Utilization Water Management in Rice Planting Next Time by Using ARIMA Model for Northern Thailand

Pornvimol Klongsangson[1,*], Chalermchai Puripat[2], Preecha Khrueasom[3]

[1]Applied Statistics Program, Faculty of Science, Udon Thani Rajabhat University, Thailand

234 M.12 Tumbol Sam Phrao Amphoe Mueang Changwat Udonthani, Thailand

[2]Kasembundit University, Bangkok, Thailand

[3]Dhonburi Rajabhat University, Bangkok, Thailand

email: pornvimon,kl@udru.ac.th

Abstract. Despite the possibility that there are main approaches in water management, utilization in agricultural rice planting is very important for the improvement agricultural production and increasing of the product per Rai(area) for farmer. Water is essential for the growth of rice and is beneficial for directional control. If the rice receives a little amount of water, it affects the growth of the rice and the growth of risk is low. The data of the rice production and the prediction of amount water were already influenced by various environmental factors, so the ARIMA forecast advantage would be under that factor. The data used in this research was the average monthly rainfall from the Hydrology and Water Management for Northern Region - Royal Irrigation Department during January 2014 to December 2018. The time series data were divided into two categories. The empirical study revealed the best ARIMA validated model to be used to forecast future values for the next years. Even though such approach mainly helps knowledge water data or forecasting future points, after the steps of identification, estimation and verification followed here to build the suitable ARIMA model, the results are understanding water managements and the foresight of the causes that may influence what will happen next to the rice product of Thailand.

Keywords: water management, ARIMA, knowledge water data.

Introduction

The amount of rice in each year of Thailand would be forecasting example modules generally utilize Box-Jenkins Model [1] as prototypes for more precise results by researcher. Pointing, Known and widely had used method for forecasting time series data of rice plantings of Northern Thailand. The ARIMA model by Box-Jenkins Techniques is a recent methodology that focuses on the study of problems involving time series information each rice growing season. This methodology is therefore suitable for forecasting amount of water in the North of Thailand because of scarcity of data. The Irrigation Department deals with uncertain systems with partially known information through gathering useful information and whatever data available. In this way, systems' operational behaviors [3] and their evolution can be correctly described and effectively monitored. Therefore, in this research, it is interesting to compare the two forecasting methods by applying them to the actual data, namely, rice cultivation during the five years period. Which is the agricultural export that generates the most income for Thailand. The forecasting model developed time series analysis, which could offer an innovative and more effective statistical technique in the time series data of rice plantings of Northern Thailand. The main aim of this study may be to develop a suitable model to determine time series data of rice plantings of Northern Thailand accurately in northern Thailand. Such a prototype would tremendously improve the water management and the irrigation of Thailand, which had been ineffective through a lack of information of unpredictable water shortage each year. (Royal Irrigation Department of Thailand) The amount of water northern Thailand [8] in the forecasting method can then be useful not only for agriculture but also the water management countrywide.

The Case study of Chaingrai, Maehongson, Nan had problem rare water in region. When there is a lack of water, the soil for cultivation loses moisture and the plants cannot sustain lives, causing disruption to their growth. The harvest will be well below the expected quality and the quantity will also diminish. Mostly, the drought affects agriculture during the months of dry season usually from January to May before the rainy season occurs with a long period of rain. We may not be able to rice in the dry season. The land that is most severely affected by shortage of water is in the Northern, where most districts are area characterized by mountain ranges, valleys, and mountain land of basins, where water cannot be maintained and the main reason why this part of Thailand that water shortage in agriculture (Department of Mineral Resources, The Ministry of Natural Resources and Environment of Thailand) by means of ARIMA model will be the new ideal model for anticipation of rice product in Thailand.

Materials and methods

Although amount water is seen as an extremely important, cultivated during the growing season, rice yield per area is common in northern Thailand [7]. Rice is the most important agricultural product. The importance of the upper northern provinces in the growing season of 2014to 2018. The provinces cover an area of approximately 2,536,258 rai, yielding 1,487,506 tons, which is estimated to be 1,212,728 tons of glutinous rice, or about 81.5% of the total rice yield. Most of the rest are jasmine rice and some are pure white rice, keeping the average price of paddy in the province in good condition because glutinous rice and jasmine rice are more expensive than white rice grown in the central region. It occupies about one-fifth of the rice field. and most of the produce is plain white rice. It accounts for about 15% of the total secondary rice production. Furthermore, if you think of the total glutinous rice production in the country, which is estimated about 7.3 million tons, this area is responsible for about one-fourth of the country's glutinous rice production.

