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Generation of Autoregressive Time Series Model at Ground Water Fluctuation at Kaushambi District

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Abstract: **-- The present study was conducted with the prime objective to develop a stochastic time series model for prediction of ground water fluctuation in Kaushambi. The area of the Kaushabi is 2012.8 sq kms and the data of 10 years from 2002 to 2011 were used to developed the model Autoregressive (AR) models of orders 0, 1 and 2 were tried to develop a autoregressive time series model for annual ground water fluctuation. The various parameters of model were estimated by the general recursive formula proposed by Kottegoda (1980).The goodness of fit and adequacy of models were tested by Box-Pierce Portmanteau test, Akaike Information Criterion and by comparison of measured and predicted correlogram. The AIC value for AR (1) model is lying between AR (0) and AR (2) which is satisfying the selection criteria. The mean prediction error is less in case of ground water fluctuation by AR (1) model. The Graphical representation between measured and generated correlogram is show that there is close agreement between pre and post monsoon. The comparison between the measured and predicted ground water table and pre and post monsoon by AR (1) model, clearly shows that the developed model can be use efficiently for the prediction of pre and post at the kaushambi district Ground water table**

Index Terms— AR Model, ground water fluctuation.

I. INTRODUCTION

India is basically an agricultural country having 70% of its popular economically active in agriculture; however per capital available land is quiet small. The solution of the problem to meet the rising demand for food, fodder, feed and fuel for human and livestock population can only be achieved by increasing the production per unit land. The obvious remedy is increase agricultural production with proper management practices particularly water management. Indian agriculture is primarily dependent on the monsoon to meet its crop water requirements. Autoregressive In statistics and signal processing, an autoregressive (AR) model is a type of random process which is often used to model is a type of random process which is often used to model and predict. An autoregressive model can thus be viewed as the output of an all-pole infinite impulse response filter whose input is white noise. Some constraints are necessary on the values of the parameters of this model in order that the model remains wide-sense stationary. For example, processes in the AR(1) model with are not stationary. More generally, for an AR(p) model to be wide-sense stationary. Many observed time series exhibit serial autocorrelation; that is, linear association between lagged observations. This suggests past observations might predict current observations. An AR process that depends on p past observations is called an AR model of degree p, denoted by AR(p). Selection of the order of an autoregressive model by squares estimator of a threshold autoregressive model for a random coefficient autoregressive model. Selection of the order of an autoregressive model by Akaike's information criterion. Consistency and limiting distribution of the least squares estimator of a threshold autoregressive model. Statistical inference for a random coefficient autoregressive model. Autoregressive model fitting for control. Power spectrum estimation through autoregressive model fitting. Some properties of the order of an autoregressive model selected by a generalization of Akaikeo s EPF criteria. The grid bootstrap and the autoregressive model. Out of 329 of total area of country 45.1 mha is net irrigated while the net wown area is 142.73 mha. In India in the year 1991-92- about 60 mha areas was estimated as drought area and 8.53 is waterlogged area. For describing Solution for leaky aquifer systems with consideration of the leakage and the effect of aquitard storage. It was found that both the leakage and the effect of aquitard storage on the head fluctuation in the confined aquifer are negligible when the aquitard storage is small and the storage ratio of the aquitard to confined aquifer is less than 0.5 Guo et al. (2010) developed an analytical solution for describing the groundwater

II. MATERIAL AND METHODS

Kaushambi District is bounded by district Pratapgarh in the north, by Chitrakoot District in the south, by Allahabad in the east and by Fatehpur district in the west. Total geographical area occupied by Kaushambi District is 2012.8 sq kms. Manjhanpur is the district headquarters. Manjhanpur is situated in the south-west of Allahabad on the north bank of the Yamuna River.

. Latitude 26048' North

Longitude 82013' East in North India.

(North to South 57.5 km. it is bounded the North by Kaushambi.

Stochastic Time Series Model

It has a certain mathematical form or structure and a set of parameters. A simple time series model could be represented by single probability distribution function f(X:Θ) with parameters $\Theta = (\Theta_1, \Theta_2, \dots)$ valid for all positions t = 1,2,….N and without any dependence between $X_1, X_2, \dots X_n$.

