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STUDY OF UKAI DAM RESERVOIR USING ANN TECHNIQUES

Kishan Rana[1], Prof. B. M. Vadher[2]

[1]Research Scholar [2]Professor

[1,2]Department of Civil Engineering

Dr. S & S. S. Ghandhy Government Engineering College, Surat, Gujarat, India

***Abstract* —Hydrologic forecasting plays a increasing role in water resource management, as engineers are required to make component forecasts of natural inflows to reservoirs for various purposes. Prediction for hydrologic events has always been an important issue for optimizing and planning the whole system. In this study, two different ANN (Artificial Neural Networks) techniques (Generalized Feed Forward network and Multilayer Perceptron) were used for Ukai reservoir project. A total of 21 years of historical data were used to train and test the networks. To evaluate the accuracy of the proposed model, the Root Mean Squared Error (MSE) and the Correlation Coefficient (CC) were employed and found the network to be cross validated and trained properly for both models. The developed model shows good results with actual observation.**

Keywords- ANN(Artificial Neural Networks); Root Mean Squared Error;10 daily data; multilayer perceptron; Generalized Feed Forward network.

I. INTRODUCTION

In present scenario population explosion has led to the growing of Economies in the world, which has resulted in water becoming a precious and insufficient resource. In this scenario there is an unsatisfied demand of water for various purposes, such as irrigation, hydropower, municipal, industrial purposes and navigation supply etc.

Therefor Reservoir system assumes an important role in water resource management. Reservoirs are structures used for water conservation and supply; they are used throughout the world. Reservoir system serves two main purposes; conservation and flood control. Water conservation is a tool to control and regulate water for hydropower, water supply, navigation, irrigation etc. and the purpose of flood control is to reduce flooding throughout and retention of water during flood periods.

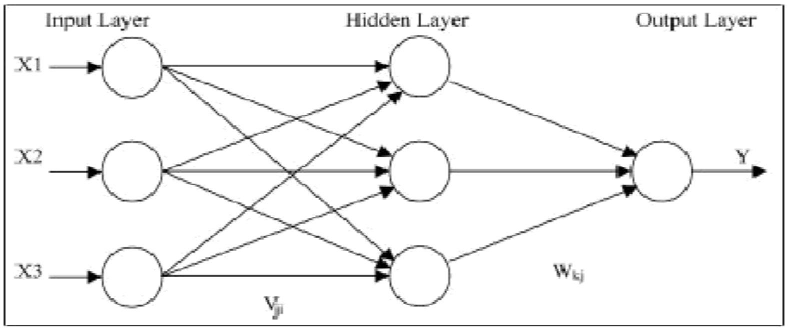
Reservoirs are physical structures like ponds or lakes either natural or artificially developed to impound and regulate the water. Reservoirs are one of the structural approaches used as flood defense; they are also used for water storage. Flood defense is a mechanism used to modify the hydrodynamic characteristics off low of rivers, in order to reduce the risk of flooding downstream. Water storage is adhered to contain water in order to maintain water supply for its use in agricultural, domestic and industrial purposes.

During flood and drought situations, decision to open or close water gates of the reservoirs, dams is a critical action that needs to be undertaken by dam operator. A delay in decision will result in flooding downstream and also damage the structure of the concerned dam. Releasing the water before the reservoir reaches its full capacity might reduce the risk of flooding downstream. But, one cannot be sure that released water will be replaced and used during less intense rainfall. Researchers believe that the use of forecasting and warning systems might improve the overall management of water in a dam. In practice, the release of water or the decision of opening the gate depends on the operating rules. These rules are static and do not take consideration the dynamic nature of the hydrology systems. So, non-structural approach such as forecasting is vital to support the water release or the gate opening decision.

II. ARTIFICIAL NEURAL NETWORK

A neural network is a method that is inspired by the studies of the brain and nerve systems in biological organisms. Neural networks have the capability of self-learning and directly abstracting. Applying this technique may less the time of modeling the complex systems. Artificial neural networks are important alternatives to the traditional methods of data analysis and modeling. The Artificial neural networks are divided into 2 periods. In the 1st period neural network is trained to represent the relationships and processes within the data. After the network is adequately trained, it is able to generalize relevant output for the set of input data. This output is compared with observed data from the real life. This 2nd period is called as testing period. The network is trained and tested on sufficiently large training and testing sets that are extracted from the historical time series.ANN is divided in three part input layer, hidden layer and output layer (Ismail KILINÇ, Kerem CIĞIZOĞLU).

