Fuzzy Logic Model for the Prediction of Groundwater Level in Amaravathi River Minor Basin

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***Abstract* – Water is a renewable resource and we are utilizing only less than 15% of surplus water from rainfall for domestic, irrigation, industrial and other research purposes. Due increased population, industrial development and fashion of living from the society has always experienced the problem of shortage of water and higher level of groundwater pollution. In order to meet such shortage it is necessary to know the groundwater level at various locations for its availability and sustainability of aquifer system to meet future demand. The prediction of groundwater level is one of the challenging aspects to understand the groundwater resource in order replicate the exact field condition. Groundwater fluctuation level prediction is consists of many practical uncertainties and result with inaccuracy in prediction by many mathematical approaches. Advanced Fuzzy logic is an excellent mathematical tool to handle such uncertainty issues. In this paper, an approach were made by using Adaptive Neuro Fuzzy Inference System (ANFIS) to predict the groundwater level fluctuation in Amaravathi river minor basin.**

***Keywords* – Groundwater, Amaravathi River Minor Basin, ANFIS, Sustainability, Fluctuation.**

I INTRODUCTION

Water present in the pores and cracks of aquifer system is called as groundwater. Due to heavy abstraction of groundwater its importance increases with the requirements at present as well as in future. The destructive way of exploitation is one of the causes of abrupt declination of groundwater level in the study area. The assessment of availability of groundwater is necessary for future prediction of groundwater pattern. The ANFIS is very powerful GUI useful to predict the groundwater level.

II GROUNDWATER MODEL

Basically two models of groundwater analysis, conceptual model and mathematical model. Various hypothesis analyses are associated with in conceptual model which are simple replication of field conditions and assumptions. Mathematical model is consisting of finite difference approach in the form of micro level conceptual analysis. These two models consist of various field constrained data and parameters which further leads in more error in the output. So the prediction part is going to be a challenging one for any groundwater modeling. To resolve this, optimized adoptive techniques are required i.e., ANFIS. The ANFIS system includes mamdani and sugeno Fuzzy inference system. The present study is done with sugeno fuzzy inference system.

III FUZZY LOGIC HISTORY

Zadeh (1965) Introduced the Fuzzy rule based approach for the various filed of science and technology sections. The model was developed through qualitative modeling scheme using natural language. The rules adopted in the process of quantitative and qualitative is based on the physical behavior of the assumed system. Wide application of fuzzy logic in the field of water resources serves in extensive level of optimization of parameters in a heavy constrained data. It is a new concept to such constrained analysis. Bardossy & Duckstein (1992) Applied the concept of fuzzy rule based modelling for karstic aquifer management problem. Bardossy & Disse (1993) analyzed the infiltration by fuzzy rules. Fontane (1997) applied the concept of fuzzy logic for reservoir simulation and making of management policies process.

IV STUDY AREA

Amaravathi river basin is located between north latitude 11^{o} 00' N and 10^{o} 00'N, east longitude 77^{o} 00'E and 78^{o}15'E. River Amaravathi originates from Thirumurthimalai in Udumalpet taluk of Coimbatore district, Tamil Nadu State. The river flows across the Erode district and into Karur district. The direction of river flow is from southwest to northeast. The total length of river is about 160 km.

