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Flood Forecasting Using Artificial Neural Networks

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Abstract—*Forecasts of future events are required in many activities.Inthis paper the applicability of Self -Organising Maps (SOM) and Multi layer perceptron for forecasting flow rates at multiple section of river Barak has been investigated. The model is applied to forecast flows at 3-hour and 6-hour ahead at Fulertor, Dholai ,Moniarkhalof Barak basin. The network training data sets consists of series of flows. The model performances are evaluated in terms of standard statistical measures root mean square error (RMSE), coefficient of efficiency (CE) and co-efficient of correlation (r). The performance measuresshows that artificial neural network (ANN) is capable in forecasting concurrent flows simultaneouslyfor river system where inflows with variety of characteristics unite at the downstream to a common flow. In the present study, the forecasting is made for 3-hourand 6-hour ahead, but, a higher lead time forecasting may also be done to make the forecasting more useful.*

Keywords: *Forecasting, Artificial Neural Network, river system, Self-Organising Maps, Multi layer perceptron*

1. INTRODUCTION

Floods are indeed a part of earth's natural water cycle and have been occurring right from the beginning. It is a temporary rise of water level, as in a river or lake or along a seacoast, resulting in its spilling over and out of its natural or artificial confines onto land that is normally dry. They hold about one-third of the total number of natural disasters produced worldwide in the 1900-2007 period [1]. Flood forecasting models are a necessity, as they help prevent loss of lives and minimize damage. In recent years, soft computing techniques are being increasingly used for forecasting floods. Various researches have successfully applied artificial neural network (ANN) for forecasting floods at different lead times [2], [3].

1.1. Artificial Neural Networks

Artificial Neural Network is an information processing system that has certain performance characteristics in common with biological neural networks. They can identify and learn correlated patterns between the input datasets and corresponding target values. They can process problems involving non-linear and complex data even if the data are inaccurate. ANNs have been developed as a generalization of mathematical models of human cognition or neural biology[4].There are many types of ANN, but in this study we are using Self-Organising Maps (SOM) and Multilayer Perceptron Neural Network (MLP).

2. STUDY AREA AND DATASETS

The Barak river is one of the major rivers of South Assam and is a part of the Surma-Meghna River system. It has many tributaries which joined it in different location of the above states. Out of the total length of about 900km, it traverses for about 532km in Indian Territory with 129km in Assam alone. The Barak valley receives annual rainfall of 2000-4000mm having 80-85% from Mid-April to Mid-October. During monsoon it receive 2-3 flood was almost every year inundating vast part of the valley. Government of India is considering various measures to mitigate the menances of flood in this region. The model is introduced in the Barak river system to three gauging sites namely Fulertol, Dholai, Moniarkhal. Altogether, two years (2000 and 2001) concurrent flow data of one hour interval pertaining to monsoon periods starting from 1st June to 15th October has been collected from Central Water Commission (CWC), Shillong. The data has been used for river flow modeling for the Barak basin only.

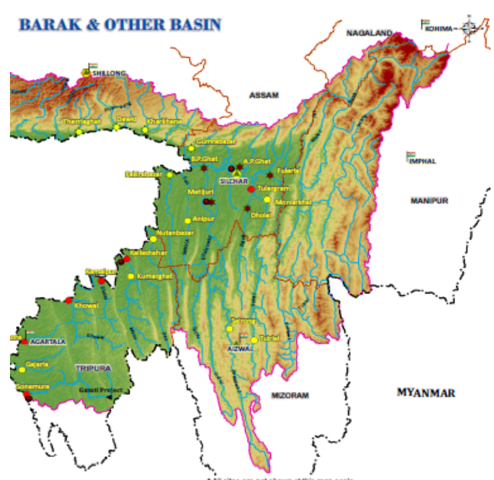

Fig. 1: Barak river basin network map

3. MODULAR MODEL

This study proposes to use the modular model SOM and MLP. Here the data sets are normalised to fall in the range [0-1]. After being normalised, the input data are inserted in the SOM, to be separated into 4 groups then these groups are included in an MLP and finally the network output is tested. After being normalised, the input data are inserted in the SOM, to be separated into 4 groups then these groups are included in an MLP and finally the network output is tested. For training in MLP, only 75% of the sequential data sets are used to train the network and the remaining 25% are used to test the network.

