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Evaluation of Artificial Neural Network and Time Series Models to Simulate Groundwater Levels

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ABSTRACT: *Based on climate divisions, Lar in Iran, which is hot and dry heat during the long, low and erratic rainfall and high mean temperature of its properties. Due to population growth and corresponding increases in agricultural and industrial activities and lack of water sources that supply the appropriateIt is necessary for proper planning and a thorough study of the underground water level to reduce the indiscriminate use of ground water have. This study of ground water level time series with neural network models with different structures and simulate the neural network model due to the statistical indicators of R2=95/89 and RMSE=4/99*

KEYWORDS : *Water level,Artificial Neural Networks,Models.*

I. INTRODUCTION :

One of the most important factors in the management of the area , having a good attitude, vision and future events in that regard. Lar groundwater hydrograph represents the general trend, based on groundwater level decline over previous years and indicate a steady decline and reduce groundwater is Zkhayrmkhazn. In this research, artificial neural network models using multilayer perceptron (MLP-RNN) Vmdl time series, simulated water level changes. Artificial neural network is a branch of AI (Artificial hntelligence) are enjoying and studying the brain and nervous system are simulated in the organism Haybyvlvzhyky and currently as a powerful computational tool in several fields The approximation of functions and mappings are detection range. (Silverman and Dracup, 2000) time series is a collection of observations that are arranged according to time with regard to the factor analysis, time series are available to resolve the suitable method to estimate and remove the two methods used in this study is the difference between making it suitable methods were used. White noise can be converted into a series of observations with the recursive moving average model (ARMA) can be used. Including research conducted on the use of artificial neural networks and time series of groundwater levels can be checked by the research Lalahm et al (2005), Including research conducted on the use of artificial neural networks and time series of groundwater levels can be checked by the research Lalahm et al (2005), Champion (2005), Kapalv and colleagues (2003), Kvlybaly et al (2001), Qdmpvr and Shqaqyan (1390) and Jhanshayy and Moghaddamnia (1391) pointed out. One of the important applications of time-series models (ARMA) in hydrology, hydrological variables to predict when one or more steps ahead. For example, in the operation of water utilities, such as dams, rivers would need to be for the foreseeable future Chndgam time. Just get out of these models to predict the temporal and spatial variation of ground water level has also been used. (BIERKENS, MFP) Vmdl hybrid neural network and time series study of the quality of water has been investigated. (Durdu, of, 2010) in the present study the ability of each of the neural network models with various structures and time series (ARMA) with p and q different studied and the best model is selected. presented in the following sections of the study area, and then each of the models listed Briefly described above. Fibre Finally, conclusions and recommendations resulting from this research are presented.

II. THE STUDY AREA

Lar city in the south of the province between the orbits of 27 degrees 16 minutes 18 seconds and 28 degrees 25 minutes and 4 seconds north latitude and 52 degrees 22 minutes 30 seconds and 55 degrees 43 minutes 30 seconds east longitude is located. The administrative divisions of the Provinces and the south and east of the province, North of the city of Darab, Forums, and arranged and the West and Southwest of the city Lamerd is limited. Figure [1] It should be noted that the data used in this study, rainfall (p), temperature (t), evaporation (e) Vtraz ground water (w) is the study of some meteorological parameters, corresponds to LAR synoptic stations Meteorological Organization is based. Brtkhlyh hours of moderate or withdraw water from the aquifer in the area, keeping the wells three thousand hours a year. Drain water from the aquifer in the basin, the 17/63 million cubic meters of Agriculture amount of 0/17 million cubic meters for industrial use, and 3/40 million cubic meters of drinking. Thus, the total annual discharge of the aquifer 21/2 million cubic meters.

Figure[1]: position of Lar in Fars Province

III. NETWORKS AND ALGORITHMS USED

3-1 - Multi-layer feedforward neural network (MLP)

The network has three layers, namely the input layer, the middle layer (hidden.) Does not limit the number of hidden layers., And output layers are. These networks of neurons in each layer after layer of neurons to transmit signals. Nodes connected by joints and each connection has its own weight, is unchangeable. Nodes are arranged in parallel layers and nodes in each layer are connected only to nodes on their sides . The first layer, the input layer and the last layer, called the output layer. Middle layer is called the hidden layer.

$$net_j = \sum_{j=1}^{L} w_{ij} x_j + w_0$$

net_j: net input of motor function w_{ij}: network weight matrix x_j: input vector to the network w_0: bias vector network

3-2 - Returns the artificial neural network (RNN)

In this network model outputs as inputs to the network are used correctly this stage, these networks are used as memory. . These networks are symmetrical in relation to the hidden layer is a layer that plays the role of memory in the network. . The same network can have an infinite memory and the relationship between the data input speed is greatly increased.

IV. DIFFERENT ALGORITHMS EDUCATION

All procedures were carried out in a network can be done by different mathematical algorithms.

4-1 - Marquardt algorithm - Markvrt LM) Levenberg-Marquardt)

This method is a modified Newton's classical algorithm for finding a solution for problems that require minimization have been used.

4-2 - Gradient descent with momentum back-propagation gradient Descent with momentum (GDX)

In this way towards the back-propagation algorithm for computing network error and to determine the weight vector and bias (critical) network so that the network has the lowest error, are used. Momentum parameter a motion to modify the inertia weight provides a number of examples that are less and less time for the system to reach convergence. The data used in numerical error is small. This method is probably the easiest and simplest way to learn networking

4-3 - Set Bayzyn (BR) Bayesian Regulazation

Bayzyn tuning algorithm that automatically puts the appropriate values for the parameters of the function. In this method, weights and Bayas·hay network-distributed random variables are assumed to be special. In order to estimate the unknown parameters of statistical techniques are used to the changes. The advantage of this algorithm is that the network would have little impact on its results. Has been used successfully in more articles.