In real life, the things people see, hear, and feel come into the brain and become the experiences in their memories. These experiences will tell them what to do better in the future when they are doing similar things. Like the human brain, the function of an ANN in engineering application is usually to learn the relationship between the inputs and outputs from a given set of data so that it can be used to predict future output values from new given input values (Kneale et al 2005).



2.1 Generalized feed forward network

Generalized feed forward networks are generalization of the MLP such that connections can jump over one or more layers. In theory, a MLP can solve any problem that a generalized feed forward network can solve. However, generalized feed forward networks often solve the problem much more efficiently. A classic example of this is the two spiral problem. Without describing the problem, it suffices to say that a standard MLP requires hundreds of times more training epochs than the generalized feed forward network containing the same number of processing elements.

2.2 Multilayer Perceptron network

Multilayer perceptrons (MLPs) are layered feed forward networks typically trained with static back propagation. These networks have found their way into countless applications requiring static pattern classification. Their main advantage is that they are easy to use, and that they can approximate any input/output map. The key disadvantages are that they train slowly, and require lots of training data (typically three times more training samples than network weights).

III. STUDY AREA

In this study the data from the Ukai Dam was used. The Ukai Dam, constructed across the Tapti River is the largest reservoir in Gujarat. It is also known as Vallabh Sagar. Constructed in 1972, the dam is meant for irrigation, power generation and flood control. The site is located 94 km from surat and is the present study area. The dam is located across the river Tapi about 29 km upstream of the Kakrapar weir. A barrier is constructed across Tapi River which store water on upstream side of the dam, forming a pool of water called as Ukai dam reservoir. The water so stored in a given reservoir during rainy season can be easily used almost throughout the year, till the time of arrival of the next rainy season, to refill the emptying reservoir again.

Table 1. Some Characteristic of Ukai Dam

River	Tapi
Place	Ukai village
Type Of Dam	Gravity dam
Gross Storage capacity	7414.29 MCM
Maximum Height	105.461 m
Mean annual rainfall	8 89 mm to 1145 mm
Live storage	6729.896 MCM
Mean annual rainfall in the catchment	785 mm

Figure 2. Location Map of Ukai Dam

IV. DATA COLLECTION

Data for the present study were collected from State Water Data Center, Ghandhinagar. Range of all Parameter used in the present study is given below in table 1.

Data set	Storage at the Beginning of the Periods in MCM	Discharge through Power Houses in MCM	Discharge through ULBMC in MCM	Discharge through Radial Gates in MCM	Evaporation in MCM	Total Inflow in MCM	Storage at the Endof the Periods in MCM
1989-2011	991.24 to 8519.82	0 to 2140.50	0 to 116.58	0 to 11917.51	9.8 to 66.15	0 to 13905.96	0 to 8519.83

V. MODEL DEVELOPMENT

The model was developed using a back propagation algorithm of ANN and its ability to forecast the 10 daily reservoir was tested using 21 years of historical data of UKAI reservoir project, fort songadh taluka, surat, Gujarat on tapi reservoir. The historical data for the ANN modeling is divided into two sets called the training and the testing set data.

The training set is the major part of the data that is used for training of the neural network for finding the governed pattern of data set. The testing patterns are used for evaluating accuracy of the ANN trained models. Several patterns of input data have been employed to develop the optimum ANN model for the hydropower reservoir inflow and storage. One or two hidden layer is designed for all the networks and each network was trained under several structures with different number of neurons in the hidden layer.

Model 1: The model is developed using 10 daily data where in one depended variable i.e. reservoir storage capacity at the end of t period and six independent parameters reservoir storage at starting of t period, inflow, evaporation losses, discharge from left bank command area, right bank command area and spill over quantity with Generalized feed forward network of ANN.

Model 2: The model is developed using 10 daily data where in one depended variable i.e. inflow and six independent parameters reservoir storage capacity at the starting of t period, evaporation losses, reservoir storage capacity at the end of t period, discharge from left bank command area, right bank command area and spill over quantity with Multilayer perceptron network of ANN.

