in the revised version of the manuscript. One more figure has been added for visualizing this analysis (figure 11).

In the conclusion section, the limitations of this study, suggested improvements of this work and future directions should be highlighted.

Reply

The conclusion section has been improved and includes the limitations of this study, suggested improvements of this work and future directions.

Reviewer #2:

The paper objective sounds interesting: it promises to evaluate the use of Artificial Neural Networks (ANN) for assessing water quality. There are very few applications concerning ANN in aquatic studies and therefore the applicability of ANN in assessing environmental quality is not known as yet. The subject addressed is within the scope of the journal. However, the manuscript, in its present form, should be improved in the light of the following comments in order to be more suitable for the readers. Addressing the following comments/modifications could be satisfactory in order to justify recommendation for publication.

Reply

The authors appreciate the referee for his opinion for our research contribution presented in this manuscript.

Major comments:

Although the authors examine the proposed model with the real data, however, the data is not recent. It would be significant to evaluate the model with real recent data.

Reply

We agree with the reviewer in his comment. However, it is NOT the data used in the this study is up to 2008, and the recent data during the period between 2009 and 2011 is NOT available yet to be able to evaluate the model for the rainfall records during this period.

Minor comments:

1-It is highly recommended to enhance the introduction section by introducing citing several researches for Artificial Intelligence application for environmental and / or other fields

Reply

Owing to the reviewer feedback, this section has been improved by adding several references in other environmental and other fields

2-There are a few formatting issues that would improve clarity, which mainly involve figure font sizes.

Reply

The authors reviews the manuscript carefully and corrects the formatting for the figures according to the instruction of HESS

3-There are a few typos in the text that the authors should address.

Reply

The whole text of the manuscript has been thoroughly reviewed and all the typos errors have been corrected

4-In the conclusion section, the limitations of this study, suggested improvements of this work and future directions should be highlighted.

Reply

The conclusion section has been improved and includes the limitations of this study, suggested improvements of this work and future directions.
