Mosquito Abundance Forecast

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***Abstract-* The mosquito species is one of most threatening insect vectors of several diseases, namely, malaria, filariasis, chikungunya, dengue and so on. In recent years, as the number of people who involve in outdoor activities continues to increase, the infection caused by these vectors also increases. Mosquito-borne diseases can make people ill and, in severe cases, can cause death. Furthermore, mosquito activity prediction is crucial for managing the safety and the health of humans. This model has been implemented as an effective solution against the spread of fatal diseases.**

Keywords- Mosquito, fatal disease, abundance prediction

1. INTRODUCTION

There have been increasing concerns about the effects of global warming on ecosystems, including the impact on the growth and activity of insects' vectors of diseases to humans. Among these, mosquitoes are known for causing more human sufferings than any other organisms. Each year, nearly 500 million people are infected by mosquito-borne diseases and approximately 10,000 to 20,000 die (WHO, 1996) Increasing temperature due to global warming could elevate the growth rates of larval mosquitoes, leading to a larger number of adult mosquitoes and thus more incidences of mosquito-borne diseases (Reiter, 2001).

In order to curb this problem, it is necessary to create a predictive system for early detection of mosquito abundance. Studies indicate that both geographical factors and climatic factors contribute to mosquito growth (Ravi Chandra Pavan Kumar Srimath-Tirumula-Peddinti, 2015) A model using machine learning algorithms can be built to forecast the outbreak of mosquito population. It is aimed to quantitatively assess the usefulness of data acquired for early detection and monitoring of their increasing growth rate.

The predictive model is build using various weather data like measure of rainfall, minimum and maximum temperature, relative humidity at 8hrs and 14hrs. The growth rate of mosquito in terms of percentage has been estimated using Multiple Linear Regression and the status level as safe or unsafe is classified using Artificial Neural Network. The organization of paper is as follows.

2. LITERATURE REVIEW

The article A Modeling and Prediction Analysis - Visakhapatnam : 2015 (Ravi Chandra Pavan Kumar Srimath-Tirumula-Peddinti, 2015) uses Simple Linear and Multiple Linear Regression Analysis to analyse malarial incidences in Visakhapatnam mandals. It is found that Multiple Linear Regression is more suited for that analysis.

Model for predicting mosquito abundance in urban area - Korea : 2015 (Keun Young Lee, 2015) journal estimates the population of mosquito in urban area using Multiple Linear Regression and Artificial Neural Network. MLR could forecast the average variability of mosquito abundances but was not able to predict the high variability.

The research put forth in Neural Network Approach for Diagnosing Mosquito Borne Diseases Based on Clinical Symptoms focuses on the diagnosis of mosquito borne diseases using artificial neural networks – Tirupati: 2016 (Jyothi & Sreelekha, 2016). The sample data accuracy can be further increased. The materials and methods chosen for the analysis is discussed as follows.

3. MATERIALS AND METHODS

3.1 Sampling

3.1.1 Mosquito data

A monthly mosquito population data of all the mosquitoes and vector stations was obtained from National Vector Borne Disease Control Programme (N.V.B.D.C.P.) office, for the periods of 2006–2011. The dataset was used for further analysis.

3.1.2 Weather data

It is well known that the climatic factors such as temperature, humidity and rainfall influence mosquito population (Wang, Ogden, & Zhu, 2011). Thus, to predict mosquito abundances, it is reasonable to consider weather data as input. A monthly total rainfall, average minimum and maximum temperatures, average relative humidity—RH1 (8:00 hrs) & RH2 (14:00 hrs) for the period 2005–2011 was procured from Indian Meteorological Department (IMD) and the Cyclone Warning Centre. These climatic factors are added to the dataset.