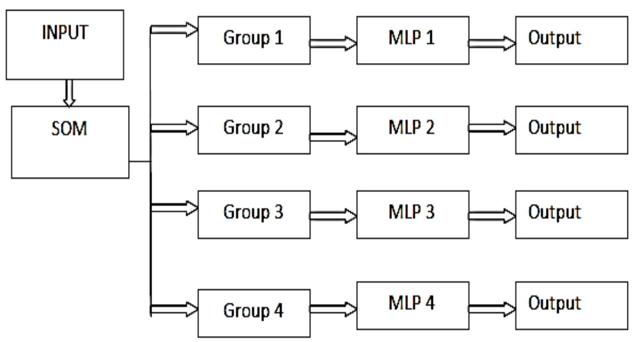

Fig. 2: Neural Network Model for flood forecasting

Three performance measures used to evaluate the models are root mean square error (RMSE), correlation coefficient (r),coefficient of efficiency (CE).

$$RMSE = \sqrt{\frac{1}{N}\sum_{t=1}^{N}(y_t-\hat{y}_t)^2}$$

$$r = \frac{\sum(\hat{y}_t-\bar{\hat{y}}_t)(y_t-\bar{y}_t)}{\sqrt{\sum(\hat{y}_t-\bar{\hat{y}}_t)^2\sum(y_t-\bar{y}_t)^2}}$$

$$CE = 1-\frac{\sum_{t=1}^{N}(y_t-\hat{y}_t)^2}{\sum_{t=1}^{N}(\hat{y}_t-\bar{y}_t)^2}$$

Where, $\hat{y}_t$ =forecasted value, y_t =observed value, $\bar{y}_t$ =mean of observed value, $\bar{\hat{y}}_t$ =mean of forecasted value,N=number of observation.

4. RESULTS AND DISCUSSION

Performance results in forecasting the test series with 3-hour and 6-hour are summarized in Table 1. The size of the mean square error (RMSE) can be used to determine how well the network output fits the desired output. The correlation coefficient is confined to the range [-1, 1]. Also the value of CE can range from −∞ to 1. An efficiency of 1 ($CE = 1$) corresponds to a perfect match of modeled discharge to the observed data. An efficiency of 0 ($CE = 0$) indicates that the model predictions are as accurate as the mean of the observed data, whereas efficiency less than zero ($E < 0$) occurs when the observed mean is a better predictor than the model.

Table 1: Network performance measure forecasting concurrent flow rates at 3-hour ahead.

Performance Index	Name of Gauge Stations		
	Fulertol	Dholai	Moniarkhal
RMSE(normalised)	0.0055	0.0032	0.0086
r	0.9940	0.3027	0.9857
CE	0.9875	-2.3056	0.9636

Table 2: Network performance measure forecasting concurrent flow rates at 6-hour ahead.

Performance Index	Name of Gauge Stations		
	Fulertol	Dholai	Moniarkhal
RMSE(normalised)	0.0071	0.0014	0.0081
r	0.9921	0.6021	0.9929
CE	0.9794	0.3414	0.9679

