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Neural and Fuzzy-Weighted-Neural Model for Water-Depth Prediction

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ABSTRACT: Ground water prediction is one of the primary requirements to control the water usage and distribution. The decision for the future year can be taken based on the requirement, current water level and the predictive level. In this work, a more intelligent water level prediction system is provided using neural modeling. Later on, the improvement to neural model is also provided by integrated the fuzzy based weight assignment for each attribute called fuzzy-weighted neural model. The work is applied on the raw featured dataset collected from irrigation department. The paper has defined the individual modeling with neural results and later on the comparative results shows that the model provided the effective estimation for different regions.

KEYWORDS: Neural, Fuzzy, Prediction, Ground Water, Rainfall

I. INTRODUCTION

Groundwater is having the significance in various applications including the domestic, agriculture and the industrial usage. The ground water is acquired by different industries, applications and units for different purpose. It is considered as the core and nature water resource. Because of this, the management and monitoring of ground water resource is required at different levels. Different methods, measures criteria can be combined under computational model for water level prediction. The water level is the main source that can fulfil the water requirement of each individual and entity. Based on the current water level, the water usage can be controlled. Because of the higher significance, it is also required to identify the factors that can reduce the water level and affect it in different ways. Some of these factors include the rain fall, drought, previous water level, consumption of water within region etc. To monitor and manage the water level, it is required to observe the fluctuation under these all vectors. Based on this fluctuation observation, the predictive decisions can be taken. The long term planning and the water level utilization can be adapted using the water level prediction. There are multiple factors relative to the environment or the climate that can affect the water level including the temperature, evaporation, humidity etc. These factors are also analysed in terms of charging and discharging rates. The phenomenon is here defined to keep the ground water in control as well as to predict it as per the requirement for next year.

There are number of methods available to control, manage and monitor the water level. Some of these methods include time series analysis, regression modeling and the physical-conceptual methods. These methods observe the current system constraints and relative take the decision. The statistical feature adaptive modeling is also provided to generate the predictive decision. The parameter adaptive methods are defined to establish the relationship among the features as well as to take the environmental aspects. The challenge is to utilize the selective information in accurate way. The requirement is also to expand the calculation by applying some real time and the mathematical modeling. The scenario specification, region analysis is also applied to take the decision. In this paper, the water level prediction is provided using neural network approach. The neural modeling and basic characterization is also described in this section.

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A. *Design Considerations:*

The neural network is the effective and adaptive classifier used to perform the prediction. This model is able to provide the optimal solution with specification of precision. In the basic form, the neural network is defined as the layered architecture in which the complete process modeling is divided in three layers as shown in figure 1. These layers are the input layer, hidden layer and the output layer. As the name suggest, the featured input is provided at the input layer. The weight driven transition is performed by the hidden layer. This layer is considered as the main processing layer that accepts the input and applies the algorithmic evaluation, weight processing and the feature observation to generate the output. The feature driven processing is applied by the hidden layer to generate the final output. At the final stage, the output is taken by the output layer and provided as the predictive or the classification results. If the results are obtained for some sample known data, then mapping can be performed on the actual and predictive results to identify the work accuracy.

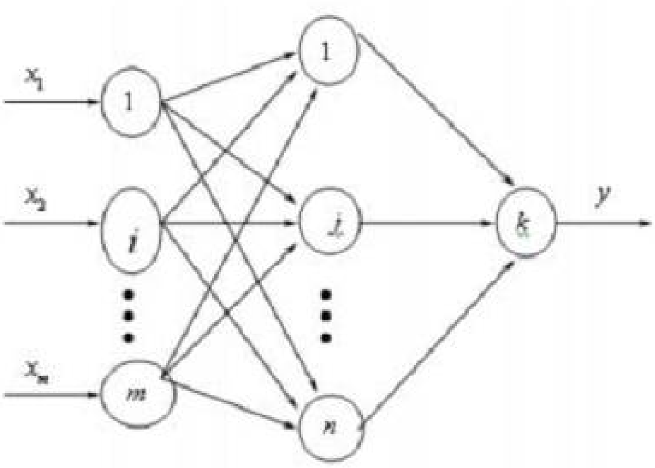

Figure 1 : Neural Network Model

Here figure 1 is showing the neural network classification model with specification of each layer. The weight driven transition is also shown in the figure. The figure shows that the model has divided in three main layers. In first layer, the input is passed to the system in normalized form. The second layer is here called hidden layer that observe the input values and relatively assign weights for each attributes. Finally, the output layer is defined that collected the predictive results. These predictive results are compared with some available output based on which the error and accuracy analysis can be performed.

