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Considering Fluctuations of Stability Level of Underground Water to Improve Water Usage Model in Agriculture Department, Case study: FARS province, ZARRIN DASHT town

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Abstract

This study aims to evaluate and predict stability level of underground water in KHOSVIEH plain located in ZARRIN DASHT town using economic models. In this regard, the approach of the box-Jenkins was used in choosing economic model. After applying remaining tests and various calculations, it was shown that the best model of estimating objective function is time series model of moving stacked correlated average (ARIMA). The data required for this research were collected monthly from data bases of east regional water organization of FARS province "between" (1995-2006). The results showed that the best estimating for modeling and predicting the future values of water stability level is ARIMA (4, 1, and 4). The recent year's values and estimated values of underground water level to 1400 are indicative of an increasing trend. So it's suggested due to dry climate and erratic rainfall in the region, water use patterns in order to increase the amount of water in wells and lower the water stability level, in order to achieve this goal, traditional methods of watering in agricultural part must be revised. In other words, the pattern of water usage in this region must be changed.

Keywords: water stability level, time series, ZARRIN DASHT town.

Introduction

Since human started using water and soil in order to produce food, water issue and right procedure of its usage was of great importance. Over time, with the increasing population and limited sources, the issue of inappropriate usage of limited sources especially water led to a lot of debate among scientists and farmers. Nowadays, innumerable uses of lack of water become such a crisis that the future century can be called the century of war against water resource's possession. One of the main and limiting factors of agricultural development in Iran is water. Water is the most precious wealth of human being especially in our country which is covered by large regions of desert. Considering dry climate of iron and recent droughts, water importance as a vital issue is becoming clear and if water resources aren't planned based on stable development, our country will face UN solving troubles in future. On the other hand, it seems that more than 94 percent of water resources of our country are used in agriculture, section.

ZARRIN DASHT town is located between longitudes of 53 58 46 to 55 01 40 and latitudes of 38 00 31 to 28 36 25 and 62 percent of 462600 hectares of its area is mountains and hilly areas and the rest is plain. This town, which is located in the southeast of FARS province, includes 8 percent of province and 1 percent of the country territory. The most trees found in this town are palm trees in a way that the town is decorated by them and is one of the most popular ones which has different kinds. AMAZSHAHUNY, GANTAL, PERKON, PIAREM, HASHT and...The most important agricultural region is DABIRAN city and the main products are wheat, corn and watermelon, recently, DABIRAN city has become a connecting road between DARAB, LAR, JAHROM and ZARRIN DASHT. Considering its special geological situation, ZARRIN DASHT town is poor with respect to underground resources. As a result of innumerable illegal usages, not only the quantity but also the qualities of these resources were affected noticeably.

In order to recharge these sources of underground water, 25 artificial feeding project were carried out that MAZAYJAN artificial feeding project with the volume 2/100/000 cubic meters is one of the most significant ones implemented.

Materials and Methods

There are a lot of pattern which can explain the role of different factors on one dependent variable (such as water supply and demand). Using this pattern requires needed statistics and these province and monthly statistics are rare. In addition, our main objective in this study is predicting water stoppage level of wells that a multi-variable function like water supply and demand can't be used. And also in order to achieve this prediction, there's no need to use different variable which affect the water stability level of well (however, the effective variables can help to get a more reliable prediction).

Based on this issue and with regard to existing statistics and information, the time series patterns were used to examine the noted variable that the whole mechanism of its implementation will be explained. Time series is a sequence of observations for a given variable which has an unchangeable combination over time. Usages of time series models in comparison with econometric models are more helpful due to the need for fewer variables. Such models are simply made and using them doesn't need prior knowledge about relationships of cause and effect between variables. Explanation or prediction of a time series behavior is impossible using structural model. For example, there may not be any data about explanatory variables which affect the dependent variable. In some cases, while estimating the structural models, standard errors are so big that most coefficients are made meaningless statistically and in result the predicting standard error is increased. And the resulted predictions are not reliable. Considering the noted issues, the relative superiority of time series models over other used models is obvious in function estimation. A time series model contains an integrated moving average random process from the random sequence of {Y_t} with degrees of q and p, is defined as follows:

