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TOWARDS THE MILLENNIUM DEVELOPMENT GOALS

Modelling Opeki river flow for sustainable rural development

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THE MODELLING OF Opeki River flow using an iterative, powerful but rather complicated modelling procedure called Box-Jenkins methodology is presented. This technique involves identification, estimation and diagnostic check stages. The Autocorrelation (ACF) and Partial Autocorrelation (PACF) are demonstrated to be useful identification tools. Average monthly discharges from 1981 to 1997 were used for the model development, three models were entertained. When Portmanteau lack of fit test was performed on these models, they show adequacy. Akaike Information Criterion (AIC) was used to select the' best' model. The potentials of Opeki River could now be realized in form of irrigation practice, hydroelectricity generation and water supply.

Keywords: Box-Jenkins methodology, Opeki River flow, average monthly discharge, Portmanteau test, AIC, sustainable development

Introduction

It is very imperative to know the importance of modelling river flow and its contributions to sustainable development. Modelling river flow has strong attachments to economic, social and environment(pillars of sustainable development (DFID, 2002)) concerns of the rural dwellers. Generally, river flow modelling involves the development of a model. When such model has been developed, it is tested to see if it is adequate for the intended purpose, if not, it may be improved by the abstraction of additional features of the series until the model is considered valid. Validity of a model means gaining confidence that the information it provides about the series is accurate for its intended purposes.

Aim of study

Development of a model for Opeki River flow (Eruwa, Oyo state, Nigeria) which can be a designing and planning tool for planners and decision-makers.

Materials and methods

Opeki River is a major river in Eruwa area of Oyo State, Nigeria. It is a seasonal river with high rainfall amount during the rainy season and a lesser amount in the dry season. It is a tributary to the Ogun River, Ogun State, Nigeria where there had been various irrigation schemes and dam development (Ogun River Basin, 1980). The average monthly discharges of Opeki River was obtained from Ogun Oshun River Basin Authority, Abeokuta, Nigeria, the custodian of such information. The data was then subjected to analysis using the Box – Jenkins modeling procedure (Box – Jenkins, 1970; Drako, 2002; Fuller , 1996; Maddala, 2001). A Statistical Package for Social Science (SPSS) was used to facilitate the analysis. The modelling procedure is as follows; **tentative models identification** (ACF and PACF acted as the useful aid), **coefficients estimation** (modified sum of squares technique), **diagnostic checking** (Portmanteau lack of fit test) **Akaike Information Criterion (AIC)** (ensuring model parsimony), and **use model for data generation, forecasting and control**.

Results and discussions

Three models were entertained by visual inspection of the ACF and PACF. They are;

Autoregressive Integrated Moving Average (ARIMA) (5,0,0) , ARIMA(1,1,1) and ARIMA(2,1,2).

Following the Box- Jenkins mathematical procedure;

ARIMA(5,0,0) becomes;

$$\emptyset_5(B)(1-B)\ln Z_t = a_t \quad (1)$$

where

$\emptyset_5$ = 5^{th} order autoregressive coefficients

B = backshift operator

$\ln Z_t$ = transformed series

a_t = white noise (error)

likewise:

ARIMA(1,1,1);

$$\emptyset_1(B)(1-B)\ln Z_t = \grave{e}_1(B^1)\, a_t \quad (2)$$

ARIMA(2,1,2);

$$\emptyset_2(B)(1-B)\ln Z_t = \grave{e}_2(B^2) a_t \quad (3)$$

$\grave{e}_1$ and $\grave{e}_2$ are the 1^{st} and 2^{nd} moving average coefficients respectively.

The models coefficients were successfully estimated and the residuals did show evidence of randomness about zero. All the models passed the diagnostic stage. The calculated Chi-square values were less then the tabulated values. The models could be said to be adequate. Akaike Information Criterion (AIC) helped to select the' best' model.

ARIMA(2,1,2) (equation 3) was discovered to be the 'best' model that represents the observed records (Figure 1). This model has the lowest AIC value of 454.22 compare

to 467.10 and 477.26 of ARIMA(5,0,0) and ARIMA(1,1,1) respectively.

Conclusions

The modelling of Opeki River flow as it relates to sustainable development has been described. The simulated values using the ' best' model looks reasonable when tested (Figure 1). The AIC technique that selects the' best' model has been employed to ensure model validity. Modelling properly and selecting the right model especially in hydrologic designs often prevent the grave social and economical consequences that occur once the project is constructed. The cost of developing an ARIMA model are insignificant when compared to the penalty that arise if river flow series is poorly modelled.

Having followed this Box –Jenkins methodology, decision-makers and planners will be able to use this developed model for planning and designing of flood controls, irrigation, inland waterway projects, water supply etc 'without fear' on Opeki River which would invariably reduce poverty and maintain livelihood into the future for Eruwa dwellers.

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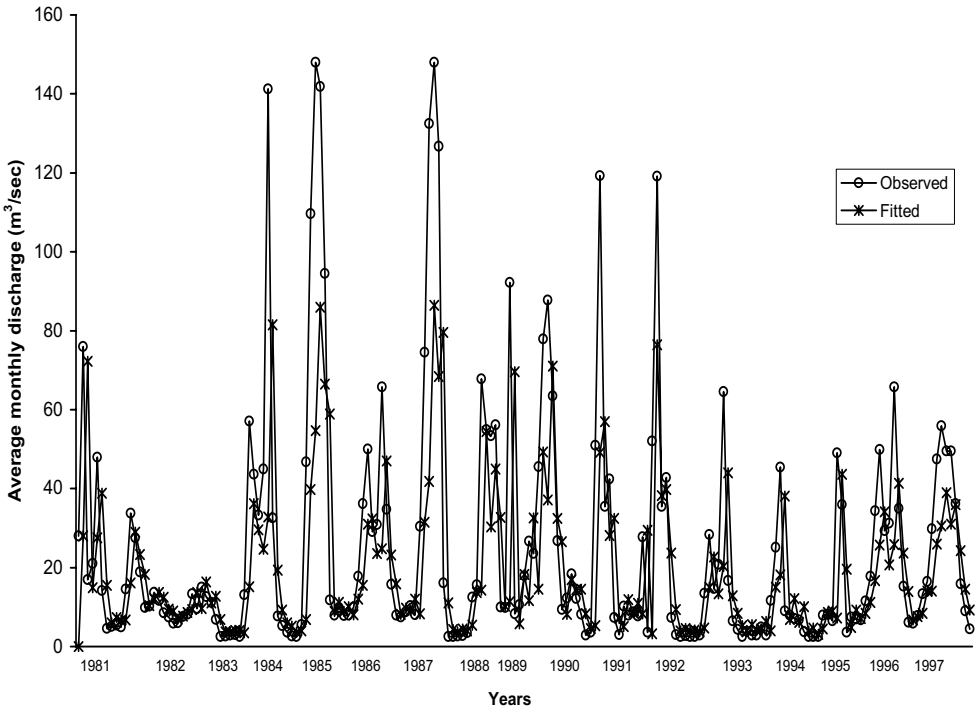

Figure 1. Forecasting analysis for ARIMA(2,1,2) model