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Design of Experiment on Sustainable Daily Air Surface Temperature Prediction in Cameron Highlands, Malaysia

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Abstract— **The objectives in this research is to investigate the interaction between air surface temperature with others climatologically parameters such as humidity, sunshine, rain and others in Cameron Highlands and to construct an appropriate neural networks model for air surface temperature. The other purpose is to provide operational prediction outlook of short and medium term using neural networks model.**

Keywords- air surface temperature, Cameron Highlands, prediction, neural networks, model

I. INTRODUCTION

Cameron Highlands is a highland region located about 121 km east of Ipoh and about 214 km north of Kuala Lumpur, in Pahang, Malaysia. At 5,000 ft (1,500 m) above sea level it is the highest area on the mainland, enjoys a cool climate, with temperatures no higher than 25 °C and rarely falls below 12°C year-round. Cameron Highlands is actually a district in the state of Pahang Darul Makmur although the road entrance is via Tapah and Simpang Pulai in the state of Perak Darul Ridzuan. Cameron Highlands district is bordered by Lipis district on the south-east, Kelantan on the north and Perak on the west. The size of the whole Cameron Highlands district is roughly two and a quarter times the size of Singapore.

Apart from the cool weather, key attractions in Cameron Highlands include a butterfly farm, strawberry farms, rose gardens and vegetable gardens. There are also the Brinchang Hindu Temples and the Sam Poh Chinese Mahayana Buddhist Temple. Other features include Cactus Point, Cactus Valley and the BOH Tea Plantation. There is Market Square, the Cameron Highlands Time Tunnel Galeria (at nearby Kea Farm) and accommodation at the Kampung Taman Sedia Homestay, Tanah Rata and The Smokehouse Hotel.

Temperature measurement using modern scientific thermometers and temperature scales goes back at least as far as the early 18th century, when Gabriel Fahrenheit adapted a thermometer (switching to mercury) and a scale both developed by Ole Christensen Røemer. Fahrenheit's scale is still in use, alongside the Celsius scale and the Kelvin scale. The world's average surface air temperature is about 15 °C.

Meteorological observatories measure the temperature and humidity of the air near the surface of the Earth usually using thermometers placed in a Stevenson screen, a standardized well-ventilated white-pained instrument shelter. The thermometers should be positioned 1.25–2 m above the ground. Details of this setup are defined by the World Meteorological Organization (WMO). The true daily mean, obtained from a thermograph, is approximated by the mean of 24 hourly readings (which is not the same as the mean of the daily minimum and maximum readings).

II. BACKGROUND OF THE RESEARCH

This is the main station managed by the Malaysian Meteorological Service's personnel. Daily rainfall is measured with a rain gauge and the hourly rainfall is extracted from a rainfall chart which is fixed inside a rain recorder. The daily rainfall is taken at 0800 local time.

The hourly air temperature is measured with dry bulb thermometer and relative humidity is calculated from the dry and wet bulb thermometers readings. The maximum and minimum temperatures of a day are measured with the maximum and minimum thermometers respectively. The daily rate of evaporation is calculated from the difference in water levels inside an evaporation pan. The daily and hourly bright sunshine hours are measured from the burnt sunshine card which is placed under a crystal ball of a sunshine recorder. Hourly solar radiation is obtained from the readings of the solarimeter. Atmospheric pressure is taken hourly from a barometer. Hourly surface wind direction and speed are taken from the anemograph.

A. Objectives

1. To investigate the interaction between air surface temperature with others climatologically parameters such as humidity, sunshine, rain etc. in Cameron Highlands
2. To construct an appropriate neural networks model for air surface temperature. To provide operational forecast outlook of short and medium term using neural networks model.

III. RESEARCH EQUIPMENTS

A. Check Gauge (Figure 1)

The Check gauge is used to measure amount of rainfall.

B. Rain Recorder (Figure 2)

The rain recorder is the instrument for measuring rainfall over a period of time (daily , weekly or monthly depending on the type of recorder and also the chart used)

C. Dry and Wet Bulb Thermometers (Figure 3)

The dry and wet bulb thermometers are placed vertically on a support inside the stevenson screen. the bulb of the wet bulb thermometer is wrapped with muslin and is tied up with a wick. the wick is then dipped inside a container which contains distilled water.

D. Maximum And Minimum Thermometers (Figure 4)

The maximum and minimum thermometers are mounted horizontally inside the stevenson screen. with the minimum thermometer slightly tilted.

E. "US Class A " Evaporation Pan (Figure 5)

"US Class A" pan is used to measure the rate of evaporation. a hook gauge is used to measure the water level inside the pan and a cups anemometer is placed beside the pan to measure the surface wind blow over it

F. Sunshine Recorder (Figure 6)

The sunshine recorder measured the sunshine hour of the day.

