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PREDICTION OF MONTHLY RAINFALL OF MANSA REGION USING ARTIFICIAL NEURAL NETWORK (ANN)

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Abstract: Rainfall is natural climatic phenomena whose prediction is challenging and difficult.Also it is the one of the most complex and difficult elements of the hydrology cycle to understand and to model. Rainfall prediction is extremely important in water resource engineering like proper management of floods and mitigation, droughts, environmental flows, water demand by different sectors, maintaining reservoir levels, and disasters. In this Study we used the Radial Basis Exact Fit, Feed Forward Back propagation, Cascade Forward Back propagation neural networks model for predicting the average monthly rainfall of Mansa Taluka. Our results show that the rainfall which is predicted with ratio of 60% - 40% during testing and validation datasets with Cascade forward back propagation algorithm gives the best results as Coefficient of correlation (r) value of 0.999 and 0.99, Coefficient of Determination (r2) values of 0.999 and 0.998, and Discrepancy ratio (D.R.) values. 1.002 And 1.003 for Mansa Taluka. Looking to the results of ANN technique it can be concluded that the ratio 60-40% Testing and validation of dataset gives the best results for Mansa taluka.

Keywords: Rainfall, Artificial Neural Network

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INTRODUCTION

Rainfall mainly controls our water supplies, which is the source for crops production and other needs for survival of life on the earth. It is especially important for rain fed land agriculture. Rainfall forecasting is also important for engineering, mainly for the design of hydrological power projects, because the system requires prior information about average rainfall, maximum/minimum rainfall, maximum intensity, duration etc[1].In the 21st century, India is an emerging economic power with vast human and natural resources, and a huge knowledge base. Economists predict that by 2020 [2].

Artificial neural networks have been widely used in these days in various features of science and engineering because of its ability to model both linear and non-linear systems without the need to make assumptions as are implicit in most traditional statistical approaches. ANN has been an aggressive model over the simple linear regression model [3].

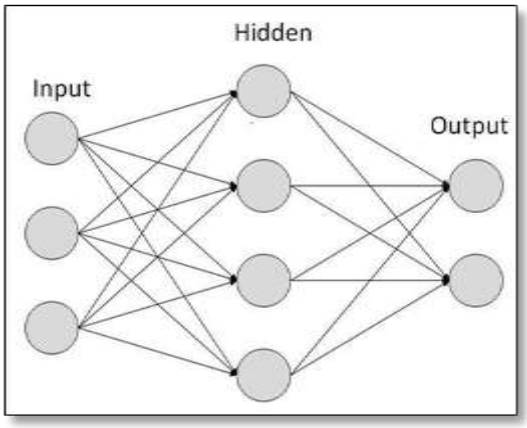

Fig.1.Artificial Neural Networks (ANN)
(Source:https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_neural_networks.htm)

The design of the multilayer neural network can have many layers where a layer represents a set of parallel processing units (or nodes). A multilayer ANN can have more than one hidden layer but a single hidden layer is enough for predicting the problems. It is the hidden layer nodes that permit the network to recognize and capture the suitable patterns in the data, and to do composite non-linear mapping between the input and the output variables. The input layer of nodes has to important role which is to transmit the external inputs to the neurons of the hidden layer.

STUDY AREA AND DATA COLLECTION

MANSA

Mansa Taluka falls in Sabarmati basin. The Taluka has a monotonous flat topography. The Sabarmati River flows through the eastern part of Mansa Taluka in North – South direction. The Sabarmati was once a perennial river; however, after construction of dam near Dharoi, it is generally dry during lean periods.[4].

Fig.2 Map of Gandhinagar District include Mansa Taluka

(Source: Preliminary Report for Ground Water Recharge Structures for Mansa Taluka*)*

The data required for assessment of this study are Rainfall, Mean Air Temperature, Relative Humidity, & Wind speed for Predictionof rainfall using ANN.

METHODS

The steps taken in the identification of a nonlinear model of a system are selection of input-output data suitable for Testing and Validation i.e. 80-20%, 70-30 % and 60-40%; selection of a model structure and estimation of its parameters; and validation of the identified models. Method Adapted for Rainfall prediction: ARTIFICIAL NEURAL NETWORK (ANN).

PERFORMANCE EVALUATION CRITERIA

To find the best method for the prediction of Groundwater level by evaluating the models with the performance indices such as Coefficient of Correlation (r),[9]

Correlation coefficient: r

$$= \frac{\sum_{i=1}^{n}(Q\,(i)-\bar{Q})(\hat{Q}(i)-\tilde{Q})}{\sqrt{\sum_{i=1}^{n}(Q\,(i)-\bar{Q})^2 \sum_{i=1}^{n}(\hat{Q}(i)-\tilde{Q})^2}}$$

Coefficient of determination

$$r^2 = \left(\frac{\Sigma_{i=1}^{n}(Q\,(i)-\overline{Q})(\overline{Q}(i)-\overline{Q})}{\sqrt{\Sigma_{i=1}^{n}(Q\,(i)-\overline{Q})^2 \Sigma_{i=1}^{n}(\overline{Q}(i)-\overline{Q})^2}} \right)^2$$

Discrepancy Ratio (D.R) $= \frac{\sum_{i=1}^{n} Q(i)}{\sum_{i=1}^{n} \hat{Q}(i)}$

Where $\hat{Q}$(i) is the n Predicted Rainfall, Q(i) is the n observes Rainfall, $\overline{Q}$ is the mean of the observed Rainfall, and Q is the mean of the Predicted Rainfall.

RESULT AND DISCUSSION

For The prediction of Rainfall of Mansa Taluka, the models were developedusing all possible training algorithms in ANN toolbox, MATLAB.

