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ANN based Model Responsible for Groundwater Level Prediction

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Abstract - *For control the water usage and distribution, the ground water prediction is one of the key resides within the environmental issue. Due to the wastage and improper management, protection and conservation of groundwater which is also a natural assert, the day will soon come when the recovery of this natural asset is not possible. The present work focuses mainly on the application of ANN (Artificial neural network). Here the current water level observation and the prediction to the next year water level are required to control the water usage. The neural model is configured on these training and testing datasets to perform the water level prediction. This paper also shows the analysis of the features like rainfall, fluctuation and water depth and also shows the comparative analysis of all these features using neural modeling. The predictive observations are compared with actual values of actual water level readings available for different regions. In this paper, environmental attributes for few years and there prediction results for the next year are correlated and trained under a neural adaptive feature processing model. This paper defines the observation results of each individual district for all the environmental features.*

Key Words: Neural, Prediction, Ground Water, Rainfall, fluctuation.

1. INTRODUCTION

Ground water means water from the ground which is the most filtered form of water as it get down after crossing many layers. The use of this ground water increases as the demand increases, as the population increases and also as its usage increases. Industrialization which came as to provide goods at a cheaper rate has now become the main cause for polluting the groundwater by secreting the chemicals directly into the ground. Other factors are also responsible for polluting the ground water. These factors are the chemical used in agricultural fields, washing of cloths near the lakes or rivers and many other domestic usage and wastage of water. Many human activities and new technologies has become the main cause for the degradation of ground water. This risk of depletion of ground water has now become the concerned for many governments of different countries [1]. The ground water affects many areas i.e. irrigation, industries etc. Groundwater is the natural resource which is used mostly for domestic, agriculture and the industrial usage, for different applications and purposes. It is considered as the core and natural water resource. Because of this, the monitoring of ground water resource should be the main focus. Although effective ways for management of ground water level should be developed, to improve this natural assert. In this paper, the water level prediction and basic characterization is provided using neural network approach. Neural network is found to be the most intelligent and adaptive tool as it predicts the result by adjusting the weights according to the change in parameters. Neural modeling is suitable for getting the desired result as the weights and rules are modified by this network to obtain the desired value. This section also shows the comparisons, results between the actual values for all the features like rainfall, fluctuation and water depth and the results obtained after applying neural network approach. Also shows the bar graph result obtained for water depth for three districts by applying neural network predictive approach.

1.1 Ground Water

The water that penetrates through the pores and cracks into the different layers of the soil present underneath the surface of earth defines the ground water. Ground water is highly important, valuable and natural resource. The sources of ground water could be from anywhere; it can be from snow, sleet and hail in north or from the rainfall. Worldwide, groundwater accounts for about one-third percent of the earth's water or about 20 times more than the total of surface waters on continents & islands [2]. Recharging and draft are the two words come in handy while discussing about the ground water. Recharging is the term used when the level of ground water is raised; it can be raise by rainfall, from the agricultural fields, lakes, river etc. In this process water steeps beneath the surface of the earth by filling the little spaces present between irregular sized particles of the soil. Draft is the term generally used when something is taken

which in this case is the water from ground hence causes depletion of water table. Ground water net balance should always be maintained in order to protect this assert for our future races.

1.2 Design Considerations

Neural network is the most powerful and intelligently pattern recognized computational network which take into consideration the existing class of data element in the form of pattern to predict new values of data elements this network is also known as layered network as it comprises of three layers:

1. Input Layer
2. Hidden Layer
3. Output Layer

All the layers consist of neurons which are the basic unit that stores information and this information is passed to the output layer through the hidden layer. The assignment of weights is done on the hidden layer that is why it is sometimes called as weighted layer. These weights can be modified according to the desired output or to get the best and suitable prediction results from the output. This layer has as many neurons as there are input categories. The number of input variables is important parameters that affect Neural Network forecasting capability. The method is defined as the layered model in which the specification of the neuron at the input layer is defined and processed in a complex form. The complex organized form gives the better and informational view of data values so that the relative effective decisions from the data can be derived [3]. Neuron is the basic unit of a parallel ANN network. For determining the non-linear relationship between the input and output data, number of layers and nodes are selected and after that the result is generalized with other data [4]. The capacity of human brain for storing the data in the pattern form was became the main reason for the development of ANN network [5]. Generally ANN is of two type feed forward and back propagation ANN .feed forward are those in which the flow of information from one node to another through the associated weights is one directional whereas the back propagation is widely used ANN network as it learn by examples.