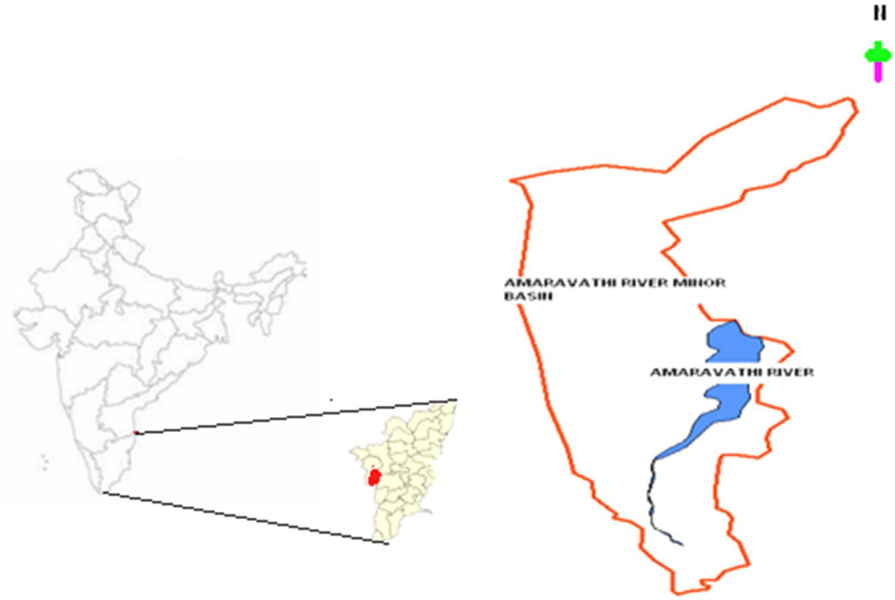

Fig.1 Index Map of the Present Study Area

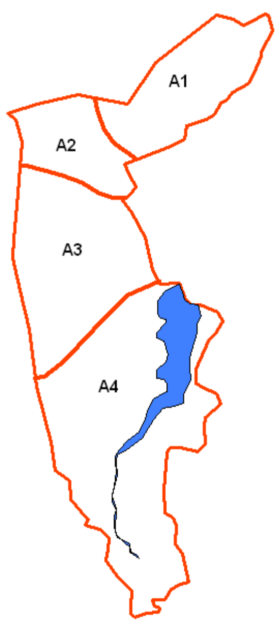

Fig.2. Sub Basin map of the study area

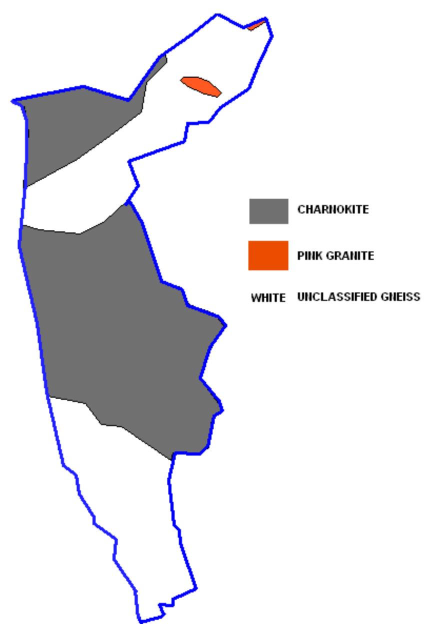

Fig.3. Geological condition of the study area

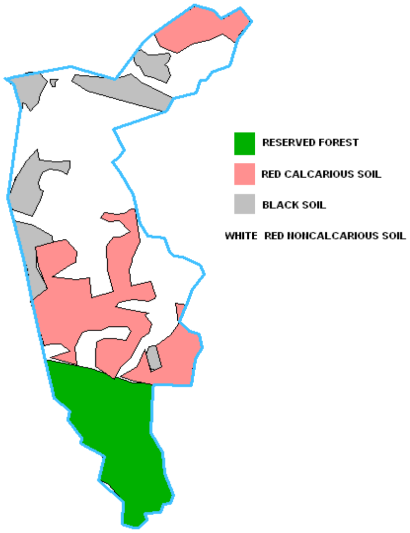

Fig.4 Soil Pattern in the study area

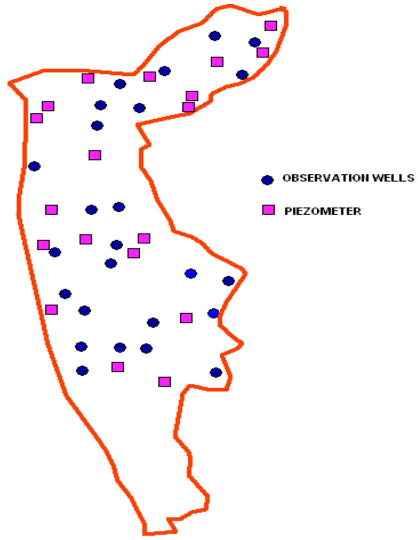

Fig.5 Observation well locations in the study area

V METHODOLOGY

A. Fuzzification of Input and Output data

In the present study the collected data are fed for qualitative analysis, so the data should be fuzzified in order to bring up the eventual scale of distribution. Groundwater recharge, Groundwater discharge, previous groundwater table and present water groundwater table fluctuation above mean sea level were fuzzified in to fuzzy subsets, in order to cover the whole range of deviation of parameters.

