STUDENT JOURNALS

water e-journal
Online Journal of the Australian Water Association

ISSN 2206-1991
Volume 7 No 1 2022
https://doi.org/10.21139/wej.2022.022

Regional flood frequency analysis using linear and non-linear techniques

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ABSTRACT

Regional Flood Frequency Analysis (RFFA) is widely used in practice to estimate design floods in ungauged catchments. Previous studies on RFFA focused on developing linear models to relate flood quantiles with catchment characteristics. Limited studies have focused on non-linear RFFA models. The purpose of this study is to focus on the following research objectives:

1. To examine the accuracy of common linear RFFA techniques used in Australia;
2. Develop RFFA models based on artificial intelligence (AI) and compare their accuracy with conventional linear models
3. Investigate the need to use AI-based models in RFFA.

We use data from 181 gauged catchments in south-east Australia. Linear models such as Quantile Regression Technique (QRT) and the Index Flood Method (IFM) were developed and evaluated. We used 70% of the selected catchments to develop RFFA models, which were then tested against the remaining 30% of the catchments. Comparing the results of QRT and IFM models, we found that the QRT performed better than the IFM.

In this study, we examined some of the most common non-linear models, including support vector machine (SVM), adaptive network-based fuzzy inference system (ANFIS), and artificial neural network (ANN), which have been seen in many cases that they perform better than linear models. ANFIS models such as fuzzy c-mean (FCM), subtractive clustering (SC) and grid partitioning (GP), were developed and tested. Evaluating the results of these three models, we found that FCM outperformed the other two models. Different types of kernels were examined to develop the best performing SVM model. The results show that Radial Basis Function (RBF) was the best performing kernel type for SVM. The ANN models were developed based on four different methods, and the results show that ANN with a multilayer perceptron (MLP) approach produces the best results. Furthermore, based on the results of non-linear models, we found that the ANN model was the best performing non-linear model.

Finally, comparing the results of the ANN model as the best non-linear model with QRT as the best linear model, we found that the ANN model is the best model among all other linear and non-linear models. Two journal articles have already been written so far, and another three journal articles will be written based on this doctoral research. The research will be completed by June 2022.