In this paper, a neural adaptive feature processing model and the fuzzy integrated neural model is defined to predict the water level. In this section, the significance of water level its dependency on different environmental attributes is defined. In section II, the work defined by the earlier researchers for water level prediction is provided. In section III, the proposed work model under neural and the fuzzy integrated neural approach are provided. This section has provided the algorithmic model for each of the stage as well as the comparative observation obtained for each method against the actual results is shown in this section. In section IV, the results obtained from the work are provided. In section V, the conclusion of work is presented.

II. RELATED WORK

Water level monitoring, processing, management and prediction are considered the more critical processes dependent on different vectors. Different researchers provided the contribution to process the water level under these different factors. Some of the work provided by earlier researchers is discussed in this section. (Darbra et. al.,2009) [1] Used the fuzzy model on different uncertainty specific parameters to observe the water level. These parameters are relative to the industry and identify the risk assessment. The chemical plant specific observation was provided by the author and trained it under fuzzy modelling to setup some relative rules. The uncertainty data behaviour was analyzed by the author to take some decision. (Mousavi et. al.,2012) [2] has taken the performance evaluation using neuro-fuzzy

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system under different measures of ground water. Author considered the parameter that affects the water quality or the purity. The parameters considered here include calcium level, magnesium, nitrate concentration level etc. The neuro-fuzzy modelling was applied to generate the best rank so that the good estimation will be obtained.

(Dohare et. al.,2014) [3] has provided the statistical evaluation on water quality issues and status. The parameter specific assessment was provided by the author to generate the quality index and to improve the quality rating. The quality management was carried out by the author periodically with resource specification. (Bhowmick et. al.,2014) [4] has provided the GIS based system to model the environment under zone specific estimation. The diverse environment specific artificial recharge was processed by the author in integrated form. The fuzzy logic and the relative feature map were processed by the author under GIS technique. The Boolean logic based assessment was provided by the author to provide time effective results. (Rahimi et. al.,2012) [5] has applied the fuzzy theory with decision making and the quality assessment for agricultural purpose. The parameter specific estimation was provided by the author for different regional aspects. The quality parameter based estimation and criteria specification was provided by the author. (Pathak et. al.,2014) [6] provided another work using Fuzzy system to evaluate the ground water quality under pollution. The vulnerability map and the constraints are identified under different variables. The criteria estimation and evaluation was provided by the author with domain specification. (Reza et. al.,2012) [7] defined anew DRASTIC model integrated with fuzzy inference system to provide more quality driven results. The index driven model is provided to control the ground water and provided the classical approach for vulnerability assessment. (Wolters et. al.,2014) [8] also work on the classical parameter based approach to identify the vulnerability assessment. The estimation tool is based on the quality deterioration within the region. The fuzzy framed analysis was provided to observe the quality aspects.

(Anornu et. al.,2012) [9] defined the GIS based resource utilization and quality assessment based on the potential water features. The source specific framework was defined by the author with conditional assessment. The criteria specific weight system assessment and slight adoption of ground water recharge was provided by author to generate the scenario specific results. (Bisht et. al.,2013) [10] has defined the table driven assessment applied using fuzzy logic and neural network approach. The quality estimation was provided under five different models and evaluates the effective model configuration. (Rather et. al.,2012) [11] has applied the fuzzy based prediction to the spatial data model to perform remote sensing. The region analysis was provided under zone driven semantic mapping under slope, landuse, lineament analysis. The control driven prediction to different layers and regions was provided by the author. (Umamaheswari et. al.,2014) [12] has defined the work on water level estimation in Amaravathi river. Author defined the neuro-fuzzy based intelligent system to identify the fluctuations. (Deepika et. al.,2014) [13] has defined a parameter driven estimation for quality aspect based estimation. The neural modelling with range specification was provided to estimate the water quality. The fuzzy based problem estimation and evaluation was provided by the author.

III. RESEARCH METHODOLOGY

Ground water is the primary water resource available for each individual and the industry including the factories, irrigation and house hold work. The ground water is having various integrated potential problems in terms of quality of ground water, ground water level etc. This particular research is focused on the water level estimation by analysing the water level and other associated factors of previous years. The water level estimation is effective to control the ground water utilization and wastage. In this work, a neural based predictive model as well as fuzzy weighted neural model is provided for water level prediction. In this section, both of these models are defined in detail.