Table 1 Rice production [Ton] Year 2014 – 2018

Provinces	2014	2015	2016	2017	2018	Average
All production	7,816,734	6,801,718	7,137,534	7,209,510	7,847,727	7,362,645
Chiang Rai	336,962	653,588	668,575	661,539	714,114	606,956
Lampang	224,381	278,834	275,846	225,748	228,456	246,653
Phayao	70,840	196,160	217,980	307,144	322,992	223,023
Lamphun	282,592	61,971	70,955	71,880	65,244	110,528
Chiang Mai	68,675	262,959	269,825	267,562	273,952	228,595
Mae Hong Son	112,100	60,584	66,512	68,504	75,776	76,695
Tak	768,639	87,351	90,979	116,795	135,859	239,925
Kamphaeng Phet	577,418	683,801	705,914	673,632	689,886	666,130
Sukhothai	154,402	414,427	534,346	499,245	543,793	429,243
Phrea	115,087	145,505	157,287	163,927	169,824	150,326
Nan	361,239	104,915	114,372	137,518	141,049	171,819
Uttaradit	782,776	244,069	322,086	334,022	320,584	400,707
Phitsanulok	963,196	715,247	747,444	723,701	773,435	784,605
Phichit	715,448	875,905	919,785	876,596	1,041,351	885,817
Nakhon Sawan	1,355,321	1,192,895	1,104,562	1,182,867	1,425,335	1,252,196
Uthai Thani	334,940	272,976	288,128	311,759	325,336	306,628
Mean yearly	884,750	767,818	805,419	813,644	887,924	831,911

Source: Office of Agricultural Economics (Refer to the Development Plan of the Upper Northern Provinces Group (2015-2018) Part 2 page 12)

The empirical data able to determine the relationship equation of rice yield (tons) of the provinces. It describes the trend of change in in-season rice production (tons Unit) that has increased by year or period, which tends to fluctuate continuously. The equation of rice yield changes according to the time series of the northern Thailand. Farmers' rice cultivation indicates changes and estimates of planting areas and rice yields, season 2014/2018. Therefore, the necessary factor for cultivation rice is the amount of water used in each growing season.

Table 2 Amount water of Northern Thailand Until Year 2014 – 2018

Monthly/ Yearly	2014	2015	2016	2017	2018	Average
January	119	134	118	178	178	145.4
February	98	94	83	95	114	96.8
March	86	92	67	52	128	85
April	88	106	46	129	180	109.8
May	182	127	199	210	265	196.6
June	209	149	279	209	605	290.2
July	728	353	799	1,163	1,639	936.4
August	1,095	944	1,919	1,102	1,920	1396
September	1,287	812	1,408	1,167	1,272	1189.2
October	431	619	630	885	494	611.8
November	262	215	242	267	239	245
December	127	171	143	208	166	163

Source: Royal Irrigation Department, prepared by: Water Resources Informatics Institute

The Box-Jenkins Analysis were referred to a systematic method of identifying, fitting, checking, and using integrated autoregressive, moving average (ARIMA) time series models (Time series analysis: George E.P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, Greta M. Ljung, 2016.). The method is appropriate for time series of medium to long length (at least 50 observations). The overview of the Box-Jenkins method is presented, concerning the how-to parts rather than the theory, most of which is summarized from the landmark book on time series analysis written by George Box and Gwilym Jenkins (1976). A time series is a set of values observed sequentially through time. The series may be denoted by $x_1, x_2, \ldots, x_t$, where t refers to the time period and refers to the value. If the x observations are exactly determined by a mathematical formula, the series is said to be deterministic. If future values can be described only by their probability distribution, the series is said to be a statistical or stochastic process.

Autoregressive Integrated Moving Average (ARIMA) Models [1,2,3]

In statistical modeling, we are often engaged in an endless pursuit of finding the difficultly solution in fact relationship between certain inputs and the output. Therefor understanding put by the quote of this chapter, these efforts usually result in models that are nothing but approximations of the " fact " relationship. This is generally due to the choices the analyst makes along the way to ease the modeling efforts. A major assumption that often provides relief in modeling efforts is the linearity assumption. A linear filter, for example, is a linear operation from one time series X_t to another time series Y_t.