$$y_t = \text{¤}_1 y_{t-1} + \text{¤}_2 y_{t-2} + \ldots + \text{¤}_p y_{t-p} + \text{¢} + \text{£}_t + {}^{-}{}_1 \text{£}_{t-1} + \ldots + {}^{-}{}_q \text{£}_{t-q}$$

$$\text{£}_t \approx iid(0, \pm_{\text{£}}^{2})$$

The process explained above is shown as ARMA (p, q). By definition, this process consists of two static components including moving average process (MA) of the second part of the above equation and the self-integrated (AR) of the first part. These two parts are distinguished by (δ).

Evaluation of static time series variables

Reviewing procedures and different criteria in determining optimal time series model is with assumption of static (static nature) moving integrated random process. Now if the noted process isn't static, prior to estimate the time series model, it must be insured that the time series is changed to a static series by required changes (such as logarithms and required subtracting). In order to search the static level of a model and time series variable, first the dependent variable average value must be calculated in length of time and then reach to this result that it will change during time. To investigate the stability, the mean value of the dependent variable is calculated from the following model then the necessary and sufficient conditions on the static value of time series model will be proposed.

$$\text{«} = \frac{\text{¢}}{1 - \sim_1 - \sim_2 - \ldots - \sim_p}$$

Considering the above equation, we can investigate the necessary condition for stability of time series variable. If the denominator in the above equation is less than 1, this necessary condition for variable stability exists but other sufficient conditions must be investigated for other variables' stability.

1. **Unit root test or Dickey-Fuller:**

In order to investigate the static variables of time series, a test which is called unit root has become well-known recently that is presented by a person named Dickey Fuller. The phases are so wide that we ignore describing them and the only point to say is that in investigating the stability of a model, if the model has a unit root, means that the coefficient of y $_{t-1}$ in the equation of $y_t = \alpha y_{t-1} + \varepsilon_t \ (y_{t-1}\ on\ y_t)$ Equals 1, then the time series variable is not static and y_t has a unit root. Faced with this issue, the subtracting of time series variable must be done to get static.

If with one process, the time series variable gets static, it will be filled with the value of 1 which is shown I (I). (I stands integration) but if with one function, the variable doesn't get static we have to do the subtracting process for 2 times so the variable is filled with I (2) and if then it doesn't get static – which is rare in predicting time series models – the subtracting process will be done n time so the variable gets static.

2. Dickey fuller generalized test or (ADF):

Static or non-static condition of variables in one study can be investigated by using statistics of generalized dickey fuller ADF. After processing of these statistics, the test will be compared to different levels of related critical values and if the absolute values of the statistic are greater than critical values, the zero assumption based of non-static series will be rejected and the time series variable will be static. Otherwise, if the statistics of generalized dickey fuller test are smaller than critical values, the time series variables are non-static and should become static by subtracting.

3. Correlogram use:

Using this function, in fact we can provide the detailed and the general self-integrated values in a graph in order to find out about static or non-static series. If the values of a series are stopped quickly or degraded relatively fast, the mentioned series will be static or dynamic. But if self-integrating degrades very slowly, the first values of this series will be non-static or non-dynamic. If our data are static, one the best models for estimating and predicting rainfall level, which is our aim in this study will be ARMA model. But if the data are analyzed and are explained in terms of static and non-static or dynamic, the model con not be used any more so the new model named ARIMA (self-integrated moving mean model) is suggested. It's clear that a dynamic process is resulted from a number of changes called subtracting a non-static series. The mentioned model with p, d, q is shown as ARIMA (p, d, and q). That d is the number of subtracting the non-static series. The ARIMA (p, d. q) for variable X can be shown as the following equation:

$$Y_t = f(t) + \sum_{i=1}^{p} \phi_i y_{t-i} + \sum \theta_j \varepsilon_{t-j} + \varepsilon_t$$

$$y_t = \Delta^d x_t = (1-L)^d x_t$$

Where:

F (t) will estimate the time process (if exists). In most economic variables, d= 1 which is the result. It should be noted that if d=0 then ARIMA process will change to ARIMA process. After investigating the static condition of the model using (the static value of water level in well) is non – static. According to the best model for estimating the parameters and predicting future values. To determine the optimal time series model, the Box- Jenkins method was used. The whole phases by Eviews5 software. The required data for this study were collected monthly from April 1995 to July 2006 out of eastern regional water organization database of Fars province.