A. *Neural Predictive Model:*

The neural modeling is the primary stage of this predictive work model. According to this model, the input dataset is taken in normalized form. For this normalization, format specific transformation is done. Once the transformation is done, the dataset is divided in training and testing sets without separating the region blocks. At the final stage, the neural parameters are adjusted and the neural modeling is applied on this training and testing sets. The neural based predictive model is shown here in figure 2.

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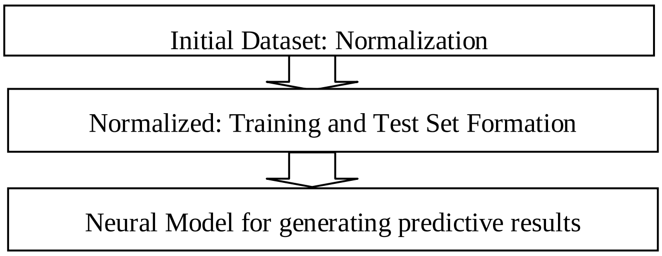

Figure 2: Neural Predictive Model

While configuring the neural model, the number of layers, epochs and the weighted function is defined. At the earlier stage, the neural model is applied on training set to generate the rules and later on it is implied on testing set for generating the predictive results. To generate the accuracy observation, the actual results are compared to the predicted results. The number of water level specific observations correctly mapped is here considered as the accurate predictive results. The error rate observation is also obtained and shown here in figure 3.

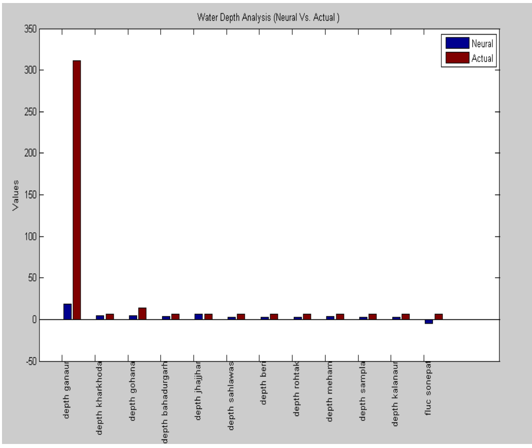

Figure 3 : Neural Predictive Analysis

Here figure 3 is showing the comparative analysis of neural modeling in terms of predictive water depth analysis. The comparision is here defined against the actual results. Lesser the bar height difference between the acutal and predictive values, more accurate the results are obtained. Here x axis is showing the blocks and y axis is showing the predictive observations obtained for each block.

B. *Fuzzy Integrated Neural Predictive Model:*

In the previous sub-section, neural modeling is applied on the water level statistics to generate the predictive water depth estimation. In this section, a more intelligent and rule framed model is provided to generate more accurate and predictive results. In this model, the fuzzy rules are integrated as sub stage to normalized data form. The dynamic fuzzy system has transformed the input data in low, medium and high values based on the dataset values observations. Later on the, neural model is applied on this fuzzy obtained normalized dataset. The dataset Splition and transformation is done in same way as of the earlier defined neural model. The defined algorithmic model is shown here in figure 4.

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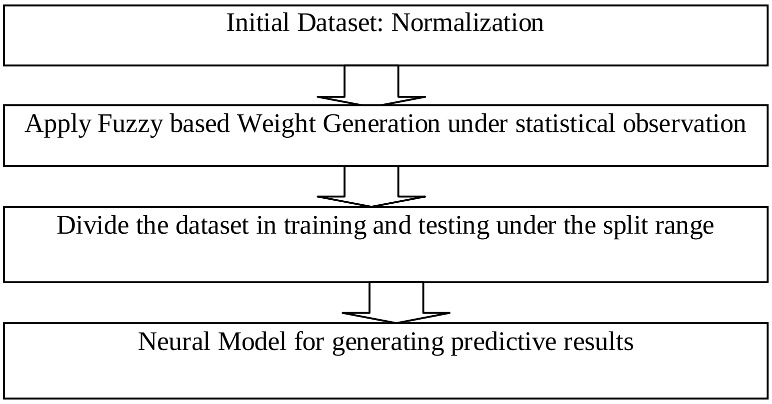

Figure 4 : Proposed Work Model

Here figure 4 is showing the proposed work model. The figure shows that the first requirement of the model is to accept the input statistical information to the rainfall as well as the water level. As the dataset is collected from primary source it was not in organized form according to the defined application. The first stage was to transform the dataset to the normalized form so that the algorithmic implementation will be done over it. After this transformation, some of larger data space is considered as the training set based on which the rules are formed and applied on the smaller test set. To perform this rule, the fuzzy weights are assigned under the minimum and maximum values observations. These fuzzy weighted values are finally processed under neural network model to generate the predictive results. The predictive results are here obtained against the actual values. The comparative predictive results of this model are shown here in figure 5.