VI. RESULT & RESULT ANALYSIS

The most vital piece of ANN model is its capacity to figure future occasions. The MSE and CC(R) foundations are utilized for assessment of the precision of both preparing and testing methodology. The best model is chosen according to the minimum MSE and the Maximum CC(R).

1. Model 1 : 10 DAYILY DATA RESULTS

TABLE 2.

Input Layer Cell	Output layer cell	Number of training data	Number of testing data	Mean square error	Correlation co-efficient
S(t-1)	S(T)	312	130	99.97725934	0.998540495
E(t)					
RBMC(t)					
LBMC(t)					
DTRG(t)					
I(t)					

Where,
S (t-1) = storage at the beginning period
E (t) = evaporation losses, I (t) = inflow
RBMC (t) = right bank main canal
LBMC (t) = left bank main canal, DTRG(t) = Discharge through radial gates

A graph for testing period of model creation is shown below it will give the comparisons of actual data of output parameters versus output data by network.

Performance	Storage at the End of the Periods
RMSE	99.97725934
NRMSE	0.013329347
MAE	46.3111215
NMAE	0.006174374
Min Abs Error	0.208493684
Max Abs Error	840.068213
r	0.998540495
Score	98.30076403

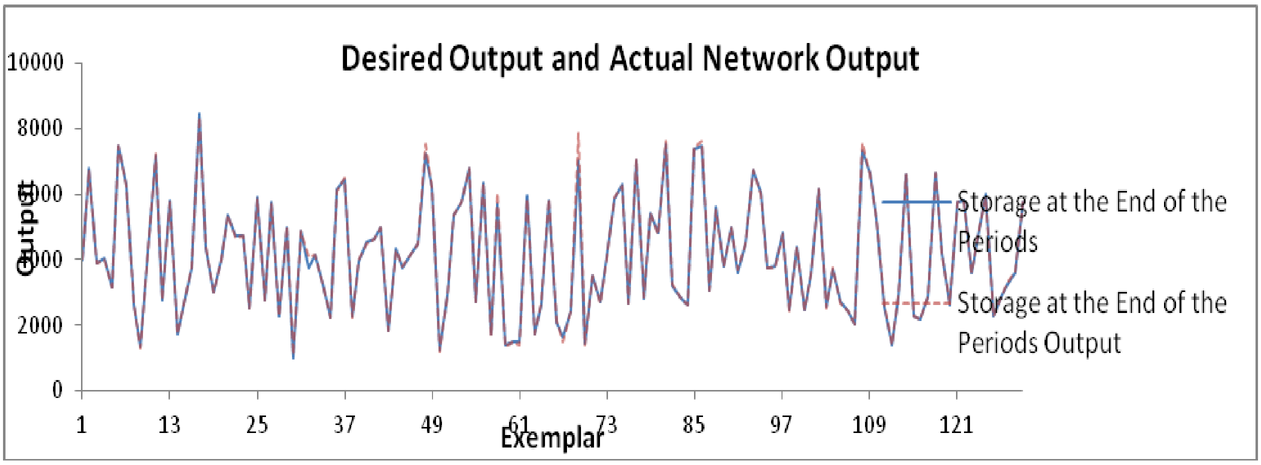


Figure 3. Actual vs. Desired

Result of testing period is shown in table and the value of "r" is 0.99 hence it can be concluded that the network is cross-validated and network is train properly. If value of "r" comes closer to 1.0, the model has very good performance and it will predict result with accuracy. Values of "r", MAE and different parameters during training period of network are shown in table and they are acceptable.