3.2 Model development

3.2.1 Multiple Linear Regression (MLR)

The MLR model constitutes a technique for forecasting process de-sign, optimization, and process control. The general MLR is represented by equation 1.

$$Y = ß_0 + ß_1X_1 + ß_2X_2 + \cdots + ß_nX_n \tag{1}$$

denotes the input variables, while Y the output variable, and n is the number of input variables included in the model, and ß the regression coefficients.

The goal of MLR is to find an approximation function for the prediction future response of the system output. We estimated mosquito abundances using the MLR model in R-Studio ver. 1.1.453.

The regression equation framed using Multiple Linear Regression is given by equation 2.

Y = -360.47 + (0.0018 * Rainfall) + (-24.69 * Min.Temperature) + (31.59 * Max.Temperature) + (-3.89 * Relative Humidity @ 8) + (5.11 * Relative Humidity @ 14) (2)

Table 1: Mean, Standard Deviation (SD) and Range of weather data.

	Rainfall	**Min.Temp**	**Max.Temp**	**Relative humid @ 8**	**Relative humid @ 14**
Mean	4247.08	24.7	31.05	73.7	74.4
SD	4182.07	2.45	1.99	5.01	5.13
Range	0-15850	19-29	27-42	62-84	63-84

3.2.2 Artificial Neural Network (ANN)

A multilayer ANN is used to create models of a system state using non-linear combinations of the input variables. The ANN employed in this study is a feed-forwarding network with activation functions in the hidden layers and in the output node using R-Studio ver. 1.1.453. Since according to Bishop's (1995) study more than one hidden layer is often not necessary, our architectures have only one hidden layer (Bishop, 1995). The ANN is trained using a back-propagation algorithm with gradient descent and momentum terms.

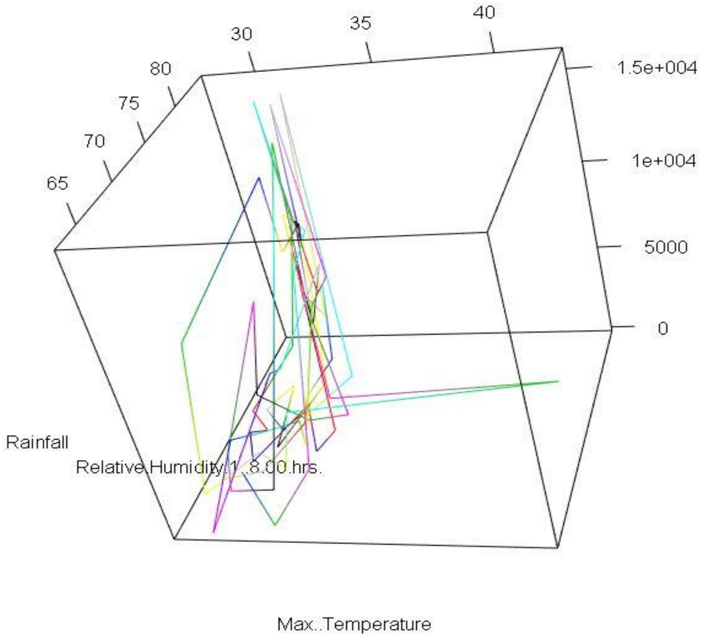

Figure 1: MLR Model

The final ANN structure had five input variables with one node accounting for bias, one hidden neuron with one node accounting for bias, a 0.7 learning rate, and one output variable of the output layer.