Auto Regressive (AR(p))

The Auto Regressive model is a format that shows that y_t observations are determined from the value of the Auto Regressive model as $y_{(t-1)}, y_{(t-2)}, \dots, y_{(t-p)}$ model and the previous observations p by the process or AR system (p) are the Auto Regressive process or system with p-rank can be written in the form of an equation (1);

$$x_t = \mu + \emptyset_1 x_{t-1} + \emptyset_2 x_{t-2} + \cdots + \emptyset_p x_{t-p} + \varepsilon_t \quad (1)$$

Where

μ = Constant Term
$\emptyset_j$ = $j = 1,2, \dots, p$
x_{t-p} = the previous time(t) of observations p
ε_t = error of time(t)

For example of AR(1) as equation

$x_t = \mu + \emptyset_1 x_{t-1} + \varepsilon_t$
$x_t(1 - \emptyset_1 B) = \mu + +\varepsilon_t$ (B as Backward shift operation)
AR(2) as $x_t = \mu + \emptyset_1 x_{t-1} + \emptyset_2 x_{t-2} + \varepsilon_t$
$x_t(1 - \emptyset_1 B - \emptyset_2 B^2) = \mu + +\varepsilon_t$

Moving Average (MA(q))

The Moving Average (MA) model is a model showing thaty_t observations were determined from the error of time as $\varepsilon_{t-1}, \varepsilon_{t-2}, \dots, \varepsilon_{t-q}$ or the error of time preceded by the process. This MA (q) system is a process calculation or a moving average system with q rank written in the form equation of MA (q) show in equation (2);

$$x_t = \mu + \varepsilon_t - \emptyset_1 \varepsilon_{t-1} - \emptyset_2 \varepsilon_{t-2} - \cdots - \emptyset_q \varepsilon_{t-q} \quad (2)$$

Where

μ = Constant Term
$\emptyset_j$ = $j = 1,2, \dots, q$
x_t = the previous time(t) observations
ε_t = error of time(t)

MA (1) is written form equations.

$x_t = \mu + \varepsilon_t - \emptyset_1 \varepsilon_{t-1}$ or $x_t = \mu + \varepsilon_t(1 - \emptyset_1 B)$

Auto Regressive Moving Average (ARMA(p,q))

The Autoregressive Moving Average (ARMA) model is the one that takes the Autoregressive and Moving Average processes are combined by a process or system. ARMA (p, q) is an Autoregressive process or system with a rank p and Moving Average. Sequency of the q-order, which can be written in the form of the equation as ARMA (p,q) show in equation (3);

$$y_t = \delta + \emptyset y_{t-1} + \emptyset y_{t-2} + \cdots + \emptyset y_{t-p} + \varepsilon_{t-1} - \theta_1 \varepsilon_{t-1} - \ldots - \theta_q \varepsilon_{t-p} \quad (3)$$

Where

y_t = The observations in the time series at time(t)
p = Autoregressive ranks
q = Moving Average
δ = Constant Term
t = The time series at time
$\emptyset$ = Parameters of Autoregressive.

θ_q = Parameters of Moving Average.
ε_{t-p} = The white noise process, which is the discrepancy at time t.

Integrated (I(d))

Integrated process (I (d)) is the difference of time series between the data. The current and the back-to-d data period by the cause of the need to find the difference of the time series. This is because the ARIMA model is required to analyze time series data with constant properties. only Stationary, in the case of derivative data, the time used for analysis is not stable in Nonstationary process, such data must be converted to stable data first. We are calculated to find the difference of the time series data before implementing the ARIMA model. And Shown in the form of equations form general, if necessary show in equation (4);

$$I(d);\ \Delta_d x_t = \Delta_{d-1}(x_t - x_{t-1}) = (1-B)^d x_t \quad (4)$$

Determine equation

$$I(1);\ \Delta_1 x_t = (x_t - x_{t-1}) = (1-B)x_t$$
$$I(2);\ \Delta_2 x_t = \Delta_1(x_t - x_{t-1}) = (1-B)^2 x_t$$

Autoregressive integrated moving average model (ARIMA)