Ground water recharge is divided into five subsets, as very low (VL), very low (VL), low (L), medium (M), high (H) and very high (VH). Ground water discharge is divided into six fuzzy subsets, as very low (VL), very low (VL), low (L), medium (M), high (H), very high (VH) and extremely high (EH). Water table elevation for both input and output is divided into seven fuzzy subsets, as extremely low (EL), very low (VL),very low (VL), low (L), medium (M), high (H), very high (VH) and extremely high (EH).

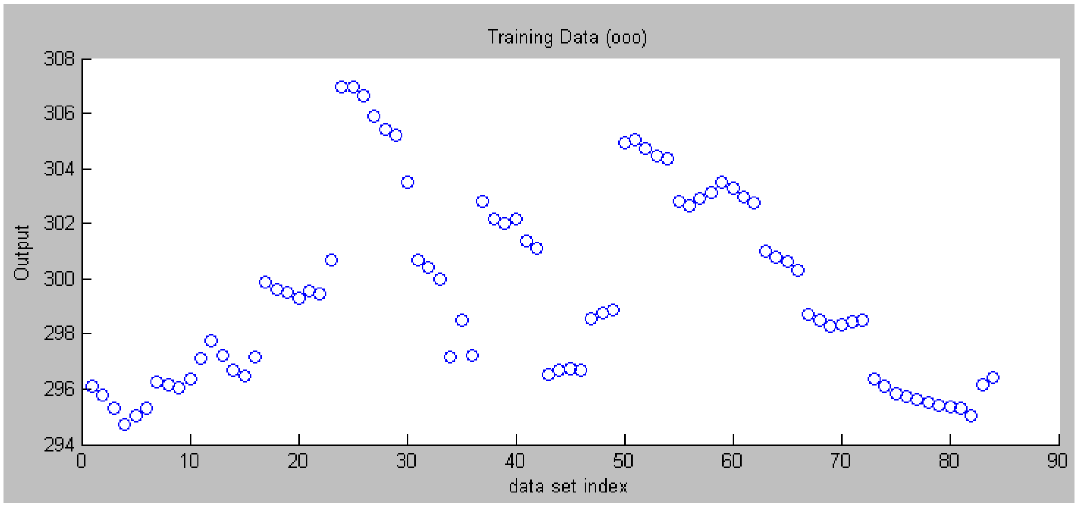

Fig.6 Training of Data

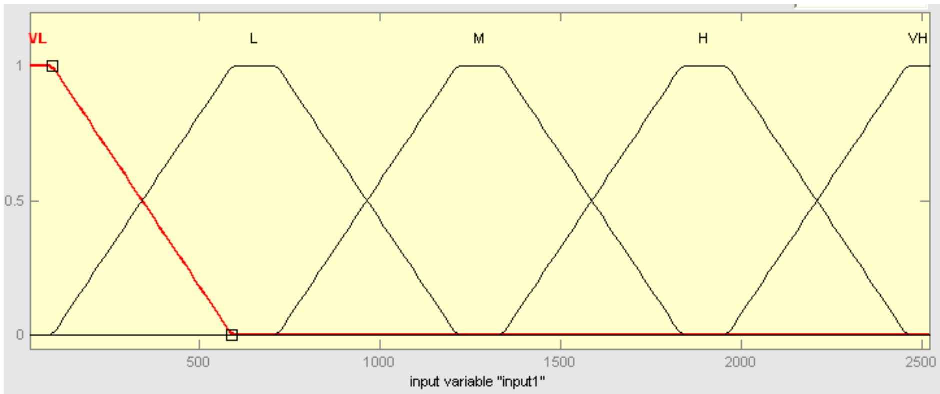

Fig.7 Fuzzified Recharge Pattern

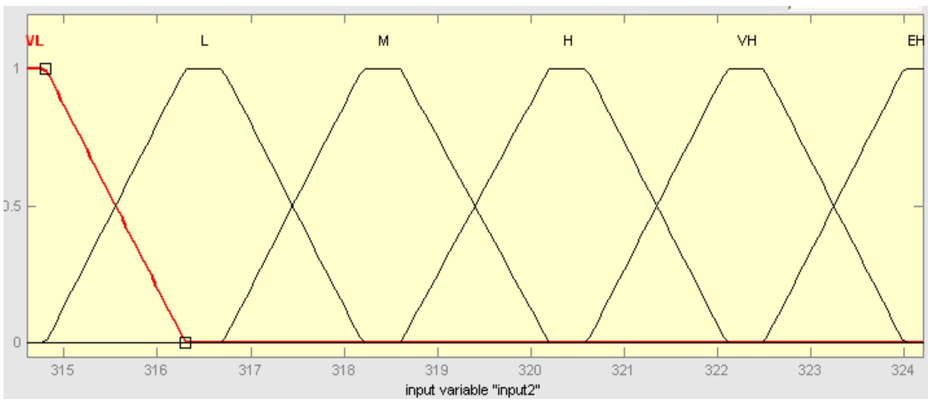

Fig.8 Fuzzified Discharge pattern

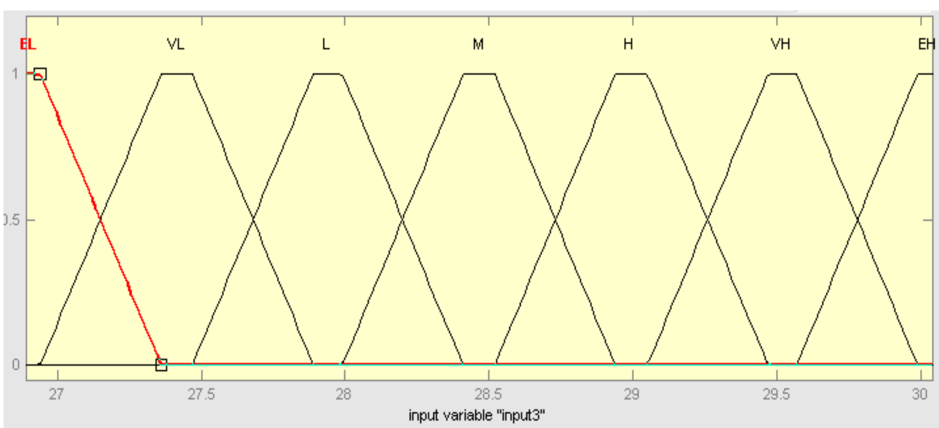

Fig.9 Fuzzified Groundwater Fluctuation

B. Fuzzy Rules

During the analysis with the available data, we describe the relation between fuzzy inputs and out puts. Based on the field observation and condition the fuzzy rules are modified for the analysis. To