V. MODELING OF TIME SERIES WITH ARMA

models Another method using time series models (ARMA) is an important parameter of the model time series is a family of observations in time is used to predict the Vaghtshashat . ARMA model with parameters p and q is generally expressed as follows.

$$x_t - \emptyset_1 x_{t-1} \dots\dots\dots\dots\dots\dots\dots\dots .. - \emptyset_p x_{t-p} = z_t + \theta_1 z_{t-1} + \cdots + \theta_q z_{t-q}$$

Xt-i: observations of groundwater level at time t-i, Zt-i: Noise SM at the time t-i and Øi, Øi: Coefficients Model

VI. CRITERIA FOR PERFORMANCE EVALUATION AND MODELING ERROR

In this study, two types of numerical benchmark to evaluate the efficiency and precision of prediction error and its ability to be used on any network.

6-1 - Root mean square error Root Mean Square Eeeor (RMSE) is calculated as follows.

$$RMSE=\sqrt{\frac{\sum_{i=1}^{N}(y_i-\hat{y}_i)^2}{N}}$$

In the above equation, y_i results of observations, $\hat{y}_i$ computational results and N is the total number of observations. RMSE difference between the observed and calculated values shows. Lowest RMSE shows the highest accuracy.

6-2 - R^2 which indicates the efficiency of the network is provided as follows.

$$R^2 = 1 - \frac{\sum(y_i - \hat{y}_i)^2}{\sum(y_i - \bar{y}_i)^2}$$

The most efficient solution would be to model the RMSE when the Sfrv R^2has an affinity towards. And in addition to the time series of steps Ressidual Analysis should also be examined.

VII. THE RESEARCH :

In this paper a modeling approach is working. Modeling as an efficient, effective and Efficient low cost makes it possible to get to know Basystam complex natural groundwater modeling can play a key role in the study of the underground water level. . Finally, the neural network for each of the above steps, respectively, 80% of the total data (153 data) for training (data for month Oct 76 to May 89), 20% for validation and testing (data monthly Tir 89 to June 92) used were. Furthermore, given that the raw data reduces the accuracy of the network are identical to the data grid using the following equation between 0 and 1 are normalization.

$$x_{norm} = \frac{x - x_{min}}{x_{max} - x_{min}}$$

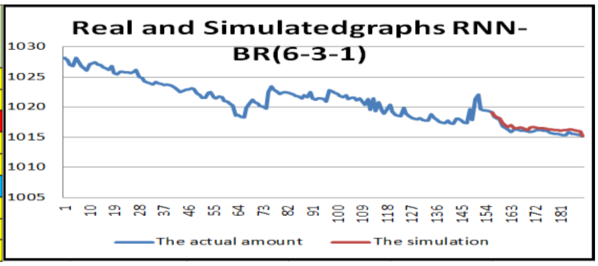
X: Not normal data, Xnorm: normalized data, Xmax: The maximum input data and Xmin: minimum input And to fit a time series model is the three basic stage. (Knowledge model, the estimated coefficients of the model and verification model) based on our data from September 76 to June 92 (189 months), and the initial chart data clearly indicate that the data are 12-period seasonal trends. In the first step the static data model chapter on data runs and then the difference between the measurements on the data is done, then the shape of ACF and pacf, the appropriate model for the data is chosen. Least square method is used to estimate the model coefficients. The next step is to identify correctly a pattern P of graphs used to test for residual normality Finally, it is estimated quantities of water levels in the next few years.

VIII. RESULTS ANALYSIS:

The results of neural networks with different structure and expression pattern using assessment 9 R2 and RMSE error in table [1] are presented, indicating that a third pattern data has achieved the best results. 5 The structure of the neural network structure is the best structure of a neural network RNN-BR was introduced to forecast the groundwater level fluctuations. Figure[2]

Template	Rank	Pattern of delayed	Number of Layers	Network types and algorithms	R2%	RMSE%
First		P(t)T(t)E(t)W(t)	4-3-1	RNN-LM	91.25	5.1
Second		P(t)T(t)E(t)W(t,t-1)	5-3-1	RNN-BR	96.61	7.83
Third	First	P(t)T(t)E(t)W(t,t-1,t-2)	6-3-1	RNN-BR	95.89	4.99
Fourth		P(t)T(t)E(t)W(t,t-1,t-2,t-3)	7-7-1	RNN-BR	93.42	7.41
Fifth		P(t,t-1)T(t)E(t)W(t,t-1)	6-9-1	MLP-BR	94.65	6.92
Sixth	Second	P(t,t-1)T(t,t-1)E(t)W(t,t-1)	7-9-1	MLP-BR	95.13	5.7
Seventh		P(t,t-1)T(t,t-1)E(t,t-1)W(t,t-1)	8-6-1	MLP-BR	90.78	5.76
Eight		P(t,t-1)T(t,t-1)E(t,t-1)W(t,t-1,t-2)	9-5-1	RNN-BR	93.26	5.68
Ninth		P(t,t-1)T(t,t-1)E(t,t-1)W(t,t-1,t-2,t-3)	10-5-1	MLP-BR	92.45	7.64

Table[1]: Best Results structures expression pattern was not



Figure[2]: Mqadyrvaqy and predict the Sakhtarshbkh nervous

Time series models (ARMA), the model for 36 months, with p, q of the number of simulations have shown that this model does not provide acceptable results. And this model to simulate the water balance of the area is not suitable larestan. Finally, with regard to the material described above, although the ARMA model parameters is less than the neural network However, neural network results more acceptable presents a neural network (RNN-BR) according to the existing parameters with R2 = 95/89 and RMSE=4/99 of the best structure to predict water level underground Lar introduced be.

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