Autoregressive integrated moving average model is determined from various details as mentioned above, if using the model Autoregressive, the moving average model, and the integrated process can be used to define the general model of the ARIMA model used in the estimation ARIMA (p,d,q) model show in equation (5);

$$\Delta_d y_t = \delta + \emptyset\Delta_d y_{t-1} + \emptyset\Delta_d y_{t-2} + \cdots + \emptyset\Delta_d y_{t-p} + \varepsilon_t - \theta_1\varepsilon_{t-1} - .. - \theta_q\varepsilon_{t-p} \quad (5)$$

Where

y_t = The observations in the time series at time(t)
p = Autoregressive ranks
q = Moving Average
δ = Constant Term
t = The time series at time
$\emptyset$ = Parameters of Autoregressive.
Δ_d = The difference so that the time series of d
d = The times of finding a difference so that the time series is stationary.
θ_q = Parameters of Moving Average.
ε_{t-p} = The white noise process, which is the discrepancy at time t-q.

The components of the ARIMA model mentioned above. Before creating a model, it is necessary to understand the subject matter. Autocorrelation Function and Partial Autocorrelation Function which details the function.

Autocorrelation Function (ACF)

Autocorrelation Function is a function of the correlation measurement between the t (x_t) time data and the tk (x_{t-k}) time data of the interval. The time difference k, which is denoted by the symbol ρ_k or r_k. In the case of self-correlation of the sample which can be calculated as show in equation (6);

$$\rho_k = r_k \frac{\sum_{t=k+1}^{n}(x_t-\bar{x})(x_{t-k}-\bar{x})}{\sum_{t=1}^{n}(x_t-\bar{x})^2}, k = 1,2,3 \ldots n \quad (6)$$

$$\bar{x} = \frac{\sum_{t=1}^{n} x_t}{n}$$

Standard error of r_k

$$se_{r_k} = \frac{1}{\sqrt{n}}$$

The self-correlation of the random data has an approximate sampling distribution. Therefore, normal distribution with the mean (mean) equal to zero and the standard error shown equation as $\frac{1}{\sqrt{n}}$

It uses self-correlation as an important tool for detecting properties of the empirical time-series data. if there is a value different from the zero and by using the Standard Normal Distribution or use the Box-Pierce Q statistic, which has the following format.

Standard Normal Distribution show in equation (7);

$$r_k \sim N\left(0, \frac{1}{\sqrt{n}}\right) \tag{7}$$

Box-Pierce Q statistic

$$Q = n\sum_{k=1}^{m} r^2 \sim \chi^2\,(m-p-q)$$

m = the maximum delay or last value (Maximum Lag)

Partial Autocorrelation Function (PACF)

PACF is giving consideration to the correlation between the variables x_t and x_{t-k}, it is possible that such correlation so result of the correlation between these two variables and the variable $x_{t-1}, \dots, x_{t-k+1}$, therefore, in order to obtain The correlation between $x_t$and x_{t-k} eliminates the association between the two variables and the $x_{t-1}, \dots, x_{t-k+1}$, accordingly, the correlation of the two variables must be measured in the form of conditional correlation of $Corr(x_t, x_{t-k}|x_{t-1}, \dots, x_{t-k+1})$.This is called partial autocorrelation, represented by the symbol $\emptyset_{kk}$, but if some self-correlation is taken into account in the form of a function, it is called $\emptyset_{kk}$ as show in equation (8);

$$\emptyset_{kk} = \frac{Cov[(x_t - \hat{x}_t)(x_{t-k} - \hat{x}_{t-k})]}{\sqrt{Var(x_t - \hat{x}_t)}\sqrt{Var(x_{t-k} - \hat{x}_{t-k})}} \tag{8}$$

Where $\hat{x}_t = \beta_1 x_{t-1} + \beta_1 x_{t-2} + \dots + \beta_1 x_{t-k+1}$

Results and Discussion

Climate variation and change of northern Thailand: This analysis required a detailed investigation of the planting and water use data allowing the researchers to deal with anomalies or less useful information. Table 1 and 2 respectively show the Rice production and amount water data of northern Thailand.The selection of rice varieties for cultivation in the highlands and river plains requires the Department of Agriculture to develop the rice varieties to be suitable for the area and the limited amount of water each year.

