Artificial Neural Network for Precipitation and Water Level Predictions of Bedup River

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Abstract—This study aims to improve water level prediction at Bedup River with estimations made to absent precipitation data, both using Artificial Neural Network (ANN). Studies to predict water level in the state of Sarawak, Malaysia have been actively carried out. However, among problem faced was absent precipitation readings, which inevitably affected water level precipitation accuracies. Backpropagation properties of ANN was used in the study to predict both missing precipitation and water level. ANN model developed in this study successfully estimates missing precipitation data of a recorder in Bedup River, Sarawak with 96.4% accuracy. The predicted values of precipitation were then used to forecast water level of the same gauging station and yielded accuracy value of 85.3%, compared to only 71.1% accuracy of water level prediction with no estimation made to its missing precipitation data. These results show that ANN is an effective tool in forecasting both missing precipitation and water level data, which are utmost essential to hydrologists around the globe.

Index Terms—Artificial Neural Network, Backpropagation, Precipitation Prediction, Water Level Prediction

I. INTRODUCTION

Sarawak is the largest state in Malaysia. Its coastal zone is generally flat and low lying. The area is very much influenced by tidal effect. Despite being 35 km from the sea, Kuching, capital city of Sarawak, experiences a tidal range of over 6m during spring tides, or locally known as King Tides. The annual rainfall for Kuching is very high, about 3800 mm, which makes the area prone to flooding. Over the last 40 years, there has been a number of significant hydrological events, all of which caused extensive flooding throughout Sarawak River. In January and February 1963, extremely heavy rainfall recorded at 2500 mm for two months brought in flood of over 7m depth in Sarawak River. The mishap claimed 4 lives, with 800 longhouses badly

damaged and destroyed all over Sarawak. Flooding occurred again in January 1974, February 2003 and January 2004 resulting from prolonged rainfall and occurrence of spring tides.

Knowing that economic development in Sarawak takes place by the rivers, accurate forecasting of water level is therefore essential to warn public of potential rise in water level and call for necessary precautions.

Among the widely used methods for estimating missing precipitation are normal-ratio, arithmetic, inverse distance, isohyetal and thiessen polygon methods. With exception to normal-ratio and arithmetic methods, the rest of estimation methods require parameters such as distance and/or topographical conditions of the area.

Water level prediction via conventional method needs accurate estimation of runoff from a given rainfall event and an accurate hydraulic model for a given discharge. Runoff generation highly depends on catchment topography, river network, soil characteristics and antecedent moisture. On the other hand, hydraulic models are available only for a limited number of cross-sections. All these parameters are not all the time available, thus making estimation of water level very complex.

ANN was chosen for its ability to generalize results from unseen data and well-suited in modeling dynamic systems on a real-time basis. These properties of ANN are suitable to forecast water level and missing precipitation as their physical relationships are not well understood.

ANN has also been used in water resources engineering over the last decade. These include flood forecasting (R. Garcia Bartual 2002, Wright and Dastorani 2001), rainfall-runoff modeling (Tokar and Johnson 1999, Sobri Harun *et al.* 2002, Thurumalaiah and Deo 2000), streamflow prediction (Dolling and Varas 2001, Dastorani and Wright 2002, Wright *et al.* 2002), and water level prediction (Patrick and Collins 2002, Huang *et al.* 2003).

In this study, estimation of missing precipitation were made using Normal-ratio method and ANN. Results of the two simulations were then used as inputs along with available precipitation data to test the ANN ability in forecasting water level data. A third ANN water level predicting model was created with no estimations made to its missing precipitation data. This will enable us to see if there are any significant effects of estimating missing precipitation data on water level prediction.

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