A time series model with dependence structure can be formed as:

$$\varepsilon_t = \phi\, \varepsilon_{t-1} + \eta_t \qquad \text{.....(1)}$$

where η_t is an Independent series with mean zero and variance $(1-\phi_1)$, ε_t is dependent series and ϕ is the parameter of the model. Time series modelling can be organized in five stages, i.e. identification of model composition, Selection of model type, identification of model form, estimation of model parameters and testing of goodness of fit for validation of the model.

Autoregressive (AR) Model

In the Autoregressive model, the current value of a variable is equated to the weighted sum of a pre assigned no. of part values and a variate that is completely random of previous value of process and shock. The pth order autoregressive model AR (p), representing the variable Y_t is generally written as.

$$Y_t = \overline{Y} + \sum_{j=1}^{p} \Phi_j \,(Y_{t-j} - \overline{Y}) + \varepsilon_t \qquad \text{........(2)}$$

where, Yt is the time dependent series (variable), ε_t is the time dependent series which is independent of Y_t and is normally distributed with mean of annual flow and rainfall data and $\Phi_1, \Phi_2, \dots \Phi_p$ are the Auto-regressive parameter

Estimation of Autoregressive parameter

$$AR\,(1): \Phi_1 = \frac{D_{1,2}}{D_{2,2}} \qquad \text{...(3)}$$

$$AR\,(2): \Phi_1 = \frac{D_{1,2} D_{3,3} - D_{1,3} D_{2,3}}{D_{2,2} D_{3,3} - D_{2,3^2}} \qquad \text{....(4)}$$

$$\Phi_2 = \frac{D_{1,3} D_{2,2} - D_{1,2} D_{2,3}}{D_{2,2} D_{3,3} - D_{2,3^2}} \qquad \text{....(5)}$$

For estimation of the model parameter method of maximum likelihood will be used (Box and Jenkins, 1970).

$$D_{ij} = D_{ji} = \frac{N}{(N+2-i-j} \sum_{\ell=0}^{N+1-(i+j)} Z_{i+\ell}\, Z_{j+\ell} \qquad \text{........ (6)}$$

Where D is difference operator, n sample size, i, j maximum possible order 1 is the autocorrelation function. The autocorrelation function r_k of the variable Y_t of equation (3.2) is obtained by multiplying both sides of the equation (3.2) by Y_{t+k} and taking expectation term by term. The relationship proposed by Kottegoda and Horder, (1980) for the computation of autocorrelation function of lag K was used which is expressed as:

$$r_k = \frac{\sum_{t=1}^{N-K} (Y_t - \overline{Y})(Y_{t+k} - \overline{Y})}{\sum_{t=1}^{N} (Y_t - \overline{Y})^2} \qquad \text{.....(7)}$$

Partial Autocorrelation function

The partial autocorrelation function or partial correlogram is used to represent the time dependence structure of a series. The partial autocorrelation PC_{kk} is the autocorrelation remaining in the series after fitting a model of order K-1 and removing the line independence. It is used to identify both the type and order of the model.

$$PC_{k,k} = \frac{r_k - \sum_{j=1}^{k-1} PC_{k-1,j}\, r_{k-j}}{1 - \sum_{j=1}^{k-1} PC_{k-1,j}\, r_j} \qquad \text{....(8)}$$

where PC_{kk} is the Partial autocorrelation function at lag K and r_k is the Autocorrelation function at lag K. The 95 percent probability limit for partial autocorrelation function was calculated using the following equation Anderson, (1942).

Parameter estimation of AR (p) model

After computation of $\overline{Y}$ and σ^2_{ε}, the remaining parameters $\Phi_1, \Phi_2, \dots \Phi_p$ of the AR models were estimated by using the sequence

$$Z_t = Y_t - \overline{Y}, \text{ fort} = 1, 2, \dots N \qquad \text{......(9)}$$

The parameters $\Phi_1, \Phi_2, \dots \Phi_p$ were estimated by solving the p system of following linear equations (Yule and Walker equation).