4. Box- Jenkins methods for time series modeling:

Consider a sequence of a static time series y_1, y_2, y_3… y_t. The goal here is to derive a model which could be generated by the series and can be used to forecast the future values of the series. A specific method for modeling linear time series was presented by Box- Jenkins in 1970 and subsequently was used widely statisticians, engineers and economists. Box- Jenkins method for modeling static time series is based on the simple, principle of coding (principle of parsimony). This means that among few models which satisfactorily fitted the data, the model with minimum number of parameters is preferable. This preference of simpler models to more complex ones has several advantages. First, with choosing the simpler model, parameter estimation accuracy is increased, second, with a simple model, model multiplicity is avoided. Box- Jenkins method isn't based on an optimal measure. This modeling approach includes three steps as follow:

1-Identification: in this stage, several models are selected from the group of ARIMA model, means that with considering the self – integrated functions, sample values for q and p are determined.

2-Estimation: in this step, models (or models) that had been chosen for the first processed on the data and its parameters are estimated.

3-Diagnostic checking: In this stage, this satisfactory condition of the model (or models) that had been chosen in the first round and had been estimated in the second round, are evaluated. This assessment is based on criteria that are intended for the same purpose (1).one of the most important steps in determining the optimal model in the third stage which means inspection and diagnosis.as it is noted as a tool to assess the economic criteria. After identification and estimation of different model (models) the most satisfying and the simplest model is selected. That's why some criteria for comparing models and choosing the final model have been proposed by researchers. Each of these criteria is searching for an optimal solution among fitting and simple models. Processing is measured in terms of the most fitted function. Simplicity of the model is determined by a number of estimated parameters. The difference between these standards is due to importance that each of them reduces the number of parameters.

5. **Akaike criterion (AIC):**

The Akaike data criterion is explained as follows:

$$AIC(m) = T\log \hat{\sigma}^2{}_m + 2m$$

In this equation, T is the number of effective observation and $\hat{\sigma}^2$ is ML estimate from the troubled sentence variance.

6. **BIC criterion Akaike**

Some studies have shown that AIC criterion ranks the self – integrated value more than the actual amount. So Akaike presented another criterion named Bayesian information criterion (BIC).

7. **SBC Schwarz Criterion:**

That is known as Schwarz Bayesian Criterion.

8. **CAT PARZAN Criterion**

PARZAN presented the following criterion to select the number of optimal parameters of a self – integrated model and named is as criterion for Autoregressive transfer (CAT). For a time series, these criteria may lead to different results. Often in the researches, AIC, SBC criterion is used for model selection.

9. **HQC (Hannan – Quinn criterion)**

These criterions which at first were suggested for selecting the degree of self – integrated moving mean models (ARMA) and self – regressive models (VAR) is defined as follows:

$$HQC(m) = \log \hat{\sigma}^2{}_m + \left(\frac{2\log\log T}{T}\right)m$$

Among the three criterion of AIC, SBC and HQC, the simplest model (with the minimum estimated parameters) which is SBC, determines T >=8. Bester AIC pays least attention to simplicity. Regarding this issue, HQC criterion is placed between these two.

Under specific condition, it can be shown that HQC and SBC are adaptable, means that in great models they lead to selection of correct model. Of course the correct model must be one of the models under consideration. Adaptability characteristic doesn't exist for AIC criterion. But it doesn't mean that SBC or HQC criteria are necessarily preferable compared to AIC because the investigating system hardly ever contains the correct model.

Results and Discussion

As stated earlier, the purpose of this study was to evaluate and predict the water stability in the wells of KHOSVIEH plain in ZARRIN DASHT town.