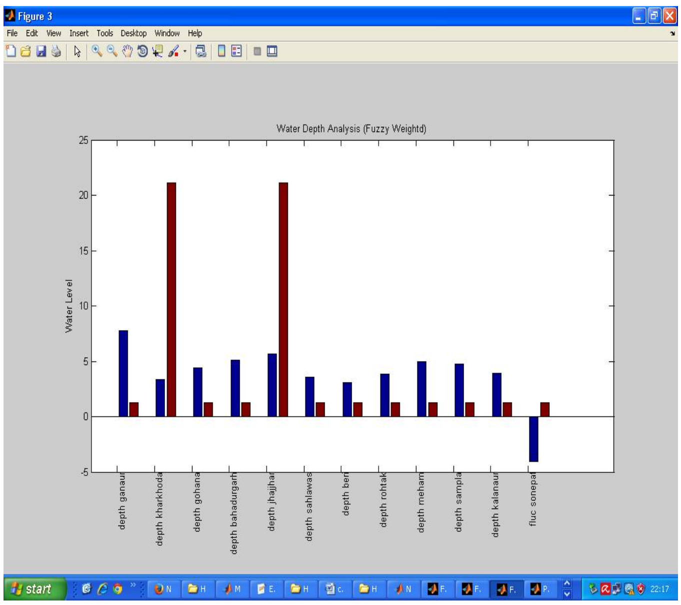

Figure 5 : Predictive Results of Fuzzy Integrated Neural Model

Here figure 5 is showing the comparative analysis of fuzzy integrated neural modeling in terms of predictive water depth analysis. The comparision is here defined against the actual results. Lesser the bar height difference between the acutal and predictive values, more accurate the results are obtained. Here x axis is showing the blocks and y axis is showing the predictive observations obtained for each block.

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Both of these defined models are separately applied on some real time dataset and implemented in matlab environment. The comparative observation is also required for these two methods also. The results obtained from the fuzzy integrated neural system, neural model and the actual predictive results are defined in next section.

IV. RESULTS

The presented work is defined to perform the ground water prediction based on the rainfall, ground water level and other parameter based evaluation. The dataset for 4 different regions of 4 districts is processed for the prediction. The dataset is here collected between the years 1997 and 2015. The dataset description associated to the work is shown here in table 1

TABLE 1: DATASET DESCRIPTION

Features	Values
Type of Dataset	Primary
Number of Districts	3
Number of Blocks in each district	4
Years	1997 to 2014
Number of attributes	5

The dataset is having the features including the rainfall, water depth level and fluctuation details. The neural and the fuzzy weighted neural models are here applied to obtain the predictive estimation of water depth. The region specific comparative results obtained from the work are presented in this section. The results for each of the region are shown here separately. The comparative observations are here taken between the neural model, fuzzy integrated neural model and the actual values. Here figure 6, 7 and 8 are showing the comparative results of water depth estimation for Sonepat, Jhajjar and Rohtak districts.

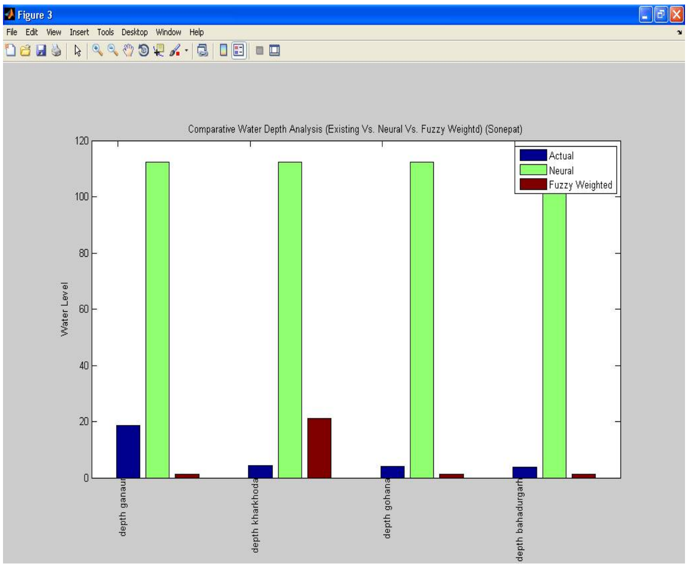

Figure 6 : Water Depth Estimation (Sonepat)

Here figure 6 is showing the water dpeth prediction results for four blocks of sonepat region. The comprative observations are provided against the actual and neural based results. The figure shows that the fuzzy adpative neural model provided more accurate results for this region.