combine input data fuzzy intersection rule area adopted for fuzzy subsets in order to bring up the accuracy of the prediction. Each model is subdivided by different fuzzy rules during the analysis.

C. De-fuzzification Method

The result arrived through the analysis are in the form of fuzzy sets which again defuzzified to get the original form of output. Centroid method of defuzzification is adopted in this study to have better accurate prediction of parameters through training and testing process.

VI RESULT AND DISCUSSION

The developed model predicted well for the present condition of the groundwater fluctuation table. Further, forecasting of groundwater level through sensitivity analysis of parameter by optimization of fuzzy rules will increase the prediction accuracy of the developed ANFIS. The average testing error is limited to 0.097 which has RMSE value is 0.902.

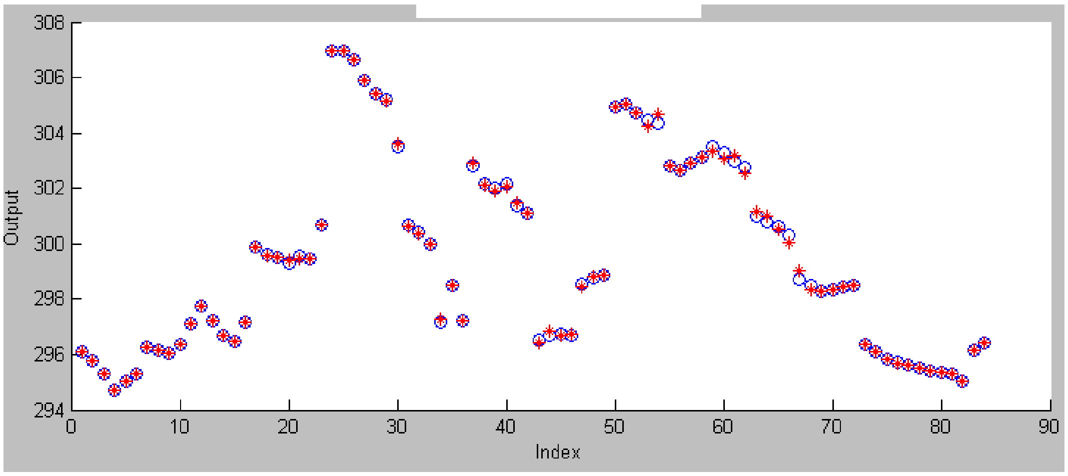

Fig.10 Groundwater Level Observed Vs Predicted

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