Goodness of fit of autoregressive (AR) model

The goodness of fit tests of AR models fitted to annual hydrologic series were accomplished by testing whether the residuals of a dependence model for correlation and whether the order of the fitted model is adequate compared with the order of the dependence model and whether the main statistical characteristics of measured series one preserved.

International Journal of Science, Engineering and Management (IJSEM)
Vol 3, Issue 3, March 2018

The following tests were performed to test the goodness of fit of autoregressive (AR) models.

IV. RESULTS AND DISCUSSION

4.1 Statistical analysis and normalization of water table data- The water table data was collected was found to be highly variable due to erotic monsoon the table 4.1 so the table analysis of variance statistical parameters for the water table of Kaushambi region from 2002-2011. The Z score normalization technique is applied to transform the annual water table data series in the normalized from to fit the data is to suitable distribution and to reduce the impact of error on parameter estimation and improved the data accuracy for using data as a model input table 4.1 so the change in the pattern of observed water table in to normalized pattern table 4.1 so the analysis of the statistical parameter for the water table of Kaushambi region the deviation of observed water table was reduced by normalization the after statistical factor curtsied variance and skews has also been reduced by normalization for data error correlation of observed and normalized data was observed fig 4.1 so the annual variance of normalized and observed water table values it is well evident from the fig that normalized water table was squeezed near to me data normalized as well provide the and error proof normalized value generation of predict model.

