FORECASTING MODEL FOR THE CHANGE IN STAGE OF RESERVOIR WATER LEVEL

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Abstrak

Takungan merupakan salah satu pendekatan berstruktur utama bagi tebatan banjir. Semasa banjir, pelepasan awal air takungan merupakan salah satu daripada tindakan yang diambil oleh operator takungan bagi menampung hujan lebat yang akan diterima. Pelepasan air lewat mungkin akan memberi kesan negatif kepada struktur takungan dan menyebabkan banjir di kawasan hilir. Walau bagaimanapun, hujan semasa tidak akan mempengaruhi perubahan paras air takungan secara langsung. Kelewatan ini terjadi kerana aliran yang membawa air mungkin akan mengambil sedikit masa untuk sampai ke takungan. Kajian ini bermatlamat untuk membangunkan model peramalan bagi perubahan pada peringkat paras air takungan. Model ini mengambil kira perubahan paras dan peringkat air takungan sebagai input dan perubahan pada peringkat air takungan pada masa hadapan sebagai output. Dalam kajian ini, data pengoperasian takungan Timah Tasoh telah diperolehi dari Jabatan Pengairan dan Saliran Perlis (DID). Paras air takungan telah dikategorikan kepada peringkat tertentu berdasarkan panduan dari DID. Algoritma Sliding Window yang telah diubah suai telah digunakan untuk membahagikan data kepada corak temporal. Berdasarkan corak berkenaan, tiga model telah dibangunkan: model paras air takungan, model perubahan paras air takungan dan peringkat paras air takungan dan model gabungan perubahan paras air takungan dan peringkat paras air takungan. Kesemua model disimulasikan menggunakan rangkaian neural dan prestasinya dibandingkan menggunakan min kuasa dua ralat (MSE) dan peratusan ketepatan. Dapatan kajian menunjukkan model perubahan paras air takungan dan peringkat paras air takungan menghasilkan MSE terendah dan peratusan ketepatan paling tinggi berbanding dua model lain. Dapatan kajian juga menunjukkan bahawa kelewatan dua hari sebelumnya telah memberi kesan terhadap perubahan dalam peringkat paras air takungan. Model ini boleh diaplikasikan bagi menyokong keputusan pelepasan awal air takungan. Oleh itu, mengurangkan kesan banjir di kawasan hilir.

Kata Kunci: Model ramalan, Perkomputeran pintar, Rangkaian neural, Operasi takungan, Paras air takungan.

Abstract

Reservoir is one of major structural approaches for flood mitigation. During floods, early reservoir water release is one of the actions taken by the reservoir operator to accommodate incoming heavy rainfall. Late water release might give negative effect to the reservoir structure and cause flood at downstream area. However, current rainfall may not directly influence the change of reservoir water level. The delay may occur as the streamflow that carries the water might take some time to reach the reservoir. This study is aimed to develop a forecasting model for the change in stage of reservoir water level. The model considers the changes of reservoir water level and its stage as the input and the future change in stage of reservoir water level as the output. In this study, the Timah Tasoh reservoir operational data was obtained from the Perlis Department of Irrigation and Drainage (DID). The reservoir water level was categorised into stages based on DID manual. A modified sliding window algorithm has been deployed to segment the data into temporal patterns. Based on the patterns, three models were developed: the reservoir water level model, the change of reservoir water level and stage of reservoir water level model, and the combination of the change of reservoir water level and stage of reservoir water level model. All models were simulated using neural network and their performances were compared using on mean square error (MSE) and percentage of correctness. The result shows that the change of reservoir water level and stage of reservoir water model produces the lowest MSE and the highest percentage of correctness when compared to the other two models. The findings also show that a delay of two previous days has affected the change in stage of reservoir water level. The model can be applied to support early reservoir water release decision making. Thus, reduce the impact of flood at the downstream area.

Keywords: Forecasting model, Computational intelligence, Neural network, Reservoir operation, Reservoir water level.

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List of Abbreviations

ANN	Artificial Neural Network
MSE	Mean Square Error
BP	Backpropagation
FL	Fuzzy Logic
ARIMA	Autoregression Integrated Moving Average
ANFIS	Adaptive Neural Network Fuzzy Inference System

CHAPTER ONE
INTRODUCTION

1.1 Background of Study

Reservoir is one of the ciritical components in water resources management. Reservoir can be defined as a natural or artificial lake or large tank used to store and control water for various purposes such as supplies and irrigation. It can also serve as a shield during flood and drought situations (Gotoh, Maeno, Takezawa, & Ohnishi, 2011; Romanescu, Stoleriu, & Romanescu, 2011; Wan Ishak, Ku-Mahamud, & Norwawi, 2011b). Typically, reservoir can be clasified into single and multipurpose reservoirs. A single purpose reservoir is constructed to serve only one purpose, such as a hydroeletric reservoir that is to generate electricity. A multipurpose reservoir is aimed to serve more than one purpose, such as flood mitigation, water supply, and recreation. Thus, the water storage has to be divided to fullfil the purposes.

Reservoir systems can be separated into four parts: upstream, reservoir, spillway gate and downstream (Figure 1.1). Upstream is the water source or inflow of the reservoir. The upstream data is recorded through gauging and telemetric stations. The water inflow is compounded at the reservoir before it is released to the downstream water channel. Reservoir is a system that is controlled by human decisions. The decisions are based on their past experience and knowledge and the current hydrological conditions such as precipitation, upstream river water level, etc. The spillway gate is used as the outlet for the reservoir water. Some reservoirs are equipped with an

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