Formation of training, testing and validation data

- **TRAINING:** it contains the largest portion of the data set.
- **TESTING**: it examines the generalized ability which means to train for the input which is not a part of the training dataset**.**
- **VALIDATION:** finally checks the training network performance.

For the starting of the process we require to give a target value corresponding to which the trained network gives an output from which error is calculated i.e. target –actual output. The process is repeated again and again till the error and the output reached minimum or close to the target value. Hence we by applying any input other then the set we get the desired output after training network.

Training period

After the collection of raw data it is divided into two parts: training and testing. For the purpose of training the data there is a need to set the time for the prediction results obtained for the present data. This training period will help in forecasting the data in most efficient ways. The two parameters that affect the training set are learning and validation.

Learning rates

It plays an important role for training of network as it controls the iteration's step size. If the size is small then the processing speed will be slow, training time increase and hence results in local minima. If the size is large then the processing speed increase but the desired accuracy will not be achieved.

2. RELATED WORK

This section discussed some of the earlier researchers work and their contribution in the field of groundwater quality and water level analysis under different factors (Darbra et. al.,2009) [1] has used the fuzzy model to determine the environmental risk based on different uncertainty parameters. Author has specified the relative parameters and observed that chemical plants are the main cause of environmental risk. The author form set of rules based on the randomness and incompleteness defined within the risk uncertainty. The author has determined the behaviour of uncertainty data and concluded the decision. (Mousavi et. al.,2012) [2] has taken the performance evaluation of 175 wells of Isfahan province using four neuro-fuzzy systems for determining the nitrate value in ground water. Author has defined some parameters which are calcium level, magnesium, nitrate concentration level etc that affects the water quality. The Neuro-fuzzy model 1 found to be best suited for evaluation of the concentration of nitrate. (Nabil Bessaih et al. 2014) [3] has taken into account the data of 3 wells in the Wadi El Jezzy Catchment and observe that this data provides the effective results and is a key feature. Author has defined the ANN model with the back propagation technique to determine not only the monthly forecasting but also the forecasting of next two months of ground water level. (A.J.Choobbasti et al. 2012) [4] has defined ANN to find the water table depth in badol area. Author has considered some parameters and also determines their relationships. The technique used by the author here is back propagation. Author has also evaluated the comparative results of ANN with the actual site data (Bisht et. al., 2013) [5] has defined assessment for five different models based on fuzzy logic and neural network

approach in the form of table. The quality estimation is provided under and evaluates the effective model configuration. (Maedeh et al. 2013) [6] has taken into account parameters related to total dissolve solids to determine the ground water quality .author has evaluated that some ions dominate more than others on neural network. (Gaurav Goel et al.2013) [7] has defined the khepa's model using the parameters like number and heights of check dams, bed slops and perimeters of drain. Author has evaluated the results based on these parameters. (Umamaheswari et al. 2014) [8] has taken into account the problem related to fluctuation of ground water level. For this author has also evaluated the comparative results of two models and concluded that hybrid model is the best suited in comparison with ANN. (Umamaheswari et al. 2014) [9] has defined Adaptive Neuro Fuzzy Inference System (ANFIS) approach and hybrid technique to determine the forecasting, pattern and fluctuation of groundwater over the months .Author has evaluated that hybrid technique is goog and most suitable in this case but other policies should also be considered for providing the desired modification required in fluctuation model. (Zohreh Alipour et al. 2014) [10] has used data related to rainfall , relative humidity, temperature and aquifer for the 14 observed wells, author here defines three models and determine the comparative results .author has also evaluated that Adaptive Neuro Fuzzy model is much more suitable. Author has also defined Time Series analysis and artificial neural network for groundwater level but the results are less satisfactory. (Lohani AK et al. 2016) [11] has defined ANN model trained with different algorithms to determine the result for different boreholes or wells. Author has evaluated that Levenberg–Marquardt algorithm is the most suitable algo used for forecasting of ground water level within the ANN model. Author covers the areas of two district of Punjab i.e. Amritsar and Gurdaspur districts.

3. NEURAL PREDICTIVE MODEL

Ground water is one of the natural assert or resource present in this world. Due to the increase in industries, population and wastage the quality of water is criticised and more secure measures are needed to overcome this. To manage the ground water quality and quantity for house hold , industries and for many other purposes ,water level estimation is the effective way. In this section, water estimation is done with the help of neural modeling. The neural model for prediction of water table depth for the next year is analysed here. The neural model based water depth prediction is defined in more detail in this next section. The main focus of the research is water level estimation through natural features by applying neural modeling.