This step is to estimate the parameters of the autoregressive and moving average terms included in the model. The estimation is handled here by statistical Model.[3,4]

At this step we check that model is fit to the data, obtain residual, obtain ACF and PACF of residual, and apply different tests for diagnostic in order to validate the models and then to chose the best of them. One simple test of the chosen model is to see if the residuals estimated from this model are white noise; if they are, we can accept the particular fit; if not, there is evidence of autocorrelation of errors, we need to go back to the identification stage and re-specify the model, by adding more lags.

Finally, the first difference of Predictorsturns out to be a stationary process, because the Augmented Ljung-Box Q Fuller test confirms that we can reject the null hypothesis that the first difference R-square has a findind root at the 5% significance level. The next stage is to determine the p, d and q in the ARIMA (p, d, q) model.

Table 3 Model Statistics

Model	Number of Predictors	Model Fit statistics			Ljung-Box Q(18)			Number of Outliers
		Stationary R-squared	R-squared	MAPE	Statistics	DF	Sig.	
Model_1	1	.520	.928	8.253	21.723	15	.115	0

Identification/Specification through: ACF and PACF This step is to find out the appropriate values of p, d, and q using correlogram and partial correlogram and Model Fit statisticsTest. After we have estimated more models, the correlogram allows us to determine the possible candidates ARIMA (p,d,q) models. One of the candidates is the amount water and rice yield Model Type ARIMA (1,0,0) form table 3,4.

Table 4 The average and monthly rainfall of Northern Thailand in 2014 – 2018 of ACF and Residual PACF

Lag	ACF	SE	PACF	SE
1	.395	.097	.395	.097
2	.035	.111	-.143	.097
3	-.095	.111	-.066	.097
4	-.195	.112	-.149	.097
5	-.279	.115	-.184	.097
6	-.378	.121	-.280	.097
7	-.231	.131	-.059	.097
8	-.163	.135	-.210	.097
9	-.040	.137	-.079	.097
10	.106	.137	-.049	.097
11	.324	.138	.168	.097
12	.444	.145	.186	.097
13	.309	.157	.097	.097
14	.056	.163	-.071	.097
15	-.200	.163	-.166	.097
16	-.172	.165	.071	.097
17	-.129	.167	.113	.097
18	-.225	.168	-.049	.097
19	-.184	.170	.020	.097
20	-.086	.172	-.013	.097
21	-.073	.173	-.177	.097
22	.108	.173	.105	.097
23	.268	.174	.056	.097
24	.346	.177	.086	.097

Source: Calculation form SPSS VERSION 22 [9]

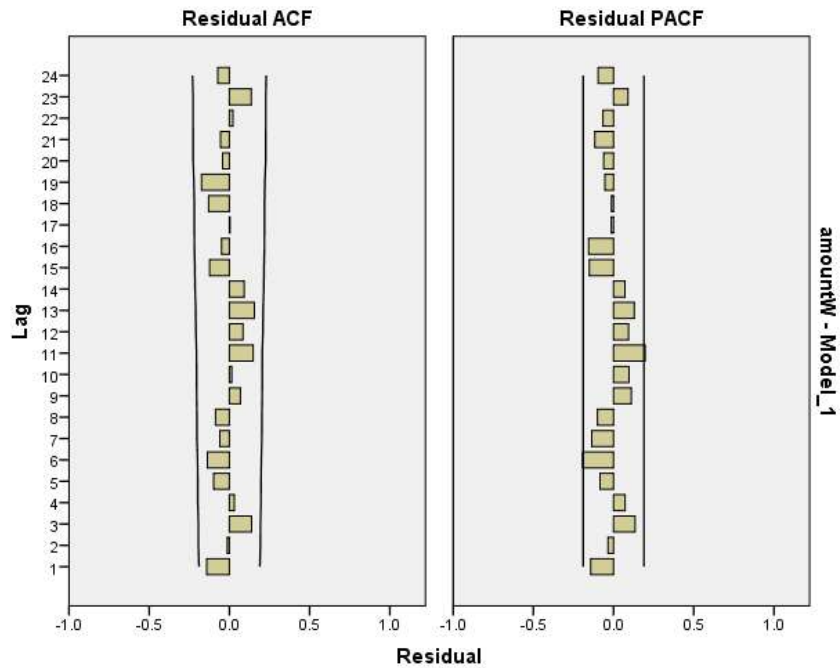


Figure 1. Analysis ACF and PACF of Amount water variations.