G. Anemometer (Figure 7)

The anemometer is used to measure wind direction and speed.

IV. LITERATURE REVIEW

In Cameron Highlands, many new development projects was growing up and gave effected to ecosystems in surrounding area. The main impact from the project development to air surface temperature. Nowadays the air surface temperature slightly warm if compared previous years. This research to study what happen to future about air surface temperature when development still continues. The relationship of air surface temperature is known to be highly non-linear and complex. The air surface temperature is one of the most complex climatological phenomena to comprehend due to the tremendous partial and variability of climatologically parameters and the number of variables involved in the modeling of the physical processes.

Neural networks models have been used successfully to model complex non-linear input-output relationships in an extremely interdisciplinary field. Since the invention of back propagation algorithm [1] to train feed forward multi-layer neural networks a decade ago, neural networks have been widely used for many types of problems in business, industry and science [2]. One major use of NN is for time series forecasting. Many successful applications suggest that NN can be promising alternative tool for both forecasting researchers and practitioners. The popularity of NN is derived from the fact that they are generalized nonlinear forecasting models. Forecasting has been dominated by linear statistical methods for several decades. Although linear models possess many advantages in implementation and interpretation, they have serious limitation in that they cannot capture nonlinear relationships in the data, which are common in many complex real world problems [3]. One of the major reasons for that problem is that there is a varying degree of nonlinearity in the data, which cannot be handled properly by linear statistical methods [4].

This study also, to investigate the interaction between air surface temperature with others climatologically parameters such as humidity, sunshine, total rain etc. in Cameron Highlands. Another objective of this study is to apply statistical model such as ARIMA model in forecasting time series data. In general, statistical model work well in cases where the underlying mechanism is less understood. The models will provide forecasts outlook of air surface temperature for short and medium term. Using several statistical methods will test performance comparison between ARIMA and neural networks. This study also, to investigate the interaction between air surface temperature with others climatologically parameters such as humidity, sunshine, total rain etc. The result form this study can be used for decision makers for their planning for future and how to maintain a cold air temperature in Cameron Highlands.

V. DISCUSSIONS AND SUGGESTIONS

A. Outputs expected from the project

1. Statistical model for modeling climate time series data
2. Forecast outlook of short and medium term for air surface temperature
3. The interaction between air surface temperature with others climatologically parameters such as humidity, sunshine, rain etc. in Cameron Highlands
4. Construct an appropriate neural networks model for air surface temperature. Provide operational forecast outlook of short and medium term using neural networks model

B. Result obtained is disseminated through;

1. Produce CD ROM of the air surface temperature modeling software.
2. Expertise gained could form the basis for air surface temperature forecasting.
3. Produce paper for international journal, seminars and conferences

C. Research methodology

Considering the need for better forecasting method, we intend to elaborate on two techniques which have not been widely used in the product quality forecasting. These are growth model and artificial neural networks (ANN), which are widely used in applied science for forecasting.

1. Data preparation from local climate data which data on Cameron Highlands climate (such as temperature, wind speed, humidity, sunshine) for three years. A large

amount of samples was required for the recognizers' testing and training data. This is common approach adopted by other researchers. This study adopted Swift's (1987) methodology to simulate individual process data since the methodology has been widely accepted by other researcher. In this study, each sample was collected twice a day with a sample size of two, n=2. A total around 2000 to 2160 sample data were used in the training and developed pattern.

2. Basic statistical analysis using standard statistical measurement, time series graph for trend analysis and Multivariate analysis using principle component analysis and cluster analysis.

3. Designing Neural Network Architecture.

The architecture f a multilayer network is not completely constrained by the problem to be solved. The number of inputs to the network is constrained by the problem, and the number of neurons in the output layer is constrained by the number of outputs required by the problem. However, the number of layers between network inputs and the output layer and the sizes of the layers.

4. Development of Neural Network Simulator

The term backpropagation refers to the manner in which the gradient is computed for nonlinear multilayer networks. Backpopagation was created by generalizing the Widrow-Hoff learning rule to multi-layer networks and nonlinear differentiable transfer functions. Backpropagation can train multilayer feed-forward networks with differentiable transfer functions to perform function approximation, pattern association, and pattern classification. The term backpropagation refers to the process by which derivatives of network error, with respect to network weights and biases, can be computed. This process can be used with a number of different optimization strategies.