In this regard, the statistics of water stability measuring of this region was the basis of this study. Table 1 Show the alluvial characteristics related to KHOSVIEH plain and table 2 shows the basic data including the annual average, maximum and minimum values of water level during a water period.

Table (1) alluvial characteristics of KHOSVIEH plain

Elevation point marks (m)	Alluvial aquifer	The area of plligon (Mari km)	U.T.M X - Y	name
1029.248	DASHT KHOSVIEH	14.4	3160756 - 244237	KHOSVIEH

Source: eastern regional water organization of FARS province.

Table (2) the statistics of level of water stability in ZARRIN DASHT town between 1995 of 2006 (meters)

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
MAEN	10.16	8.49	9.77	11.09	11.95	14.84	20.12	26.68	28.49	29.10	29.23	34.18
MAX	11.74	9.19	11.72	12.85	13.77	15.74	22.8	29.97	29.2	31.27	30.97	36.95
MIN	8.68	7.68	8.24	9.17	10.56	12.47	15.2	22.8	26.7	26	28.11	31.16

Source: eastern regional water organization of FARS province.

The following chart shows the changes of water-level in well from Farrar din 1995 to July 2006. The horizontal axis indicates year and the vertical axis indicates water-stability level (in meters).

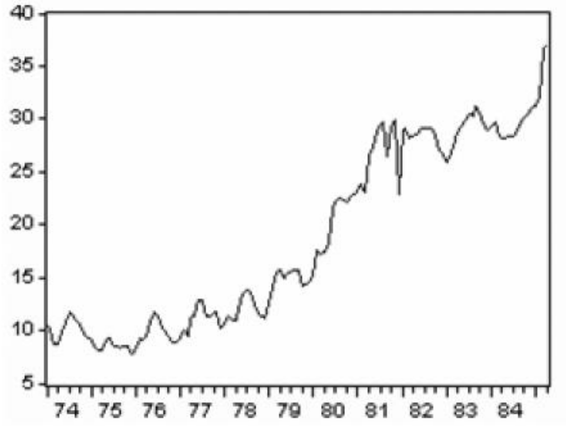

Figure 1. Monthly series changes of water-stability level between 1995-2006 (in meters)

For investigating the stability of the above time series model unit root test was used that tested two criteria: SBC and AIC. The results of dickey fuller test for water stability variable is shown in table 2 (the test equation is not included) and in table 3 (the test equation is included).

Table (3). Unit root test for stability level variable without test equation.

SBC	AIC	The test statistic	(d)
3.38	3.34	0.19	*ADF(0)*
3.37	3.33	-13.29	*ADF(1)*

Source: research findings. The numbers in parenthesis is the order of subtracting (d). Critical numbers of %5.1 and %10 for generalized dick-fuller statistic (ADF) are respectively -3.47, -2.88 and -2.57

Table (4) - unit root test for stability level variable with test equation

SBC	*AIC*	The test statistic	(*d*)
3.35	3.29	-2.74	*ADF(0)*
3.39	3.33	-13.39	*ADF(1)*

Source: research findings. The numbers in parenthesis is the order of subtracting (d) the critical numbers of %5.1 and %10 for generalized dickey-fuller stability (ADF) are respectively -4.02, -3.44 and -3.14.
As it is noted in the second condition of sufficient ones for stability tests, it the absolute number of statistic of ADF in critical values are bigger in levels of 1 or 5 or 10 percent the model is static. In view of this and the results of static test (dickey-fully unit root test) it was shown that in the equation with trend (table4) and without trend (table 3). The stability of model with one subtracting (ADF 1) can be done, so the numerical value of d for entering into the final form of ARIMA model (p, d, and q) is equal to 1. Now, we consider identifying pauses of moving mean sentences (q) and self-integrated (p) of time series model. Since there can be different models for determining the optimal time series model.so the table of AIC. SBC values are planned in order to select the best one with the least parameters based on bon-Jenkins method. For this purpose, we review various models of ARMA (p, q) for p, q= 0, 1, 2, 3, 4.