A. PREDICATION OF RAINFALL FOR MANSA

Table 1Performance Evaluation Parameters Different training algorithms of Mansa Taluka – Testing 60% and Validation 40%

Ratio %		Testing			Validation		
	Network type	r	r^2	D.R.	r	r^2	D.R.
80-20	Radial Basis Exact Fit	0.998	0.996	1.024	1.000	1.000	1.000
70-30	Feed Forward Back propagation	0.997	0.993	1.001	0.998	0.996	1.003
60-40	Cascade Forward Back propagation	0.999	0.999	1.001	0.999	0.998	1.003

Here table -1 show that while using ANN for Mansa taluka the best model comes out is 60-40% model with Cascade Forward Back propagation algorithm which having Coefficient of Correlation (r) 0.999, Coefficient of Determination (r^2) 0.999 and Discrepancy ratio (D) 0.995 during Testing and Coefficient of Correlation (r) 0.999, Coefficient of Determination (r^2) 0.998 and Discrepancy ratio (D) 1.003 during validation.

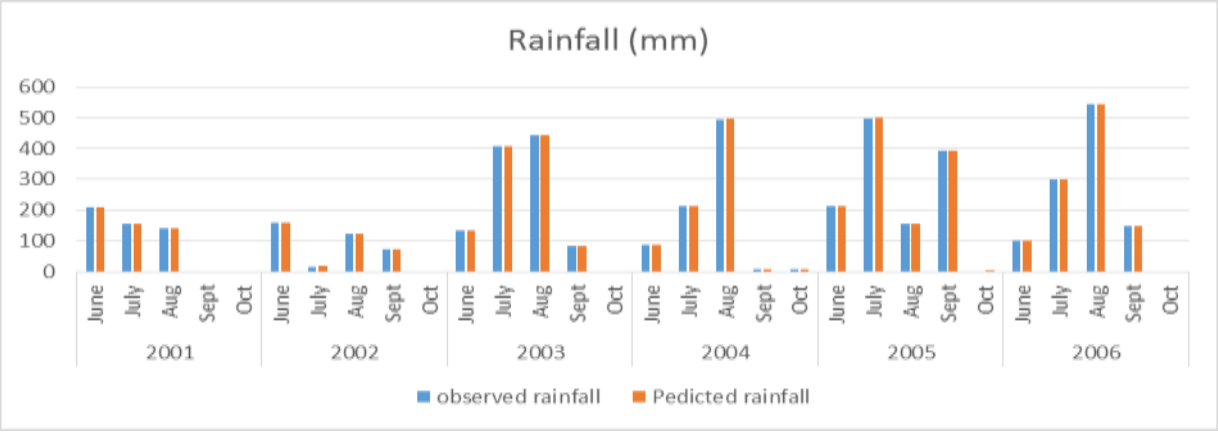

Fig.3 Comparison of observed Rainfall and predicted Rainfall during testing (For Mansa)

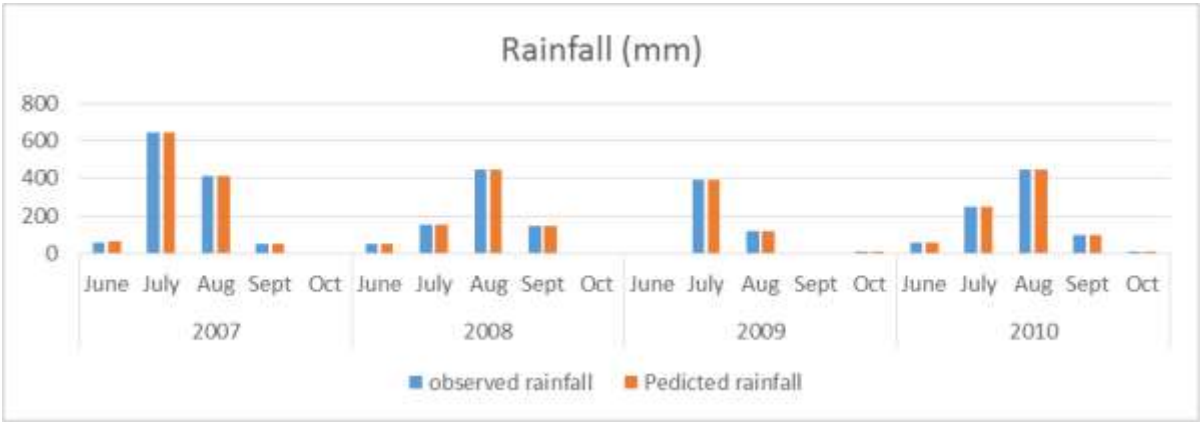

Fig.4Comparison of observed Rainfall and predicted Rainfall during Validation (For Mansa)

Fig.3 and 4 shows Comparison of observed Rainfall and predicted Rainfall of model 60-40% during testing and validation correspondingly for Mansa. From figures it is observed that for Mansa for training and validation predicted Rainfall by Artificial Neural Network is nearly equal to the observed Rainfall.

CONCLUSION

As seen from the results of the different combinations of Testing and Validation data, From Artificial Neural Network, the results shows that the rainfall which is predicted model with ratio of 60% - 40% during testing and validation datasets with Cascade forward back propagation algorithm gives the best results as Coefficient of correlation (r) value of 0.999 and 0.99, Coefficient of Determination (r2) values of 0.999 and 0.998, and Discrepancy ratio (D.R.) values. 1.002 And 1.003 for Mansa Taluka. Looking to the results of ANN technique it can be concluded that the ratio 60-40% Testing and validation of dataset gives the best results for Mansa taluka.

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