UNIVERSITI TEKNOLOGI MARA

DEVELOPMENT OF ARTIFICIAL NEURAL NETWORK (ANN) FLOOD MODEL FOR JETI KASTAM STATION BASED ON SIGNIFICANT RAINFALL LOCATIONS USING Z-SCORE

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MSc

November 2019

ABSTRACT

A review of floods modelling in use today shows that new techniques are required that solves the problems of flood prediction and damage estimation. It is generally acknowledged in the environment sciences that the choice of computational model impacts the research results. Such models mainly used to simulate rainfall and water level prediction involve that use an intelligent model. This study aims to explore the use of an Artificial Neural Network (ANN) models to predict the water level at Jeti Kastam. Rainfall and water level were considered as the primary factor influencing the likelihood of flood and a number of ANN architectures were evaluated as flood prediction models. The Kelantan river area is one such region which has been vulnerable to flood disasters. This study predicts river water level from rainfall and water level data. The data collection start with rainfall and water level data provide by Department of Irrigation and Drainage Malaysia (DID). Then it followed by identifying its significant station using Z-score technique. After that, ANN model was developed based on significant data stations of rainfall and water level at Kelantan river. The use of six stations of rainfall and water level along Kelantan River from upstream to downstream which are Kuala Koh, Tualang, Kuala Krai, Kusial, Dataran Air Mulih and Jeti Kastam were coded as S1 to S6. It specifically analysed the historical data of rainfall and water level stations in Kelantan river basin from January 2013 until December 2015. The total of 105,120 rainfall data and water level data were collected per year. It means, the total of 315,360 data of rainfall and water level were used for analysis. Z-score technique was proposed to identify the significant data stations of rainfall and water level in order to increase the performance of ANN training networks model. This study shows the comparison results between with Z-score and without Z-score technique that will affect the performance of ANN prediction model. Z-score technique highlighted that four data stations of rainfall and two data stations of water level stations were recognized. For water level stations, they are Kuala Koh, Tualang, Kuala Krai and Jeti Kastam. Meanwhile, Kuala Koh and Tualang were recognized for rainfall stations. Feedforward algorithm was used as neural network architecture in this flood modelling and it showed that, this architecture can predict the water level very well. The ANN model was trained, validated and tested successfully with Mean Square Error (MSE) was calculated at every node. The result with Z-score showed that the number of hidden neurons was kept at five in hidden layer afforded the lowest MSE value was 0.0000245. However, the result of without Z-score technique showed that the MSE value is 0.0000758 with six hidden neurons in hidden layer. The results of the modelling and identification system are presented such that can be used as an aid to the flood modelling. This approach produced acceptable results for the requirements for the neutral network architectures that were studied.

ACKNOWLEDGEMENT

In the name of Allah, the Most Beneficent and the Most Merciful. Salam to Nabi Muhammad S.A.W, his friends, companion and the people who follow his path.

Alhamdulillah, all praises to Allah S.W.T for the strengths and His blessing in completing this thesis. My sincere honour, gratitude and appreciation and greatly expressed to my supervisor, Assoc Prof Ts Dr Mohd Hezri Fazalul Rahiman for his guidance, valuable suggestion and invaluable advices which has helped me tremendously in completing this work. I would also like to express my sincere gratitude to all my co-supervisor, Assoc Prof Dr Ramli Adnan for his valuable help and guidance.

I would like to thank Kementerian Pendidikan Tinggi Malaysia for giving me the financial support throughout the Master's research. My acknowledgement also goes to Institute of Graduate Studies (IPSiS) for giving guidance on writing the Master's thesis. My appreciation goes to the Department of Irrigation and Drainage Malaysia (DID) for providing me with the real-time data used in my research.

I express my deep sense of thankfulness to Ir Ts Dr Nurlaila Ismail for her helped, knowledge sharing and providing me support that I believed I learn from the best. I express my sincere thanks to thank Process Instrumentation and Control Group (PICon) members for valuable help and their kindness. I wish to express my sincere gratitude to Dr Mazidah, Dr Hezri Marzaki, Nuzaihan, Najidah, Siti Naimah, Aftas, Nadia, Shakila and Sakinah.

My special thanks to my best friend, Siti Rahila for her kindness and moral support during my study. I dedicate my grateful thanks to my family especially my parents, Jaafar Che Bakar and I who supported me emotionally and financially also for their endless love and prayers. My sisters, Fauziah, Habsah and Mazni deserve my wholehearted thanks as well.

Last but not least, I would like to thank all that have directly and indirectly helped me to bring out this thesis. Only Allah S.W.T could repay their kindness. Thank you very much.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Floods are natural hydrological phenomena [1]. Floods can be describe as a the most dangerous disasters will cause of loss of life and property [2]. There are very few countries worldwide that do not suffer a risk from flooding. The biggest floods recorded in recent Malaysian history occurred in 1967, 1971 and 1998 [3]. Cause of flooding had been identified from either natural, unnatural or both factors [4]. Natural factors are those directly cause by heavy rainfall and the topography within the riverbanks [5]. Unnatural factors that contribute to floods are the effects of uncontrolled development, disturbance to river flow such as the building of bridges and roads along the river [6]. The floods that occurred in every monsoon season over the east coast Malaysia region such as Kelantan, Terengganu and Pahang are in a state of unpreparedness [4, 7]. Generally, flood is classified into two types; the monsoon season and flash flood [5]. In Malaysia, the monsoon season usually occurs in the months of November until March and experienced major floods in the years since 1926 [6].

Developing a model in the analysis for flood has been a popular subject study to researchers [8, 9]. Artificial Neural Network (ANN) has been extensively used in various application as an efficient tools of modelling and forecasting these two decades [10]. Many models are used in hydrology model for various purposes. Some of these models include the Nonlinear Auto Regressive Exogenous Input (NARX) Model, Autoregressive with Exogenous Input (ARX), Back Propagation Neural Network (BPN), Elman Neural Network (ENN) and Artificial Neural Network (ANN) [11-13]. For flood forecasting purposes, some of the physical parameters such as rainfall-runoff relationship, depth of river water level, streamflow and stream slope are needed defined as input and output models [5, 14]. The popular model such as in hydrology prediction is ANN where it was recognized as the most effective and its ability in analyzing the dataset [15, 16]. This method is limited to the subject of flood modelling since only three years data were collected in identified the significant stations and fed to ANN model for development.

The State of Kelantan belongs to the Eastern Region of Peninsular Malaysia