5. Neural Network training and testing.

There are generally 4 steps in the training process for the backpropagation training functions in the toolbox to train feedforward neural networks to solve specific problems :

a) Assemble the training data
b) Create the network object
c) Train the network
d) Simulate the network response to new inputs

6. Using Neural Network algorithm to forecast pattern and future point and modeling which the relationship between air surface temperature and other climatologically parameters

7. Results, discussions and conclusion.

(viii) Documentation will be done to ensure all technical details are available for future improvement.

8. Transfer of result to customer may be done upon completion of the documentation.

D. Suggestion for Future Research

To develop the project activities as following below;

1. Data preparation from Cameron Highlands climate.
2. Basic statistical analysis using standard statistical measurement
3. Designing NN architecture and development of NN simulator
4. NN training and testing
5. Forecast pattern and future point and validated models.
6. Documentation

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Figure 1: Check Gauge

Figure 2: Rain Recorder

Figure 3: Dry and Wet Bulb Thermometers

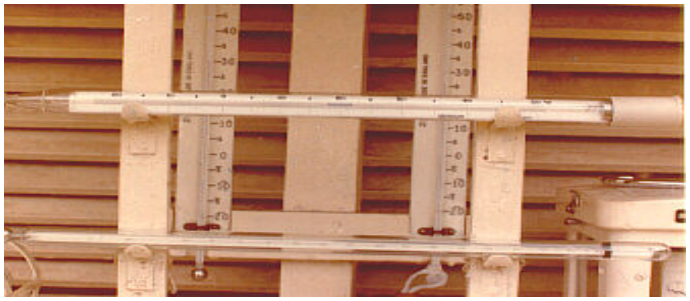

Figure 4: Maximum And Minimum Thermometers

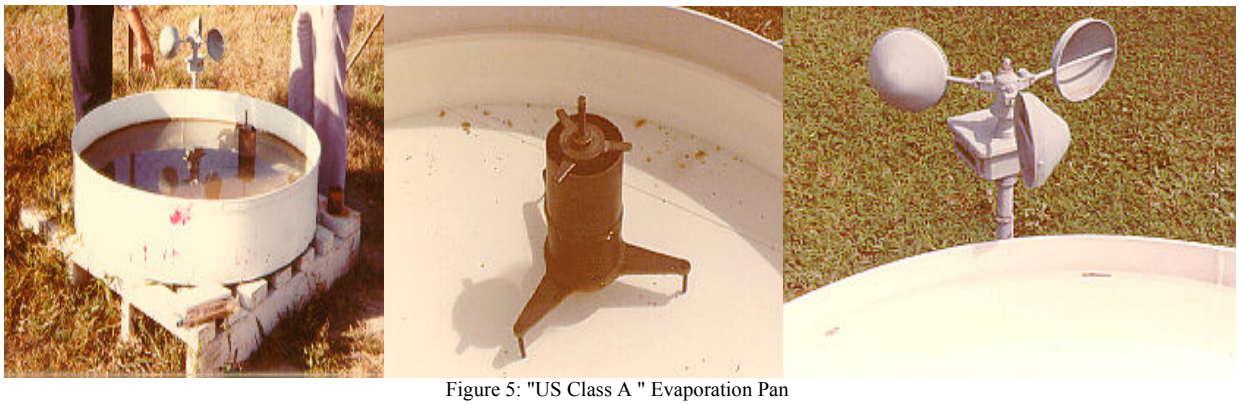

Figure 5: "US Class A " Evaporation Pan

Figure 6: Sunshine Recorder

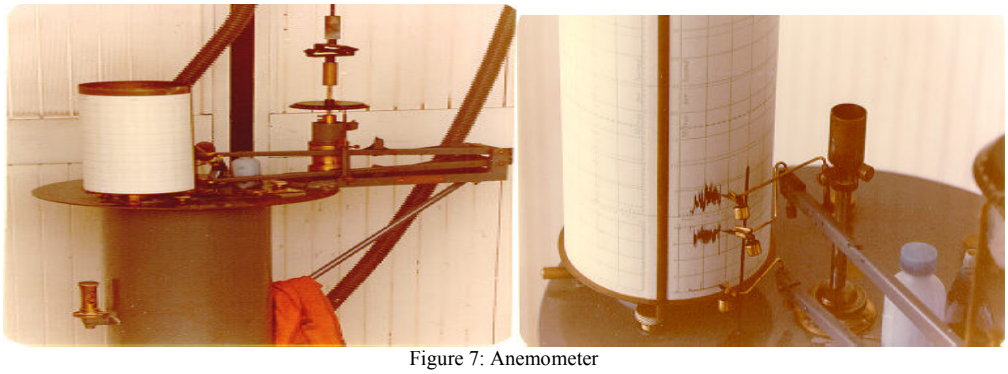

Figure 7: Anemometer