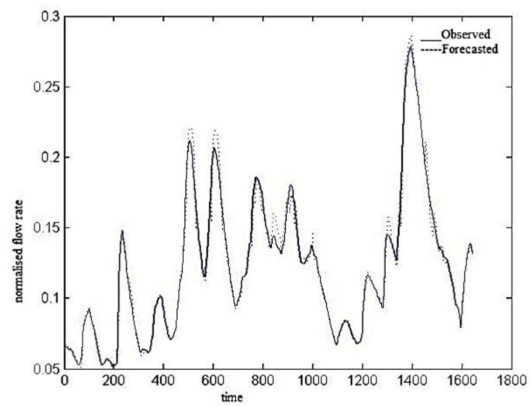

Fig. 3: Observed and 3-h ahead forecasted flow at Fulertol

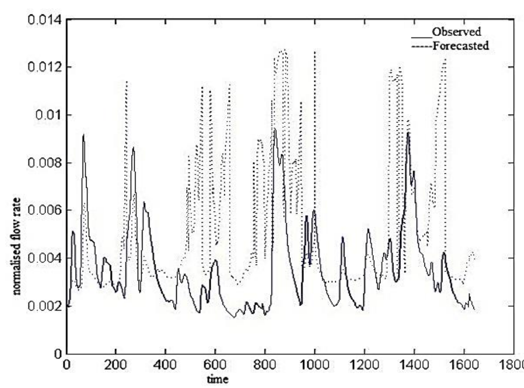

Fig. 4: Observed and 3-h ahead forecasted flow at Dholai

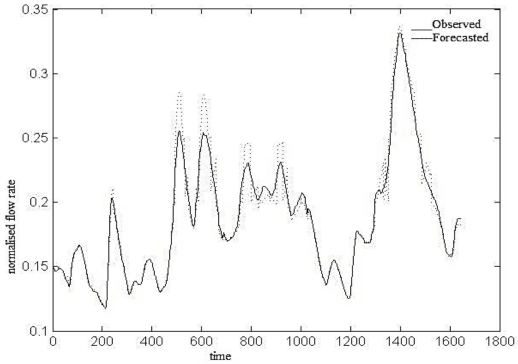

Fig. 5: Observed and 3-h ahead forecasted flow at Moniarkhal

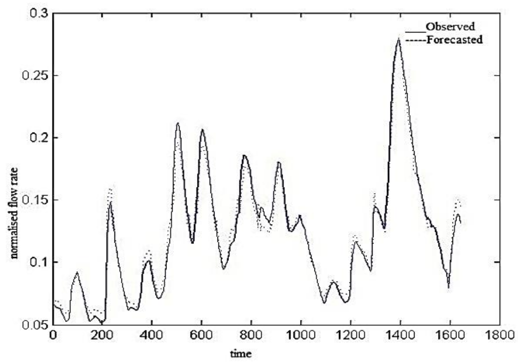

Fig. 6: Observed and 6-h ahead forecasted flow at Fulertol

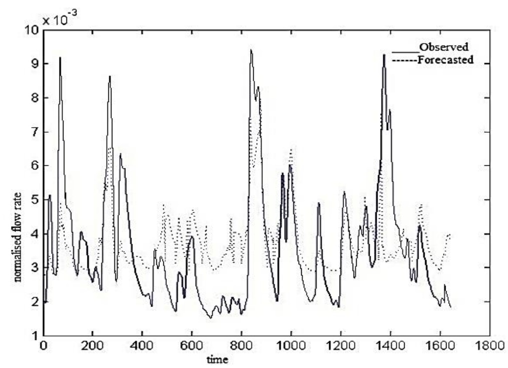

Fig. 7: Observed and 6-h ahead forecasted flow at Dholai

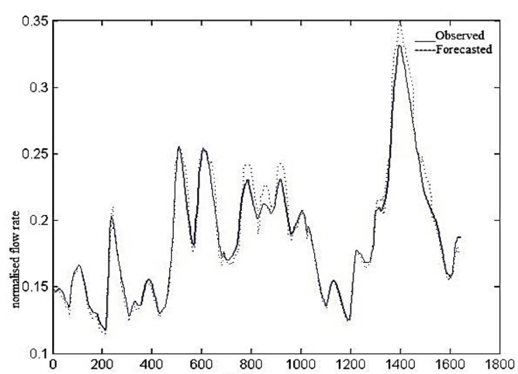

Fig. 8: Observed and 6-h ahead forecasted flow at Moniarkhal

5. CONCLUSION

In this paper, the application of ANN has been successfully demonstrated using modular model SOM and MLP for flood forecasting in Barak river system. It has been observed that this modular model is suitable for forecasting concurrent flows in a river system where flows from different river reaches draining water from different watersheds with variety of characteristics unite downstream contributing to a common flow. In the present study, the forecasting of concurrent flows is made for 3-hour and 6-hour ahead . But, a higher lead time may also be investigated further to make the forecasting more useful.

REFERENCES

[1] Gabriel Minea, LilianaZaharia, "Structural and Structural and Non -Structural Measures for Flood Risk Mitigation in the Bâsca River Catchment (Romania)" Forum geografic. Volume 10, (1) June 2011, pp. 157-166

[2] Christian W. Dawson, Robert Wilby, "An artificial neural network approach to rainfallrunoff modeling", Hydrological Sciences—Journal—des Sciences Hydrologiques, 43(1) February ,1998

[3] A.Piotrowski, J.J. Napiorkowski, and P.M. Rowinski, "Flash-flood forecasting by means of neural network and nearest neighbour approach- a comparative study". Nonlinear processes in geophysics,13, 2006, 443-448.

[4] Rao S. Govindaraju, "Artificial neural networks in hydrology I: Preliminary concepts"Journal of hydrologic engineering, 5(2) ,2000, ASCE.

[5] Ivna Valenca and Teresa Ludermir, "Hybrid system for river flood forecasting using MLP, SOM and Fuzzy systems"., part 1,ICANN 2009,LNCS 5768,557-566, Springer.

[6] Ozgur Kisi, "River flow modelling using artificial neural networks" Journal of hydrologic engineering, vol.9,no.1,2000, ASCE.

[7] Ozgur Kisi, "Streamflow Forecasting using different Artificial Neural Network Algotithms" Journal of hydrologic engineering,vol.12,no.5,2007,ASCE.

[8] Konda Thirumalaiah and M.C. Deo, "River stage forecasting using artificial neural networks". Journal of hydrologic engineering 3(1),1998, ASCE.

[9] Rajesh Raj Sherstha, Stephan Theobald and Franz Nestmann, "Simulation of flood flow in a river system using artificial neural networks". Hydrology and earth system sciences,9(4), 2005,313-321.

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