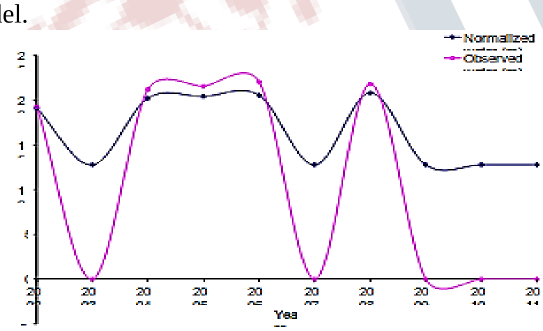

Fig. 4.1 Observed & normalized water table pre monsoon village chail

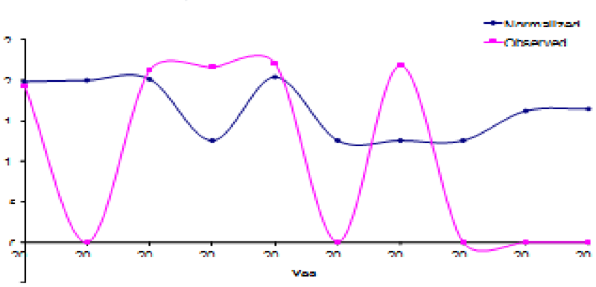

Fig. 4.2 Observed & normalized water table post monsoon village chail

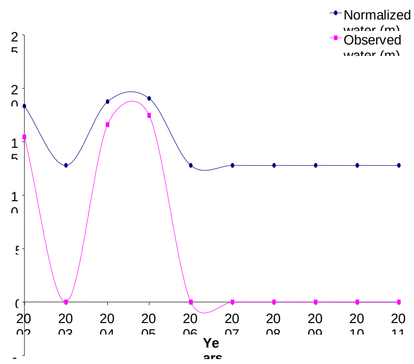

Fig. 4.3 Observed & normalized water table pre monsoon village charawan

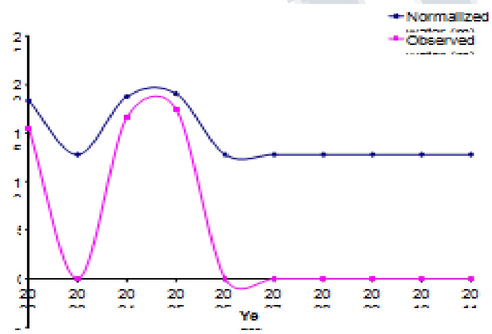

Fig. 4.4 Observed & normalized water table

OBSERVED AND PRIDICTED PRE AND POST MONSOON GRUOND WATER TABLE ANALYSIS

The whole study was completed for estimation of ground water data using autoregressive time series model about identification and parameter estimation the model and Evaluation and performance adequacy of the model by it is statistical parameter which means this describe the probability structure and of an observed phenomenon they are also data which means that there structure is based on not on a physical description of the system Ground water data analysis – to the ground water data collected was founds to be highly variable due to erotic nature of ground water table fluctuation region data was shows the observed ground water table data pre and post monsoon the Kaushambi district region from the year 2002- 2011. The AE model applied to the annual ground water table data estimated from to fit to data in distribution and to redubs impact to error on parameter predicted and improved to data accuracy from using data as a model input fig no 4.22 to 4.60 shows the graphical representation of observed and predicted annual ground water table data and those fig shoes that the coefficient R2=0.999 Fig 4.22to 4.60 shows the graphical representation of the correlogram of observed and predict ground water table fluctuation data has one measure

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Vol 3, Issue 3, March 2018

variation shows the value of observed and predict ground water fluctuation data given from fig 4.22 to 4.60 and measure variation are shows.

12 and models are given as under and fig 1 & 3.

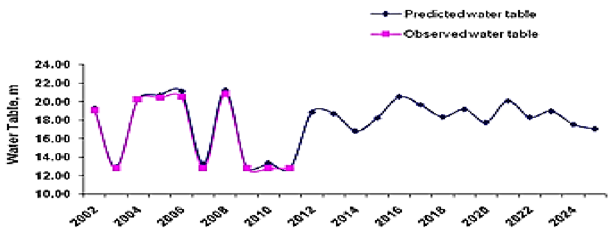

Fig.4.21 Pridicted & observed water table of village chail

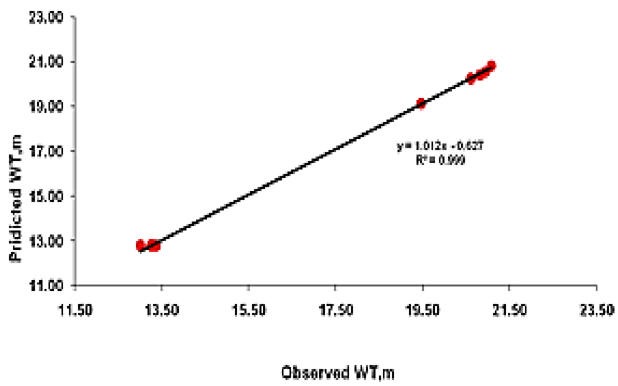

Fig.4.22.Corelation between observed and Pridicted Pre monsoon water table of village Chail

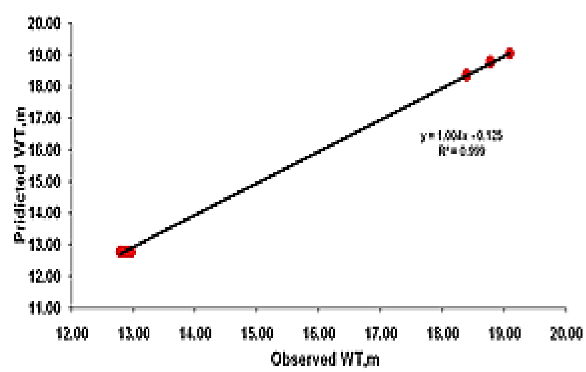

Fig.4.24.Corelation between observed and Pridicted pre monsoon water table of village Charawan

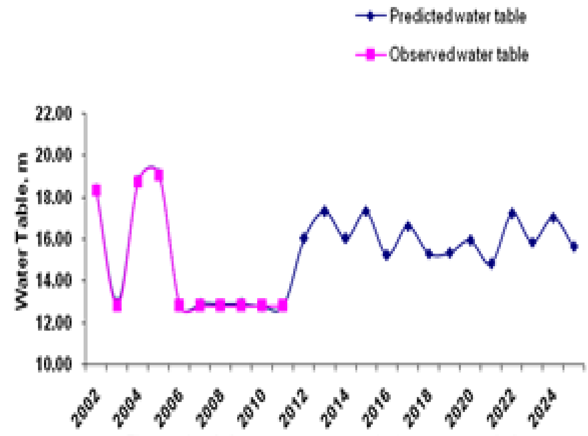

Fig.4.23 pridicted & observed Water table of village Charawan

Table 4.1 Statistical characteristics of Measured and Predicted annual Ground water table fluactuation.