Table 5- AIC values in estimates model ARMA (p, q)

p\q	0	1	2	3	4
0	7.18	6.77	5.30	4.77	4.52
1	3.34	3.33	3.34	3.32	3.31
2	3.34	3.34	3.31	3.32	3.33
3	3.33	3.30	3.34	3.33	3.31
4	3.33	3.34	3.36	3.33	3.19

Source: research findings.

Table 6- SBC values in estimates model ARMA (p, q)

p\q	0	1	2	3	4
0	7.20	6.81	5.36	4.86	4.62
1	3.38	3.39	3.42	3.43	3.44
2	3.40	3.43	3.42	3.45	3.48
3	3.42	3.41	3.48	3.48	3.48
4	3.44	3.47	3.51	3.50	3.39

Source: research findings.

In AKAIKE values table (table 5), ARMA (4, 4) model and in Schwartz values table (table 6), and ARMA (0, 1) model allocated the least values to themselves in comparison to the others. It's worthy to note that in Schwartz values table, ARMA(4,4) model is placed in the second rank, that after studying the research statistical results, it was shown that this model has much better results than ARMA(1,0). So, in two cases, ARMA (4, 4) can be suggested as the final model for determining the ranks of q and p. earlier, d (the subtracting) was equal to one. Provided with 3 ranks of d, q and p, the final model of stability level can be presented as ARIMA (4, 1, 4). After computing the estimated function model of final time series, rainfall level was as follows: the F statistic for estimated regression is 919.17 and this amount is confirmed by validity of validity of 99 percent statically.

This high value of F statistic indicates the high level of the whole regression. The fixed component of regression wasn't meaning full statistically but between all rounds, six of them with possibility of 1 percent (certainty of %99) were statistically meaning full. The calculated statistic of this regression was 0.98. It means Thant the interrupted time series were able to define %98 of changes in rainfall level simultaneously. Dorbin-watson statistic of this regression was calculated nearly 2 which indicates the absence of self-integration in this model.

Now after determining the optimal model and considering the statistical values, this model can help to predict the future values of water-stability level in regional wells which was the objective of this study. The predicted values are considered to 2021. The predicted values of rainfall level fan are seen in the following table.

Table 7- the predicted values of water-stability level in wells of KHOSVIEH to 2021 (In meters)

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
mean	41.2	45/8	50.9	56.4	62.5	69.1	76.3	84.2	92.7	102.1	112.4	123.5	135.7	149.1	163.6

Source: research findings.

The graph of these changes will be shaped as a that indicates the accurate changes in predicted values. These changes can be seen in figure 2.

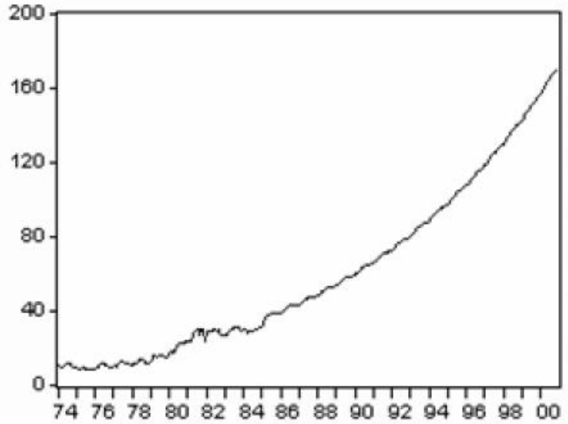

Figure 2- the predicted values of water-stability level in wells of KHOSVIEH of March of 2021

As the graph above shows, the water-stability level of a well changes with an uprising trend and says that in the future, this level increases. The consequence is that reaching underground water will get more difficult and result in increasing costs of digging wells.

Suggestions

- Changes in cropping patterns and removal of plants such as corn because they need lots of water.

- Use of smart watering systems such as electric pumps which are able to water the agricultural lands in due course and in accordance of water organization's standards.
- Changes in usage pattern by farmers and holding classes in order to teach optimal water usage.
- Desert removal, planting drought-resistant plants and artificial forests.

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