Relationship between amount water variations: ACF and PACF analysis [3,4] were used to analysis the relationship between planting and amount water for Northern Thailand. Essentially, long term data can be characterized by major variation frequencies and this is clearly shown in the following graphs. Once identified, the frequencies were preparing to periods, interestingly showing the same period for all locations. Figure 1 shows the ACF and PACF of Rice production and amount water of the study high land and all provinces show a cycle of 2 years (5-6 years) in both Rice production and amount water time series. The figure refers to planting and the ACF and PACF to water use for each of the respective Northern Thailand.

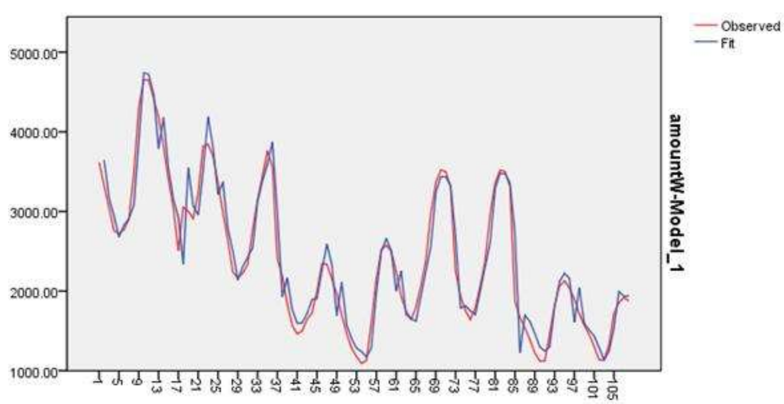


Figure 2. Graph of Amount water of yearly.

Selection of the Model If there are more than one forcasting models validated for the same time series, we can choose the best of them corresponding with the decreasing value of the amount waterInformation where the amount water characterize the quality estimation and The standard error (SE) is a key penalty. Finally we choose to forcast the model with the lowest amount water, that is the ARIMA(2,1,1) model. The same forecasts of the xˆ_t, for the next period reveal a constant tendency of the time series values for the next sixth years. Although, the mean absolute percent error had not changed, a measure often used to assess the accuracy of forecasting as same Fig. 1 Fig. 2, and also for future comparing reasons as follwing show in equation (9);

$$\hat{x}_t = 1.445x_{t-1} - 0.5148x_{t-2} - 0.05696x_{t-3} + 3321.6 \quad (9)$$

Table 5 Model Rice product

			Model Type
Model	Rice product	Model_1	ARIMA(1,0,0)

Table 6 Residual ACF

Model		ACF	SE	PACF	SE
rice product - Model_1	1	.128	.316	.128	.316
	2	-.227	.321	-.248	.316
	3	-.554	.337	-.527	.316
	4	-.013	.418	0.51	.316
	5	.068	.418	-.216	.316
	6	.196	.419	-.129	.316
	7	-.039	.428	-.083	.316
	8	.015	.429	-.051	.316
	9	-.074	.429	-.081	.316

Source: Calculation form SPSS VERSION 22 [9]

The test leads to the acceptance of the null hypothesis of non autocorrelation of errors form table5,6. The same conclusion is reached also if it was observed that the autocorrelation functions ACF and partial autocorrelation PACF are similar to those computing of using Lag2 process.

