Rainfall Classification for Flood Prediction Using Meteorology Data of Kuching, Sarawak, Malaysia: Backpropagation vs Radial Basis Function Neural Network

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***Abstract*—Rainfall is often defined by stochastic process due to its random characteristics, i.e. space and time dependent and it is therefore, not easy to predict. In general, rainfall is a highly non-linear and complicated phenomenon. In order to acquire an accurate prediction, advanced computer modeling and simulation is required. Artificial Neural Network (ANN) has been successfully used to predict the behavior of such non-linear system. Among the different types of ANN models used, Backpropagation Network (BPN) and Radial Basis Function Networks (RBFN) are the two common ANN models that had produced valuable results. However, there was no study conducted to research on which, among these two methods, is the better model for rainfall forecast. Therefore, this study will fill this gap by comparing the capabilities of these two ANN models in rainfall forecast using metrological data from year 2009 to 2013 obtained from Malaysian Meteorological Department for Kuching, Sarawak, Malaysia. From the research, it is concluded that, BPN (MSE≈0.16, R≈0.86) performs better as compared to RBFN (MSE≈0.22, R≈0.82). The strengths and weaknesses of these models are also presented in this paper.**

***Index Terms*—Artificial neural network, backpropagation, radial basis function, rainfall, classification.**

I. Introduction

Weather forecasting is a complicated procedure yet the most essential and vital process for the mankind nowadays, because it severely affect hu-man activities. Highly accurate weather forecast could help to prevent casualties and damages. Amongst all the weather happenings, floods are the leading cause of natural disaster death world-wide and were responsible for 6.8 million death in the 20th century [1].

The flood-prone areas in Malaysia is approximately 29,000km2 and the population on these areas is more than 4.82 million people, which is 22% of the whole Malaysian [2]. The damage caused by flooding is estimated to be around RM915 million (£160 million). The impact of flood to Malaysia could be seen in the increase budget allocated for flood mitigations in the 5-year Malaysia Plan shown in Table I.

TABLE I: Flood Mitigation Expenditure in Malaysia [3]

Period	RM	Remark
1971-1975	14 million	2nd Malaysia Plan
1976-1980	56 million	3rd Malaysia Plan
1981-1985	141 million	4th Malaysia Plan
1986-1990	155 million	5th Malaysia Plan
1991-1995	451 million	6th Malaysia Plan
1996-2000	845 million	7th Malaysia Plan
2001-2005	1.8 billion	8th Malaysia Plan
2006-2010	4 billion	9th Malaysia Plan
2010-2015	5 billion	10th Malaysia Plan

Rainfall is one of the most significant parameters in hydrological model. Due to the importance of rainfall, large numbers of attempts have been made to predict rainfall accurately using various traditional statistical and numerical methods. However, due to the nonlinear characteristics of rainfall, the prediction accuracies obtained by these methods were still not at satisfactory level. Recent advancements entitled Data Driven Modeling (DDM) which encompasses computational intelligence has emerged. DDM is based on analyzing the data about the system, in particular finding connections between the system variables (input, internal and output variables) without explicit knowledge of the physical behavior of the system. Artificial Neural Network (ANN) algorithms have been successfully applied in rainfall classification. Among the different ANN algorithms applied, the Backpropagation Neural Network (BPN) and Radial Basis Function Network (RBFN) are the two most commonly used in rainfall prediction and yield satisfactory results [4]. However, there is no research on verifying which method applied better accuracy result as comparing to the other.

II. Data

A. Meteorology Data

The study area selected for this study is Kuching city, the capital city of Sarawak located in the east Malaysia. Kuching, one of the fast and highly developed cities in Malaysia, is located at the southwest of the Sarawak state with latitude 1.6019N and longitude 110.3244E. Kuching city has a cover area of 895.09 km2 and a population of 681,901 [5]. Malaysia experiences an average of 143 flood events annually between 2001 to 2015 and more than 90% of these events are flash flooding. Sarawak, a state on Borneo in Malaysia, experiences an annual rainfall of around 3000-4000mm. Kuching, the capital city of Sarawak, is established besides

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