RAINFALL TIME SERIES MODELING FOR A MOUNTAINOUS REGION IN WEST IRAN

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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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Dedicated to the author’s beloved Father and Mother
Abstract of the thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Master of Science

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By

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One of the major problems of water resources management is rainfall forecasting. Different linear and non-linear methods have been used in order to have an accurate forecast. Whilst there are some debates on whether the use of linear or non-linear techniques is better, it was found that rainfall modelling for the short term period is receiving more attention than those for long-term periods. This study gives attention to long-term rainfall modelling since long-term forecasting could provide better data for optimal management of a resource that is to be used over a substantial period of time. Hence, this study is to investigate the effect of linear and non-linear techniques on long-term rainfall forecasting. One of the non-linear techniques being widely used is the Artificial Neural Networks (ANN) approach which has the ability of mapping between
input and output patterns without a priori knowledge of the system being modelled. The more popular linear techniques include the Box-Jenkins family of models.

A feedforward Artificial Neural Network (ANN) rainfall model and a Seasonal Autoregressive Integrated Moving Average (SARIMA) rainfall model were developed to investigate their potentials in forecasting rainfall. The study area is the west mountainous region of Iran. Three meteorological stations among the several stations over the region were chosen as case study. The stations are the Hamedan Foroudgah, Nujeh, and Arak. Three different ANN models with three different input sets were trained. The first model investigated the effect of number of lags on the performance of the ANN. The number of lags varied from 1-12 previous months. The second model investigated the effect of adding monthly average to the inputs, and the third model considered seasonal average as an extra input in addition to the ones in the second model. The effect of the number of hidden nodes on ANN modeling was also examined. The preliminary inputs for SARIMA were found by examining the Autocorrelation and Partial Autocorrelation of the series. The 26 years monthly rainfall of 1977-2002 was used for training the models. The ANN models were trained and simulated using a program written in MATLAB environment (M-file). The SARIMA models were developed using SPSS syntax. The models were tested with one year monthly rainfall of 2003. It was proven that the larger lags outperform the lower ones in ANN modeling. Also, adding the extra monthly and seasonal average to the input set leads to better model performance. The number of hidden nodes was varied from 1-30. It was demonstrated that input nodes have more effect on performance criteria than the hidden nodes. The models were trained based on
the Levenberg-Marquardt algorithm with tan sigmoid activation function for the hidden layer and purelin activation function for the output layer. Simulation results for the independent testing data series showed that the model can perform well in simulating one year monthly rainfall in advance. The SARIMA models were built using the same set of data as for the ANN. Model selection was done among multiplicative and additive models and the results revealed that additive SARIMA models have the best performance. The simulation results from the ANN and SARIMA model showed that the SARIMA model has a better performance both in training and testing. Thus, it is recommended for modeling rainfall in the region.
MODEL BERSIRI MASA HUJAN UNTUK SEBUAH KAWASAN BERGUNUNG-GANANG DI BARAT IRAN

Oleh

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fungsi pengaktifan sigmoid untuk lapisan terlindung dan fungsi pengaktifan paris tulin bagi lapisan output. Keputusan simulasi bagi siri data ujian tak bersandar menunjukkan bahawa model tersebut adalah sangat baik nutuk menyimulasikan hujan bulan satu tahun kedepan. Model SARIMA juga dibentukkan dengan set data yang sama diguna untuk membentukkan ANN. Pemilihan model dibuat daripada model yang berdaya tambah dan yang berpendaraban dan keputusan menghasilkan bahawa model SARIMA berdaya tambah berperstasi terbaik. Keputusan simulasi daripada model ANN dan SARIMA menhasilkan bahawa model SARIMA lebih berprestasi bagi kajian latihan dan ujian. Oleh demikian ianya disyorkan untuk memodelkan hujan dikawasan tersebut.
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I certify that a Thesis Examination Committee has met on (June 2010) to conduct the final examination of Fatemeh Mekanik on her Master of Science thesis “Rainfall Modeling for a Mountainous Region in Western Iran” in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institutions.

FATEMEH MEKANIK

Date: 1 November 2010
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