According to this model, the raw data is taken and converted into the dataset and then this data set is transformed into a much suitable form which is normalized form. This transformation is required as it is read by the neural network easily and hence can be applied effectively on the neural model. After this transformation the data is divided, the larger part of the data is trained and the smaller part of the data after division is tested. Here the blocks are not separated while dividing the dataset. The training part is responsible for generation of rules and adjustment of weights according to the desired output whereas the testing part which consist of smaller data is responsible for providing the desired prediction values for the next or further years. After generation of rules and adjustment of weights the neural based prediction model is applied.

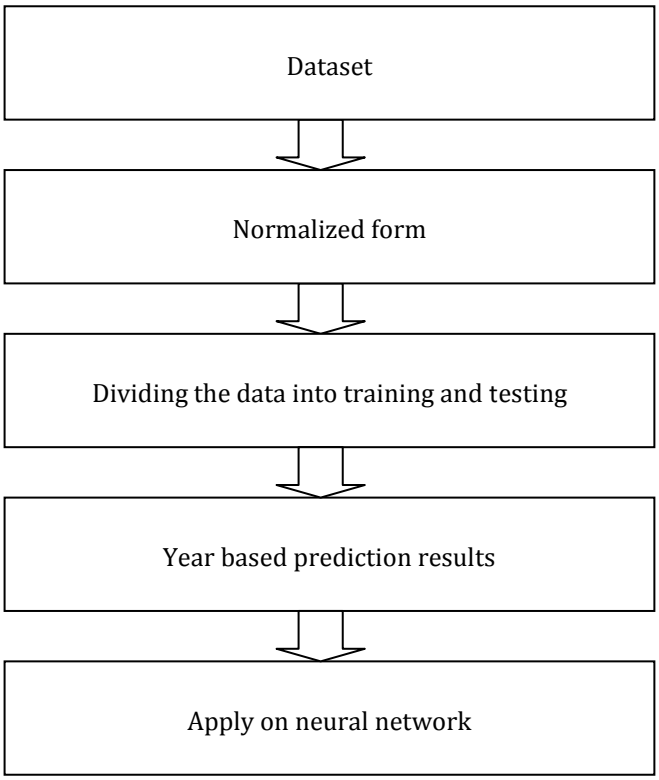

Figure 1: Neural Predictive Model

This figure 1 shows the steps followed for estimating the ground water depth results for the next year. While defining the number of epochs, layers and weight function and hence applying the neural model on the training and testing data. Finally the prediction results are obtained based on the years. The mapping of all features with the actual value is obtained and also the comparative results are obtained and analysed under the neural predictive results.

4. RESULTS

The presented work defines the neural model and its performance analysis, validation results, regression results, all features analysis, comparative features analysis and finally the water depth. The dataset includes parameters like rainfall, water depth level and fluctuation details to perform the ground water prediction between the years 1997 and 2015.The dataset here is defined for 4 districts for the prediction.

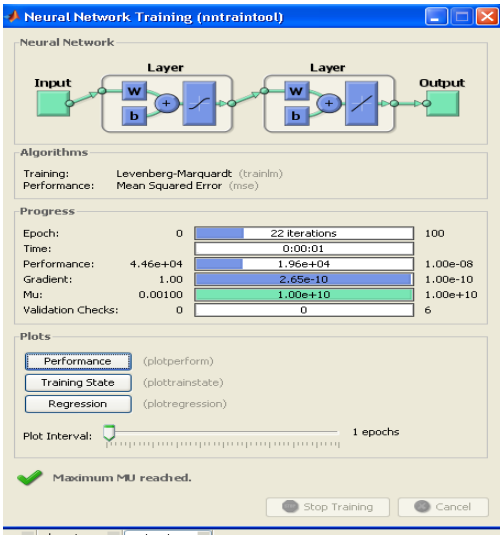

Figure 2: Neural Modeling

Here figure 2 showing the Neural network based prediction result. This model is used to determining the performance of features related to ground water. First the raw data is transformed into normalized form and then divided into training and testing. The rules are generated by the training set part and the prediction result based on small data is accomplished by the testing data. The model is in the form of buttons, each button specifies the performance, regression and training state.