Vill		Mean	SD	SKEW	MEAN	SD	SKEW
Chail	PRE	16.073	3.948	0.0413	16.35	3.353	1.017
	POST	15.931	3.352	0.001	16.44	3.326	-0.963
Charawan	PRE	14.32	2.870	1.04	14.64	2.833	0.196
	POST	15.44	3.173	0.166	15.33	3.194	-0.673
Sahapur	Pre	14.636	3.373	1.035	15.12	3.392	0.093
	Post	15.178	3.353	0.497	15.63	3.348	-0.387
Mohammadpur	Pre	16.387	4.33	0.003	17.00	4.332	1.106
	Post	16.166	4.039	0.0238	16.74	4.083	-1.10
Chakbadsahpur	Pre	14.733	3.302	1.046	15.28	3.313	0.382
	Post	14.389	3.433	1.032	15.04	3.451	-0.039
Daliyaapur	Pre	14.31	3.924	1.040	15.33	3.334	1.148
	Post	14.730	3.743	1.o44	15.22	3.743	0.9012
Kathhra	Pre	14.731	3.743	1.040	15.23	3.766	0.063
	Post	14.327	3.300	1.033	14.97	3.333	-0.318
Jaalsipur	Pre	14.346	4.002	1.038	15.40	3.963	0.037
	Post	14.67	3.673	1.050	15.34	3.633	0.0237
Lalapur	Pre	15.367	4.2009	0.487	16.14	4.248	0.348
	Post	16.060	3.938	0.033	16.38	3.962	-0.371
Rasoolpur	Pre	15.232	3.646	0.300	15.68	3.673	0.062
	Post	15.850	3.313	0.243	16.39	3.320	-0.761

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Vol 3, Issue 3, March 2018

AR(p) models for prediction of ground water table:

Chail-

Pre- AR (1) = $Y_t = 16.073+0.8562(Y_{t-1}- 16.073)+\varepsilon_t$

Post- AR (1) $Y_t = 15.951+0.6780(Y_{t-1}- 15.951) +\varepsilon_t$

Charawan-

AR(1)= $Y_t= 14.32+0.7877(Y_{t-1}- 14.32)+ \varepsilon_t$

AR(1)= $Y_t = 15.44+0.7058(Y_{t-1}- 15.44)+ \varepsilon_t$

Sahapur-

AR(1)= $Y_t = 14.65+0.7942(Yt-1- 14.65)+ \varepsilon_t$

AR(1)= $Y_t = 15.178+0.8267(Yt-1- 15.178)+ \varepsilon_t$

Mohammadpur-

AR(1)= $Y_t = 16.387+0.7810(Y_{t-1}- 16.387)+ \varepsilon_t$

AR(1)= $Y_t = 16.166+0.7905(Y_{t-1}- 16.166)+ \varepsilon_t$

Chakbadsahpur-

AR(1)= $Y_t = 14.755+0.7335(Y_{t-1}- 14.755)+ \varepsilon_t$

AR(1)= $Y_t = 14.589+0.7529(Y_{t-1}- 14.589)+ \varepsilon_t$

Daliyanpur-

AR(1)= $Y_t = 14.81+0.7258(Y_{t-1}- 14.81)+ \varepsilon_t$

AR(1)= $Y_t = 14.730+0.7396(Y_{t-1}- 14.730)+ \varepsilon_t$

Kathhra

AR(1)= $Y_t = 14.731+0.7328(Y_{t-1}- 14.731)+ \varepsilon_t$

AR(1)= $Y_t = 14.527+0.7608(Y_{t-1}- 14.527)+ \varepsilon_t$

Jankipur-

AR(1) = $Y_t = 14.846+0.7248(Y_{t-1}- 14.846)+ \varepsilon_t$

AR(1) = $Y_t = 14.76+0.7492(Y_{t-1}- 14.76)+ \varepsilon_t$

Lalapur-

AR(1)= $Y_t = 15.567+0.7553(Y_{t-1}- 15.567)+ \varepsilon_t$

AR(1)= $Y_t = 16.060+0.7975(Y_{t-1}- 16.060)+ \varepsilon_t$

Rasoolpur-

AR(1)= $Y_t = 15.232+0.7726(Y_{t-1}- 15.232)+ \varepsilon_t$

AR(1)= $Y_t = 15.880+0.8076(Y_{t-1}- 15.880)+ \varepsilon_t$

Box Pierce Portmonteau test for AR model

The Box-Pierce Portmonteau lack of fit test to check the adequacy of autoregressive models for both annual w.t. for AR(0), AR(1) and AR(2) models were estimated. The results revealed that all three models, viz. AR(0), AR(1) and AR(2) were giving good fit and were acceptable.

Akaike Information criterion test for AR models

In order to choose the better model among these two models, Akaike Information Criterion (AIC) for all three models were computed. The computed values of AIC for w.t. are given in Table. Respectively. It is clear from the table that AIC value of AR(1) in all three cases are lying in between AR(2) model and AR(0) model therefore it was considered suitable model for further prediction of w.t.

Comparison of the Measured and selected model correlogram

The correlogram of Measured and Predicted series for ground W.T. were developed by plotting autocorrelation functions against lag K. The autocorrelation functions rk(k) of the fitted AR(1) model is calculated . or SPPSS software. The measured and generated values are given in the table. Graphical representations of measured correlogram with the selected model. The graphical representation of the data shows a closer agreement between measured correlogram and predicted correlogram of rainfall, runoff for selected model. So the developed model can be utilized for the prediction of future trends.

Statistical Characteristics of Data

The mean, standard deviation and skewness of measured and predicted data was calculated to evaluate the fitting of the model in moment preservation. The results of w.t are tabulated. The results of the skewness of predicted data by AR (1) model and measured data is lying between -1 to +1 and therefore AR (1) model give the better results of mean and skewness.

Performance Evaluation of AR(1) model for pre monsoon and post monsoon

The statistical characteristics such as MFE, MSE, were also used to test the adequacy of the model for future prediction with higher degree of correlation to previous measured observations. The different types of errors in rainfall and runoff of the generation of AR (1) model are calculated. The data of the table clearly represents that prediction AR (1) model is giving the best results. Since all the errors are very less. It indicates that AR (1) model can used for prediction of ground water table. The co-relation between the observed and predicted coefficient are (R2 = 0.999) The graphical representation of data shows the strong co-relation between observed and predicted values.

V. CONCLUSION

The first model used for prediction is Stochastic Time Series model in which Autoregressive (AR) models of orders 0, 1 and 2 were tried for annual Ground water table fluctuation and different parameters were estimated by the general recursive formula proposed by Kottegoda (1980). The goodness of fit and adequacy of models were tested by Box-Pierce Portmanteau test, Akaike Information Criterion (AIC) and by comparison of historical and predicted correlogram.. The mean forecast error is also very less. On the basis of the statistical test, Akaike Information Criterion, AIC the AR (1) model with estimate model parameters was estimated for the best future predictions of Ground water table fluctuation at Kaushambi District This is also proved by Graphical representation between historical and generated correlogram, and spectral analysis was shown where in Ground water table there is a very close agreement In case of Ground water table fluctuation there is an effective agreement between historical and generated date with mean forecast error, mean absolute error, mean, mean relative error, mean square error. The regression model between observed and estimated ground water table was developed, and also observed that the correlation coefficient was found to be 0.999. The analysis it was observed that the maximum Standard Deviation data. Consider the normalized data shows that Standard deviation was normalized to maximum. Conclusion it was observed the AR(1) model are most suitable for prediction that was chose to observed normalized value. These of pre validation of PCF ACF are within desired confidence limit.

AR(1) model for water table analysis of was found to be more suitable . The statistical parameter fulfill the ACF was estimated. The model was analyzed and validation was estimated PCF, ACF and spectral analysis and find suitable for future use.

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