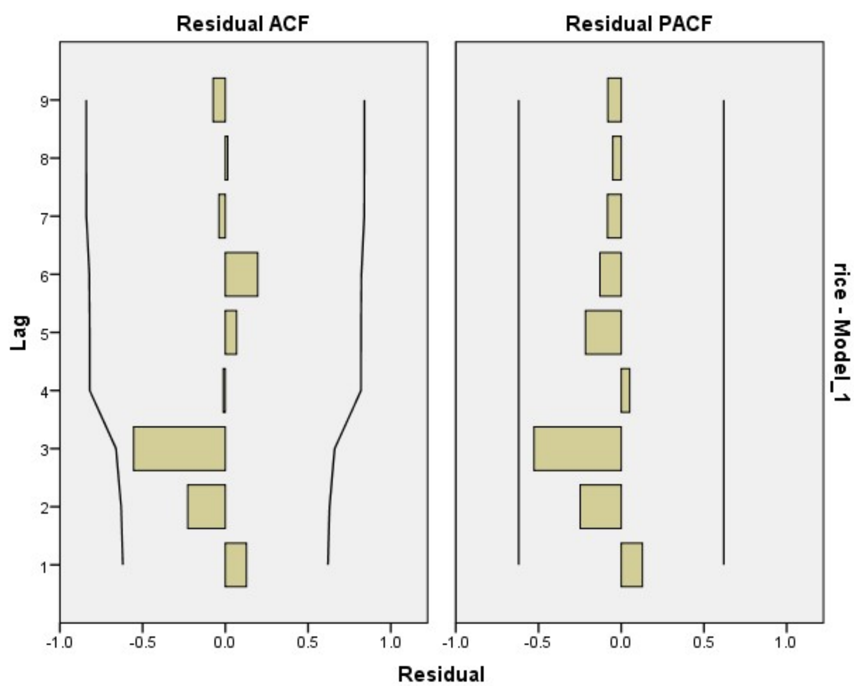


Figure 3. Residual Rice production and amount water variations.

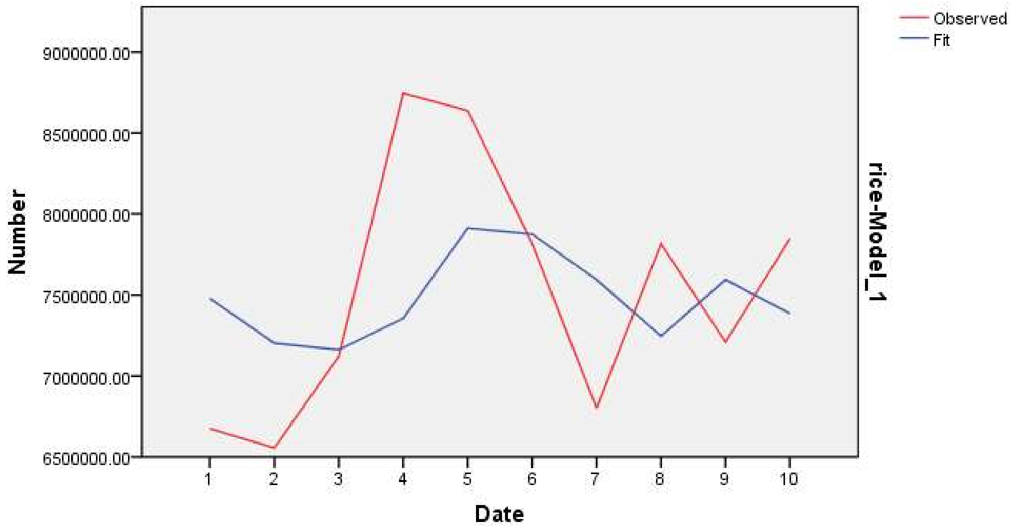


Figure 4. Graph of Residual Rice production.

Solution of the ARIMA model if there are more than one forcasting models validated for the same time series, we can choose the resultes of them corresponding with the increasing value of the rice product area information and the amount water as limited and the quality estimation of rice as well as checking method form the standard error (SE) may be a key pecising about forecasting. Finally we choose the model with theRice product, that is the ARIMA(1,0,0) model. The forecasts of the $\hat{x}_t$, for the next period reveal a constant tendency of the time series values for the next sixth years. The mean absolute percent error, a measure often used to assess the accuracy of forecasting, and also for future comparing reasons as follwing show in equation (10);

$$\hat{x}_t = 0.269x_{t-1} - 0.26679x_{t-2} + 7663984 \quad (10)$$

Conclusion

The first goal of the study was to determine whether recent climate variations in Northern Thailand are in anyway unusual in the context of the 5-6 years of Rice production and amount water records. All amount water in dam northern Thailand has been below average during 2009-2018 but this does appear to be stable rice product than years per but amount water as low, much and infirm almost ever years.

The second goal of this study was to determine if rice production and utilization amount water variations [8] in northern Thailand area over the past century could be described by relatively big problem relationship of trend. Both fact finding rice production and suitable water range appeared to vary coherently in the study planting of northern zone. How solution forecasting and relationship found reply to planting an increasing rice production [7] and had limit of amount water each year for agriculture. The results can be up-dated normally from now on therefore providing a useful new tool for monitoring climate variation and change in this part of Thailand. The periodic nature of planting and water use may have important implications for climate change over the years along the high land of northern Thailand. We had disaster about flood so heavy in 2011. More particularly, Prediction of amount water was noted to be inversely related to northern plant in every season. Pointing, the lower Standard error is associated with rice product as lower quality and amount water as limited and low. The relationship between rice planting and use water has been high and unstable over the record period. This research paper explains the result of the study of management of amount water [5,6] used in upstream supply chain of rice and maize in Thailand [7] in sequential production. The data collection collected from selective farmers and middlemen in various provinces in North regions of Thailand. The some paper also studied the efficiency and value added of used new tools and also summarizes relevant policies which impact to the agricultural area and water cost in Thailand dam[8] each year.

