Predicting Late Spring Frost in the Zab Catchment Using Multilayer Perceptron (MLP) Model

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Extended Abstract:

1- INTRODUCTION

Temperature is one of the most important ecological factors affecting the life of the plants. For each species, there is a specific temperature below which the plant growth would be halted. That is, it represents the minimum growth temperature of a plant (Mohammadneya et al, 2010). Thus, if the climate elements are not sufficiently considered in the agricultural planning, the results will not be much promising, as it has been proved that the low efficiency of agricultural crops is mainly due to the inability to maintain moderate climate conditions. Temperature drop and frost at different stages of growth and reproduction of agricultural crops could be dangerous, limiting the ultimate production of plants.

2- METHODOLOGY

Politically, Zab Catchment includes Sardasht and Piranshahr cities in the West Azerbaijan Province and a part of Bane Town in the Kurdistan Province. In this study, artificial neural networks has been employed to predict the late spring cold and frost in the Sardasht and Piranshahr stations. To this end, the 18-year (1995-2012) statistical records of Sardasht and Piranshahr synoptic stations as well as the functions and features embedded in MATLAB software were used for the purpose of training and testing this model. The variables of monthly mean of minimum humidity, station pressure, total precipitation and sunshine hours were selected as inputs, and the network performance indicators such as the coefficient of determination, root mean square error, mean square error, mean absolute error, the percent relative error and correlation coefficient were examined.

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3- THEORETICAL FRAMEWORK

According to Hopfield (1982), artificial neural networks are mass information processing systems parallel to one another with functions that resemble those of the human brain neural network. In this method, based on the inherent relationships among the data, a nonlinear graph is established between the dependent and independent variables, thereby offering a unique structure for solving complicated and intriguing problems (Patterson, 1996). They are strong mathematical tools modeled after the biologic neural system (Fulop et al, 1998). In fact, these systems aim at modeling the neurosynaptic structure of human brain (Men haj, 2005)

4- RESULTS & DISCUSSION

The study of the input variables of the neural network model showed that a 3-layer perceptron model with five neurons in the input layer, one neuron in the output layer and Marquardt-Levenberg (LM) training algorithm offered the desired outcome (monthly mean of the minimum temperature) with the network yielding optimum results in this case. To determine the error of models, a comparison was drawn between the observed data and the data predicted by multi-layer perceptron model, with the indices presenting desirable results. The maximum model error with real data in the Piranshahr and Sardasht stations were 0.35 and 0.15 °C, respectively. It demonstrates the remarkable ability of this model in modeling late spring cold and frost predictions.

5- CONCLUSIONS & SUGGESTIONS

The accurate prediction of minimum temperatures is vital to estimate the occurrence and severity of frost, as it allows finding effective strategies to reduced damage to crops. The results of testing different models show that the most favorable artificial neural network model to predict the mean of minimum temperature will be a 3-layer perceptron model with 5 neurons in the input layer, one neuron in the output layer and the Marquardt-Levenberg training algorithm with a correlation coefficient of 0.82 and 0.85 for Piranshahr and Sardasht stations respectively. The mean relative errors were also 1.68 and 0.47%. The results of this study are consistent with the findings of Hosseini (2010) in Ardabil, Esfandiari and Partners (2011) in Sanandaj, Esfandiari et al. (2013) in Saqez and Hosseini and Mesgari (2013) in Tehran. Finally, based on the findings of the study, it can be concluded that the artificial neural network provides an effective instrument to predict the minimum temperatures for determining late spring cold and frost, especially due to the determination of training error.

Naturally, with the growth of information database in the future, the accuracy of these methods would be enhanced, thereby allowing them to be used in seasonal, annual and long-term predictions. The results of such predictions can be useful not only in the agriculture sector, but also in the management of energy resources, industries, disease outbreaks, road accidents and transportation, water transport

lines and so on. Moreover, it can help implement strategies of coping with the cold and its adverse consequences along with the resource management.

Key words: Minimum temperature, Prediction, Late frost, Zab Catchment, Artificial networks

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