CHAPTER SIX

MONTHLY FLOW MODELS

In this chapter, seven monthly streamflow generation models are described with the basic concepts and some important modifications. These models are Thomas - Fiering model, Disaggregation model, Two-Tier model, method of fragments, etc. The modifications will mainly be concerned with the preservation of skewness coefficient for all these models except method of fragments. Monthly flows are first generated using a Thomas-Fiering monthly model and then adjusted against the annual flow series obtained from Markov models.

6.1 REMOVAL OF SEASONALITY

Seasonality in the monthly flows, $Q_{i,j}$, can be modelled using a harmonic function. The periodic component in the mean can be estimated from

$$\mu_j = \mu + \sum_{k=1}^{\omega/2} (A_k \cos(2\pi jk/\omega) + B_k \sin(2\pi jk/\omega)) \quad \text{....... (6.1.1)}$$

in which

$$A_k = 2/\omega \sum_{j=1}^{\omega} \bar{Q}_j \cos(2\pi jk/\omega) \quad \text{....... (6.1.1a)}$$

$$B_k = 2/\omega \sum_{j=1}^{\omega} \bar{Q}_j \sin(2\pi jk/\omega) \quad \text{....... (6.1.1b)}$$

$$\bar{Q}_j = 1/n \sum_{i=1}^{n} Q_{i,j} \quad \text{....... (6.1.1c)}$$

$$\mu = 1/\omega \sum_{j=1}^{\omega} \bar{Q}_j \quad \text{....... (6.1.1d)}$$

n = number of years of flow records; and ω = 12 for monthly flows. Similarly, the periodic component in the standard deviation can be estimated from

$$\sigma_j = \sigma + \sum_{k=1}^{\omega/2} (A'_k \cos(2\pi jk/\omega) + B'_k \sin(2\pi jk/\omega) \quad \text{....... (6.1.2)}$$

in which A'_k, B'_k, and can be obtained from Eq. (6.1.1a), (6.1.1b) and (6.1.1d) by replacing $\bar{Q}_j$ by S_j which is obtained from

$$S_j = [1/(n-1) \sum_{i=1}^{n} (Q_{i,j} - \bar{Q}_j)^2]^{1/2} \quad \text{.......... (6.1.3)}$$

The periodic components in the means and variances are removed from $Q_{i,j}$ by

$$q'_{i,j} = (Q_{i,j} - \mu_j)/\sigma_j \quad \text{.......... (6.1.4)}$$

in which $q'_{i,j}$ is stationary in the mean and variance. The mean and standard deviation of $q'_{i,j}$ will not exactly equal 0 and 1, respectively, and a further transformation is required:

$$q''_{i,j} = (q'_{i,j} - \bar{q}_j)/s_j \quad \text{......... (6.1.5)}$$

in which $\bar{q}_j$ and s_j = the mean and standard deviation of $q'_{i,j}$, respectively corresponding to month j. Roener and Yevjevich(1966) called series $q''_{i,j}$ the standardized fitted series.

Alternatively, for monthly flows, it is convenient to use $\bar{Q}_j$ and S_j as the estimates of μ_j and σ_j to remove the periodicities in the mean and variance

$$q_{i,j} = (Q_{i,j}-\bar{Q}_j)/s_j \qquad \ldots\ldots\ldots\ldots \text{(6.1.6)}$$

This method is referred to as the non parametric method of cyclic standardization (Svanidze, 1964) and the series $q_{i,j}$ is called the standardized series. Srikanthan and Mcmahon (1982) found that there was little difference in the correlograms of $q'_{i,j}$ and $q_{i,j}$. Because of these observations and computational simplicity, the cyclic standardization is preferred to hamonic analysis in removing the seasonalities.

6.2 THOMAS-FIERING MODEL

This model takes into account the seasonality in the monthly means, standard deviations and lag one autocorrelation coefficients automatically in the generating equation which is given below

$$Q_{i,j} = \bar{Q}_j + b_j(Q_{i,j-1} - \bar{Q}_{j-1}) + t_{i,j}S_j(1-r_j^{\,2})^{1/2} \qquad \text{(6.2.1)}$$

and

$$Q_{i,1} = \bar{Q}_1 + b_1(Q_{i-1,12} - \bar{Q}_{12}) + t_{i,1}S_1(1-r_1^{\,2})^{1/2} \qquad \text{(6.2.2)}$$

in which b_j is the regression coefficient for estimating the flows in the j^{th} month from the $(j-1)^{th}$ month, $t_{i,j}$ is a random normal deviate with zero mean and unit variance, S_j is the standard deviation of the flows in the j^{th} month and r_j is the correlation coefficient between the historical flows of the j^{th} and $(j-1)^{th}$ months.