Suggestions

We can choose the more other the ARIMA(p,d,q) model by considering there are other factors out of control and may influence our forcasting model such as meteorological data , Irregular weather , the forest area etc. Including extensive study of the data of the rice production and the prediction of amount water management in Thailand.

Acknowledgement

Authors thank Director of Hydro – Informatics Institute (Public Organization), National Hydroinformatics Data Center, Thai Rice Exporters Association (Thailand), for providing all the help for performing this study. Applied Statistics Program, Faculty of Science, Udon Thani Rajabhat University for their financial support.

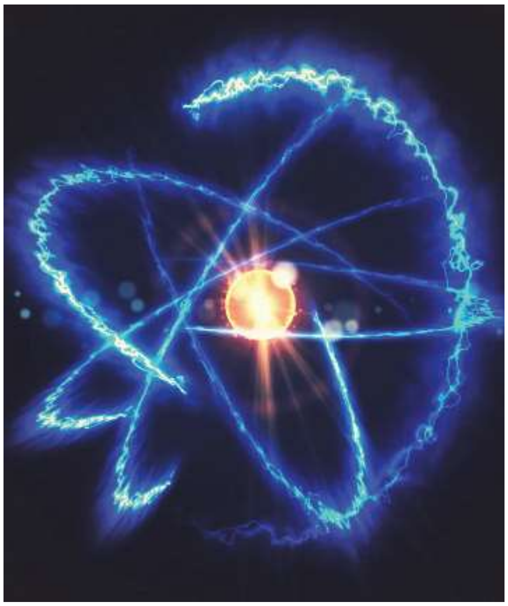
References

[1] B. Abraham, J. Ledolter, Statistical Methods for Forecasting, New York, John Wiley, 1983.
[2] P. Burridge, K.F. Wallis, Prediction theory for autoregressive-moving average Process, Econometric Reviews. 7(1988) 65 – 95.
[3] Bowerman, O'Connel, Time Series Forecasting Unified Concepts and Computer Implementation, 2nd Edition, Duxbury, New York, 1990.
[4] J. Andel, On residual analysis for time series models, Kybernetika. 33(1997) 161 – 170.
[5] J. Johnston, J. DiNardo, Econometric methods, Fourth edition, McGraw-Hill,McCalman, St. 2012. Forecasting, National Economic Review, Issue 67, National Institute of Economic and Industry Research (NIEIR).
[6] S. Boes, P. Flaumer, University student enrollment forecasts analyzing structural ratios using ARIMA-methods, Allgemeines Statistisches Archiv 90, Physica-Verlag. (2006) 253-271. ISSN 0002-6018.
[7] Office of Agricultural Economics (Refer to the Development Plan of the Upper Northern Provinces Group (2015-2018)
[8] Royal Irrigation Department, prepared by: Water Resources Informatics Institute
[9] license code for spss statistics 22 as Y6RXWXE7Y964DMZB48IZZH74N95O MI2XXPXEEHM96LW3OBCN27V6W43TMNIBJGNSS7X7QPAJNQNR39BZXKVDAQEVO33 4HQUJAO8#

E-Proceeding of the

I-SEEC2021

11th INTERNATIONAL SCIENCE, SOCIAL SCIENCE, ENGINEERING AND ENERGY CONFERENCE



24-25 June 2021

ISBN 978-616-586-967-6

The 11th International Science, Social Sciences, Engineering and Energy Conference (I-SEEC2021)

June 24th – 25th, 2021 via ON-LINE platform.

Edited by:

Burin Narin, Prapon Lertloypanyachai,

Jakrapong Kaewkhao and Eakgapon Kaewnuam

The 11th International Science, Social Sciences, Engineering and Energy Conference (I-SEEC2021)

ISBN (e-book) : 978-616-586-967-6

Published by: Dr.Burin Narin