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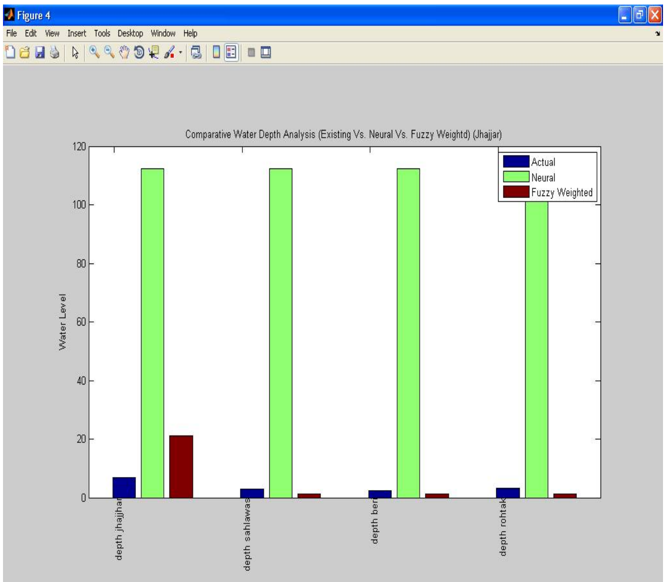

Figure 7 : Water Depth Estimation (Jhajjar)

Here figure 7 is showing the water dpeth prediction results for four blocks of Jhajjar region. The comprative observations are provided against the actual and neural based results. The figure shows that the fuzzy adpative neural model provided more accurate results for this region.

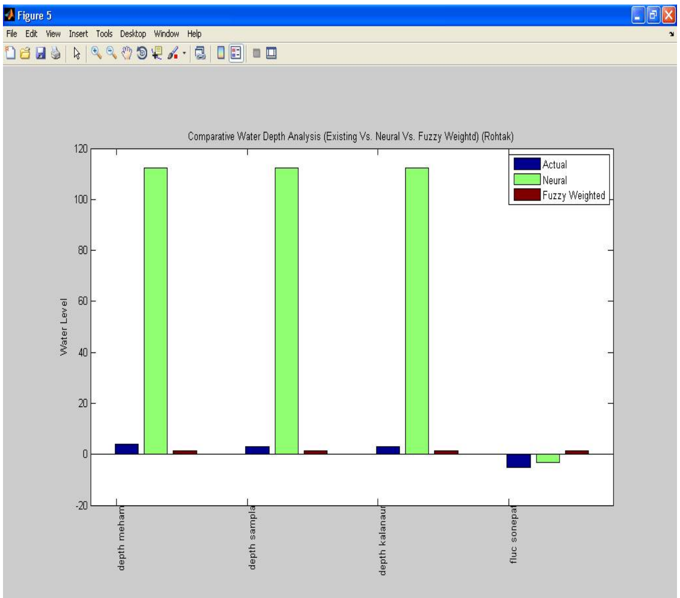

Figure 8 : Water Depth Estimation (Rohtak)

Here figure 8 is showing the water dpeth prediction results for four blocks of Rohtak region. The comprative observations are provided against the actual and neural based results. The figure shows that the fuzzy adpative neural model provided more accurate results for this region.

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V. CONCLUSION

In this paper, a fuzzy weighted neural model and the neural model are provided for water depth estimation. Two different models are defined in this paper to generate the predictive water depth estimation. In the first model, the normalized real time dataset is processed under configured neural approach for different regions. The predictive water level results are obtained relatively. Then the fuzzy integrated neural model is applied to generate more accurate predictive results. This model is here defined to accept the attribute evaluation of previous years and applied the fuzzy rules for generating the weights over the dataset. Later on, the neural modeling is applied to generate the predictive results. The comparative observations show that the defined fuzzy integrated neural method has provided more effective results. The observations are here taken for each district separately.

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