6.2.1 Estimation of Parameters

Let $Q_{i,j}$; i = 1,2,3,...,N ; j = 1,2,3,...,12 be observed discharge in the j^{th} month of the i^{th} water year of a set of available data of N years then the parameters of the model in the j^{th} month are computed from the following relationships.

1. the mean,

$$\overline{Q}_j = (1/N)\sum_{i=1}^{N} Q_{i,j} \qquad \text{............ (6.2.3)}$$

2. the standard deviation

$$S_j = [1/(N-1)\sum_{i=1}^{N} (Q_{i,j}-\overline{Q}_j)^2]^{1/2} \qquad \text{............ (6.2.3a)}$$

3. the correlation coefficient,

$$r_j = \sum_{i=1}^{N}(Q_{i,j}-\overline{Q}_j)(Q_{i,j-1}-\overline{Q}_{j-1}) / [\sum_{i=1}^{N} (Q_{i,j}-\overline{Q}_j)^2 \sum_{i=1}^{N}(Q_{i,j-1}-\overline{Q}_{j-1})^2]^{1/2} \qquad \text{....... (6.2.4)}$$

4. the regression coefficient,

$$b_j = r_j s_j / s_{j-1} \qquad \text{........... (6.2.5)}$$

In Eq. (6.2.4) and Eq. (6.2.5), when j=1 the index j-1 should be 12 instead of 0.

6.2.2 Modifications to Account for the Skewness

Yagil (1963) has shown that the regression equation of the above form does preserve the mean, the variance and the correlation between the flows of successive monthly streamflow sequences. Eq. (6.2.1) and (6.2.2) apply to the cases where the monthly flows are normally distributed. In order to take into account the skewness, Thomas and Fiering (1962) replaced the random component

$t_{i,j}$ by $\epsilon_{i,j}$, which is definced as

$$\epsilon_{i,j} = \{(1+\gamma(\epsilon_j)t_{i,j}/6-\gamma(\epsilon_j)^2/36)^3-1\}2/\gamma(\epsilon_j) \quad ...... \quad (6.2.6)$$

where the skewness of $\epsilon_{i,j}$ denoted by $\gamma(\epsilon_j)$ is related to the skewness of $Q_{i,j}$ denoted by γ_j by

$$\gamma(\epsilon_j) = (1-\rho_j^3)\gamma_j/(1-\rho_j^2)^{3/2} \quad .... \quad (6.2.7)$$

With $\epsilon_{i,j}$ as the random component. Eq. (6.2.1) and (6.2.2) may be used to generate synthetic events that will resemble the historic events in terms of means, standard deviations, skewnesses and lag one autocorrelations. The flows will be approximately distributed as Gamma. Matalas (1967b) proposed a technique for generating flows which are exactly distributed as Gamma, but only for particular values of γ_j and is limited to $\gamma_j < 2(2)^{1/2}$.

6.3 TWO - TIER MODEL

Harms and Campbell (1967) extended the Thomas-Fiering model for the sequential generation of monthly streamflows, so as to preserve the monthly as well as annual parameters. In this method, the monthly flows are generated by a Thomas-Fiering monthly model using Eq. (6.2.1) and (6.2.2). The annual streamflow sequence can be generated by an appropriate generation model. If Q_i is the annual streamflow volume for the year i, then the adjusted monthly flow volumes are given by

$$Q'_{i,j} = Q_i Q_{i,j}/\sum_{j=1}^{12} Q_{i,j} \quad ; \quad j = 1,2, ..., 12 \quad .... \quad (6.3.1)$$

$Q'_{i,j}$ = adjusted monthly generated flows

$Q_{i,j}$ = unadjusted monthly generated flows

i = year and j = month

This adjustment procedure preserves the annual parameters of the streamflow sequences at a slight expense of the monthly parameters.

Although the results presented by Harms and Cambell suggest that the model works well, Srikanthan and McMahon (1982) have found that the model distorts seasonal monthly parameters. To improve the seasonal monthly parameters, the Two-Tier model was modified as follows. The annual series obtained from an annual model and the series obtained by summing the monthly flows from the Thomas-Fiering monthly model were ranked separately. The monthly flows for each twelve month period were then adjusted using Eq. (6.3.1) against the annual flows having the same rank as the summed monthly flows. The adjusted monthly flows were then rearanged according to the original sequencing of the annual series. This modified procedure improved the seasonal parameters, especially the means and standard deviations, but had little influence on the skewness and correlation. In addition the method of adjusting monthly data does not allow the monthly serial correlation coefficient from the end of one year to the beginning of the next to be preserved.

6.4 DISAGGREGATION PROCESS

The disaggregation model of Valencia and Shaake (1973) for a single site takes the form

$$X = AY + Z \qquad \text{................} \quad (6.4.1)$$

where X is a (12x1) matrix of monthly flows, Y is the annual flow, A is a (12x1) matrix of constant coefficients and Z is a (12x1) matrix of residuals which have zero mean and are uncorrelated with Y. The elements of matrix X are assumed to be circularly stationary and ergodic; this implies that the aggregation of the lower level events or the series Y is stationary.