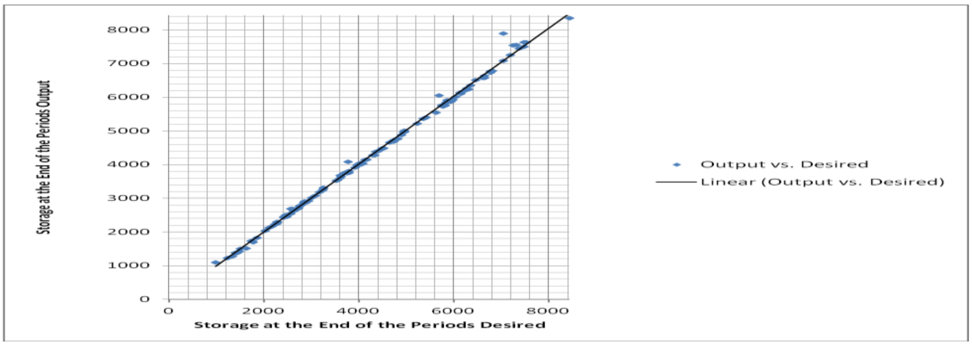


Figure 4. Actual output vs. Model output

MODEL 2: 10 DAYILY DATA RESULTS FOR INFLOW

Fig 5 shows that the values of desired output and actual output are nearer to each other, so that the value of "r" is nearer to 1.0 and hence the obtained result for testing period is acceptable.

TABLE 3.

Input Layer Cell	Output layer cell	Number of training data	Number of testing data	Mean square error	Correlation co-efficient
S(t-1)	I(T)	312	130	98.77167191	0.993840275
E(t)					
RBMC(t)					
LBMC(t)					
DTRG(t)					
S(t)					

Where,
S (t-1) = storage at the beginning period
E (t) = evaporation losses, I (t) = inflow
RBMC (t) = right bank main canal
LBMC (t) = left bank main canal, DTRG(t) = Discharge through radial gates

Performance	Total Inflow in MCM
RMSE	98.77167191
NRMSE	0.010250532
MAE	53.14167716
NMAE	0.005515048
Min Abs Error	1.275819488
Max Abs Error	607.9342111
r	0.993840275
Score	98.25607368

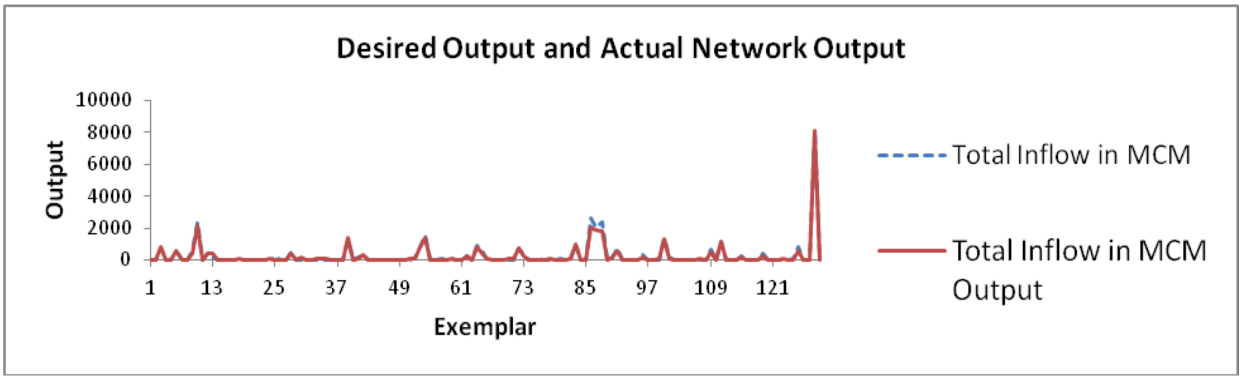


Figure 5. Actual vs. Desired (INFLOW)

Result of testing period is shown in table no 3 and the value of “r” is 0.993840275 hence it can be oncluded that the network is cross-validated and network is train properly. If value of “r” comes closer to 1.0, the model has very good performance and it will predict result with accuracy. Values of “r”, MAE and different parameters during training period of network are shown in table and they are acceptable.

VII. CONCLUSIONS

- The reservoir storage so obtained will be helpful in
  1. Determining minimum and maximum storage in the reservoir for given request.
  2. Help in keeping up water level in the reservoir as per monthly demand.
  3 The created model will likewise help in flood control as it predicts.