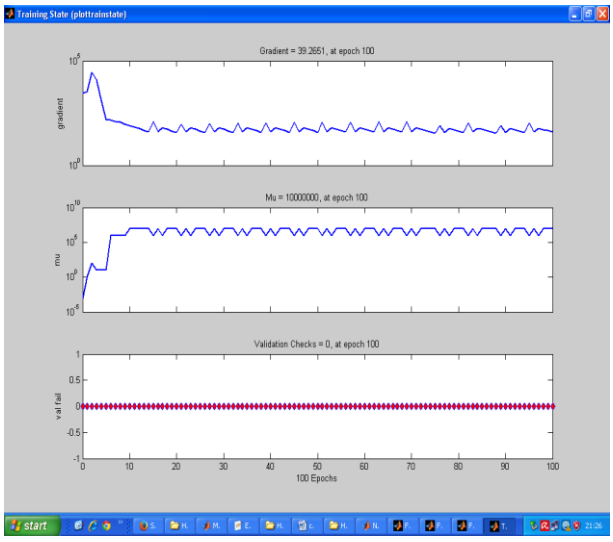

Figure 3: Validation Results (Neural)

Here figure 3 is showing the validation result in terms of gradient result , error evaluation and validation analysis at epoch 100. Here x axis is showing the epochs and y axis is showing the relative parameter. The gradient part in the graph is showing the tracks of error and the mu part in the graph is showing the mapping of the model to the target value and validation part shows that the model is not failed for any of the rule formulated by training set.

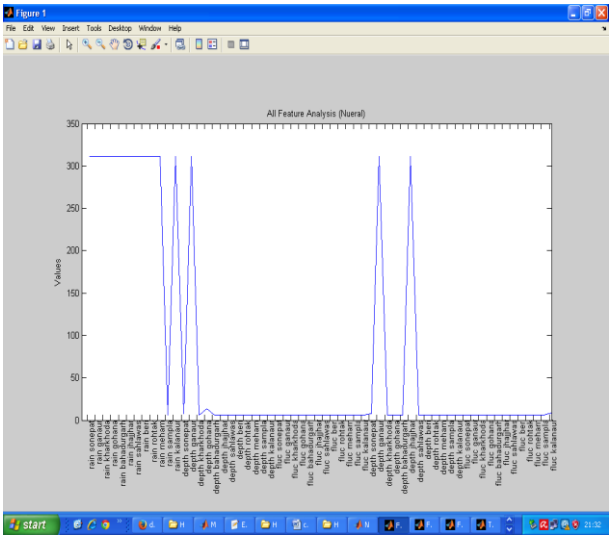

Figure 4: All Features Analysis (Neural Modelling)

Here the figure 4 is showing the all features analysis predictive results in terms of rainfall, water depth and the fluctuation. The result is shown for three districts Rohtak, Sonepat and Jhajjar each having 4 blocks. Each feature is having a value after every12 value separations. Here the y axis is showing the corresponding values and the x axis has mentioned the block name with relative features.

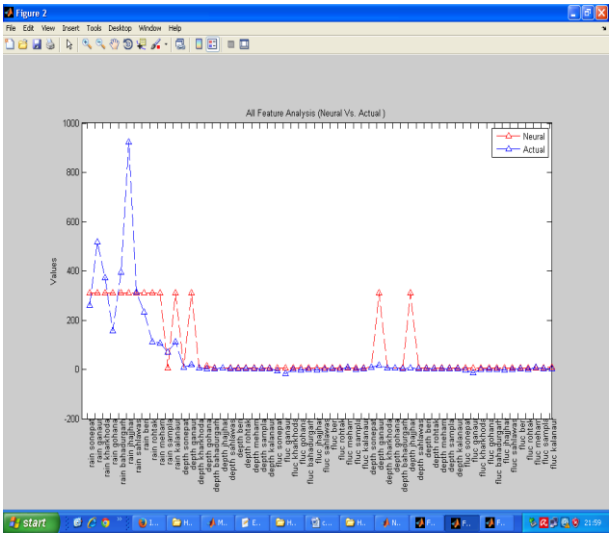

Figure 5: Comparative Features Analysis (Neural Modelling)

Here figure 5 is showing the comparative features analysis using neural network. Here the results obtained for each of the district including Rohtak, Sonepat and Jhajjar which are defined with four blocks, here the x axis is showing the block name with relative features and y axis is showing the corresponding values. Actual results are shown by the blue line and neural results are shown by the red line.