Table 2: Mosquito abundance model performance statistics

	Mean	SD	RMSE
MLR	771.4	2304.2	315.31
ANN	741.8	2311.8	0.57

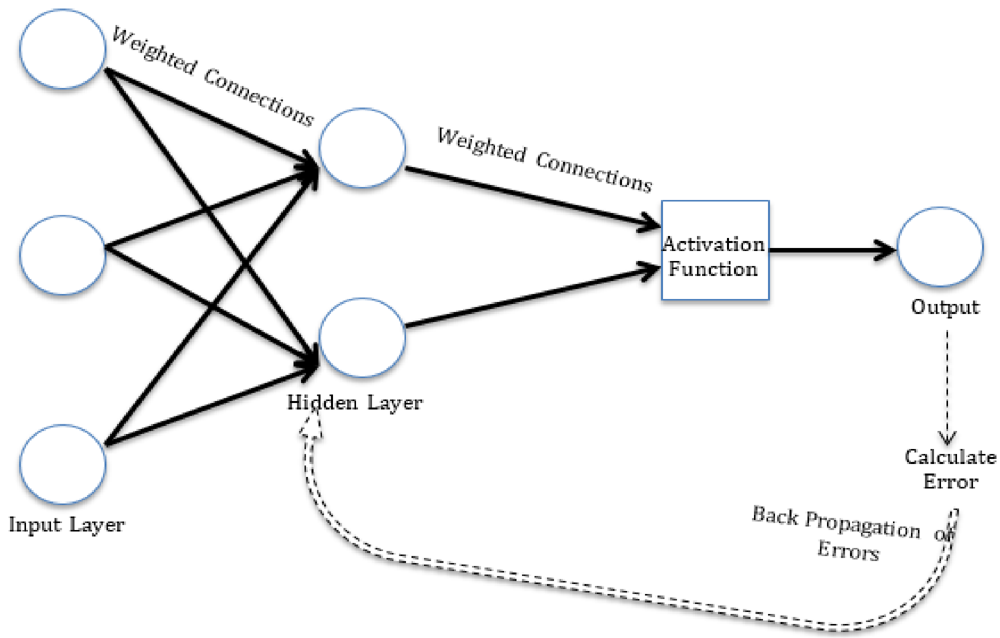

Figure 2: ANN Model

4. PROPOSED SYSTEM

The proposed system is built using Multiple Linear Regression (MLR) and Artificial Neural Network (ANN) algorithms. It takes the weather factors as input predicts the result using both the algorithms. Thus, earlier forecasting is made to estimate the growth of mosquito in local areas.

5. RESULT

The weather factors except Minimum and Maximum temperature are negatively correlated with number of mosquitoes. Increase in temperature favours the growth of mosquito. Maximum temperature showed the highest correlation in Multiple Linear Regression (MLR) Table 3.

Table 3: Correlation between Dependent and Independent Attributes.

Attributes	Correlation
Max. Temperature	0.26
Min. Temperature	0.13
Rainfall	-0.03
Relative Humidity @ 14	-0.17
Relative Humidity @ 8	-0.23

6. DISCUSSION

In this study, two different predictive model is developed which helps to estimate the abundance of mosquito in local area. The environmental factors were selected as parameters to both the models. The developed models are then evaluated.

When compared it is found that MLR model is less suited than ANN model in this study. The ANN model gives 83% accuracy and predicted if the area is in safer zone or not.

REFERENCE

Bishop, C. (1995). Neural Networks for Pattern Recognition.

Jyothi, S., & Sreelekha, O. (2016). Neural Network Approach for Diagnosing Mosquito Borne Diseases Based on Clinical Symptoms.

Keun Young Lee, N. C. (2015). Application of an artificial neural network (ANN) model for predicting mosquito abundance in urban area.

Ravi Chandra Pavan Kumar Srimath-Tirumula-Peddinti, N. R. (2015). Association of Climatic Variability, Vector Population and Malarial Disease in District of Visakhapatnam, India: A Modeling and Prediction Analysis.

Reiter, P. (2001). Climate change and mosquito borne disease. Environ. Health Perspect.

Wang, J., Ogden, N., & Zhu, H. (2011). The impact of weather conditions on Culex pipiens and Culex restuans (Diptera, Culcidae) abundance: a case study in peel region. J. Med. Entomol.

Wenbiao Hu, S. T. (2006). Rainfall, mosquito density and the transmission of Ross River virus: A time-series forecasting model.

WHO. (1996). World Health Report.