REFERENCES

1. Amir F. Atiya, Suzan M. El-Shoura, Samir I. Shaheen et al 1999 “A Comparison between Neural-Network Forecasting Techniques—Case Study: River Flow Forecasting.” IEEE transactions on neural networks, vol. 10.
2. Amir Jalalkamali and NavidJalalkamali 2011 “Groundwater modelling using hybrid of artificial neural network with genetic algorithm.” African Journal of Agricultural Research Vol. 6(26), 12 November.
3. Azhar K. Affandi and Kunio Watanabe 2007 “Daily groundwater level fluctuation forecasting using soft computing technique.” Nature and Science, 5(2).
4. Bogdan M. Wilamowski 2007 “Neural Network learning and architecture”. IEEE
5. D.F. Lekkas, C. onof1 M. J. Lee, E.A. Balta January 2005 “Application of artificial neural networks for flood forecasting”. Global Nest: the Int. J. Vol 6, No 3.
6. D.Nageshkumar, K. SrinivasaRaju and T. Sathish December 2003 “River Flow Forecasting using Recurrent Neural Networks”. Water Resources Management 18: Kluwer Academic Publishers.
7. DebbarmaSentu, D. G. Regulwar 2011 “Inflow Prediction by Different Neural Network Architectures: A Case Study” International Journal of Earth Sciences and Engineering ISSN 0974-5904, Volume 04, No 06 SPL
8. E. Mutlu, I. Chaubey, H. Hexmoor and S. G. Bajwa 2008 “Comparison of artificial neural network models for hydrologic predictions at multiple gauging stations in an agricultural watershed.” hydrological processes Hydrol. Process. Published online in Wiley Inter Science (www.interscience.wiley.com) DOI:10.1002/hyp.7136.
9. Faridah Othman and Mahdi Naseri January 2011 “Reservoir inflow forecasting using artificial neural Network” International Journal of the Physical Sciences Vol. 6(3), 4 February.
10. Girish Kumar Jha “Artificial Neural Networks and its applications “Indian Agriculture Research Institute, PUSA, New Delhi.
11. Girish Kumar Jha“Artificial Neural Networks” Indian Agriculture Research Institute, PUSA, New Delhi.
12. M. K. Akhtar, G. A. Corzo, S. J. van Andel, and A. Jonoski 2009 “River flow forecasting with artificial neural networks using satellite observed precipitation pre-processed with flow length and travel time information: case study of the Ganges river basin.” Hydrol. Earth Syst. Sci., 13.
13. Maryhelen Stevenson, Rodney Winter, Bernard Widrow 1990 “Sensitivity of Feed forward Neural Networks to Weight Errors” IEEE Transactions on Neural Networks, vol. I. No. I.
14. N. J. de Vos1 and T. H. M. Rientjes 2005 “Constraints of artificial neural networks for rainfall-runoff modelling: trade-offs in hydrological state representation and model evaluation.” Hydrol. Earth Syst. Sci. Discuss., 2.
15. Ozgur Kisi 2003 “Daily River Flow Forecasting Using Artificial Neural Networks and Auto-Regressive Models”. Journal of hydrologic engineering © asce / January /February.
16. OzlemTerzi and SadıkOnal 2012 “Application of artificial neural networks andmultiple linear regression to forecast Monthly River flow in Turkey.” AfricanJournal of Agricultural Research Vol. 7(8), 26 February.
17. Paulo Chaves, Fi-John Chang 2008 “Intelligent reservoir operation system based on evolving artificial neural networks.” Elsevier and sciencedirect.
18. U.C.Roman, P.L.Patel and P.D.Porey 2012 “Prediction of missing rainfall data using conventional and artificial neural network techniques.” ISH Journal of hydraulic engineering.
19. V. Birinci“A Comparison of MLR and Three Different Artificial Neural Networks Techniques for Daily Mean Flow Prediction” recent advances in environment, ecosystems and development isbn: 978-960-474-142-7
20. V.Jothiprakash and SuhasiniSakhare 2008 “Ground Water Level Fluctuations using Artificial Neural Network.” The 12th International Conference of International Association for Computer Methods and Advances in Geomechanics (IACMAG) October.
21. VarawootVudhivanich, SantiThongpumnak, NimitCherdchanpipat, AreeyaRittima and NattaphunKasempun 2006 “Application of Artificial Neural Networks for Reservoir Inflow Forecasting” Kasetsart J. (Nat. Sci.) 40.