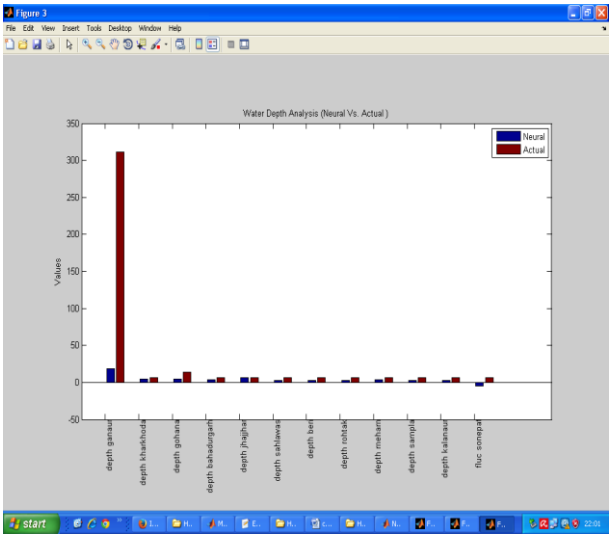

Figure 6: Comparative Water Depth Analysis (Neural Modeling)

Here figure 6 is showing the comparative water depth analysis using neural network. Here Y axis is showing the corresponding water depth values and x axis is showing the features of all the blocks and. The brown coloured bar shows the actual value and the blue coloured bar shows the prediction results obtained after applying neural. Jhajjar block shows the effective result whereas the negative prediction result is obtained for the sonepat block.

5. CONCLUSION

In this paper, neural model is provided for better estimation of depth of the groundwater. Here all feature analysis and comparison of all features for different blocks are also obtained. In the comparative analysis the water depth values are providing quite a stable fit with the neural result. Finally the bar graph obtained by the neural modeling shows the water depth for all the blocks of each of the three districts. The comparative observations show that neural modeling provides effective results of prediction for most of the blocks.

REFERENCES

[1] R.M. Darbra1 and J. Casal, "Environmental risk assessment of accidental releases in chemical plants through fuzzy logic." Chemical Engineering Transactions 17 (2009), pp 287-292.

[2] Sayed Farhad Mousavi and Mohammad Javad Amiri, "Modelling Nitrate Concentration of Groundwater Using Adaptive Neural-Based Fuzzy Inference System" Soil & Water Res. Vol.7,No.2, 2012, pp 73–83.

[3] Nabil Bessaih, Mohsin Qureshi, Fatima Salem Al-Jabri, Iman Rashid Al-Harmali and Zahra Ali Al Naamani, "Groundwater Water Level Prediction in Wadi El Jezzy Catchment Using ANN" Proceedings of the World Congress on Engineering , ISSN: 2078-0966 , Vol I, July 2 - 4, 2014.

[4] A.J.Choobbasti, E.Shooshpasha and F.Farrokhzad, "3-D Modelling of Ground Water Using Artificial Neural Network Case Study of Babol" Indian Journal of Geo Marine Science, Vol.42 ,No.7, pp 903-906, 2013.

[5] Dinesh Bisht1, Shilpa Jain and M. Mohan Raju2, "Prediction of Water Table Elevation Fluctuation through Fuzzy Logic & Artificial Neural Networks" International Journal of Advanced Science and Technology Vol. 51, pp 107-120, February 2013.

[6] P. Abbasi Maedeh, N. Mehrdad1, G.R. Nabi Bidhendi and H. Zare Abyaneh, "Application of Artificial Neural Network to Predict Total Dissolved Solids Variations in Groundwater of Tehran Plain, Iran" International Journal of Environment and Sustainability ISSN 1927-9566, Vol. 2, No. 1, pp. 10-20, 2013.

[7] Gaurav Goel, Prbhakar Sharma, Ranvir singh And Baldev Setia, "Optimal use of Surface Drain for Enhancing Ground Water Recharge" Journal of Indian Water Resources Society, Vol. 33, No. 3, pp 43-52, July 2013.

[8] Sumant Kumar, N.C. Ghosh and Surjeet Singh, "A Comparative Study of Artificial Neural Network and Hybrid Model for Prediction of Groundwater Level" Journal of Indian Water Resources Society, Vol.33, No.4, pp 17-23, October, 2013.

[9] G. R. Umamaheswari and Dr. D. Kalamani, "Adaptive Neuro Fuzzy Inference System for Monthly Groundwater Level Prediction in Amaravathi River Minor Basin" Journal of Theoretical and Applied Information Technology, ISSN: 1992-8645, Vol. 68, No.3, 31st October 2014.

[10] Zohreh Alipour, Ali Mohammad Akhund Ali, Feraydoun Radmanesh and Mahmoud Joorabyan, "Comparison of Three Methods of ANN, ANFIS and Time Series Models to Predict Ground Water Level", Bull. Env. Pharmacol. Life Sci., Vol 3 [Special Issue V] , pp 128-134, 2014.

[11] Lohani AK1 and Krishan G, "Application of Artificial Neural Network for Groundwater Level Simulation in Amritsar and Gurdaspur Districts of Punjab" J Earth Sci Clim Change, ISSN: 2157-7617, Vol.6, Issue 4, pp 1-6, 2015.