The random component matrix Z may be generated by the relation of

$$Z = BV \qquad \text{......................} \quad (6.4.2)$$

where V is a (12x1) matrix of independent, identically distributed normal deviates and B is a (12x12) coefficient matrix in order to preserve the coveriance and cross-covariance structure of the residuals. The matrices A and B can be obtained from

$$A = S_{XY}\, S_{YY}^{-1} \qquad \text{...............} \quad (6.4.3)$$

$$BB^{T} = S_{ZZ} \qquad \text{...............} \quad (6.4.4)$$

$$= S_{XX} - S_{XY}.S_{YY}^{-1}S_{YX}$$

where $S_{XX} = E[XX^{T}]$ .... (6.4.5)

$S_{XY} = E[XY]$ .... (6.4.6)

$S_{YX} = E[YX^{T}]$ .... (6.4.7)

$S_{YY} = E[Y^{2}]$ .... (6.4.8)

and $S_{ZZ} = E[ZZ^{T}]$ .... (6.4.9)

E[X] denotes the expectation of X.

The coefficient matrices A and B preserve the first and second moments of the historical annual and monthly flows. The solution of (6.4.4) requires that the matrix BB^{T} be positive semi definite. Valencia and Schaake (1973) showed that if BB^{T} is obtained by means of the least square estimator of sample covariances, then BB^{T} is positive semi definite. The techniques usually used to solve for B given BB^{T} are the principal component analysis (Anderson, 1960) or the Cholesky decomposition of BB^{T} (Healy, 1968)

6.4.1 Cholesky Decomposition of BB^{T}

In this method, the matrix B is assumed to be lower-triangular and the elements $b_{i,j}$ of B are obtained from the following recursive relationships:

$$b_{1,j} = 0, \qquad j > 1 \qquad \text{.............. (6.4.10)}$$

$$b_{1,1} = c_{1,1}^{1/2} \qquad \text{.............. (6.4.11)}$$

where $c_{i,j}$ is the element of matrix $C = BB^T$. The remaining elements in the first column of B are given by

$$b_{i,1} = c_{i,1}/b_{1,1} \qquad \text{............. (6.4.12)}$$

The j^{th} diagonal element is obtained from

$$b_{j,j} = [c_{i,j} - \sum_{k=1}^{j-1} b_{j,k}^{2}]^{1/2} \qquad j = 2,3, \ldots ,w \quad \text{.... (6.4.13)}$$

The solution is complete when $j = w$. Otherwise, the other elements of column j of B are computed from

$$b_{i,j} = [c_{i,j} - \sum_{k=1}^{j-1} b_{i,k}b_{j,k}]/b_{j,j}, \quad i = j+1, j+2, \ldots , w$$
$$\text{.............. (6.4.14)}$$

6.4.2 Wilson-Hilferty Transformation

To generate skewed monthly flows is as follows. Expanding Eq. (6.4.1) and assuming B to be a lower triangular matrix, for month j

$$x_j = a_j Y + \sum_{k=1}^{j} b_{j,k} v_k \qquad \text{.............. (6.4.15)}$$

where x_j, a_j, $b_{j,k}$ and v_k are the elements of j^{th} row of the matrices **X**, **A**, B and V respectively and Y is the annual flow. Assume that the sample values of **X** and Y are adjusted to have zero mean. Cubing both sides of Eq. (6.4.15) and taking expectations

$$E[x_j^3] = a_j^3 E[y^3] + \sum_{k=1}^{j} b_{j,k}^3 E[v_k] \qquad \text{......... (6.4.16)}$$

By dividing both sides of Eq. (6.4.16) by $\sigma_j^{3}\sigma^3$,one would obtain

$$\gamma/\sigma^3 = (a_j/\sigma_j)^3\gamma + 1/(\sigma^3\sigma_j^{3}) \sum_{k=1}^{j} b^3_{j,k}\gamma(v_k) \quad \ldots\ldots \ (6.4.17)$$

where σ_j - standard deviation of the j-th monthly flow

γ_j - coefficient of skewness of the j^{th} monthly flows

γ - coefficient of skewness of the annual flows

σ - standard deviation of the annual flows

and $\gamma(v_k)$ - coefficient of skewness of the k^{th} random variable in V

The required skewness of the random numbers are given by the following recursive relationship:

$$\gamma(v_1) = \{\sigma_1^{3}\gamma_1 - (a_1\sigma)^3\gamma\}/b^3_{1,1}$$
$$\gamma(v_2) = \{\sigma_2^{3}\gamma_2 - (a_2\sigma)^3\gamma - b^3_{2,1}\gamma(v_1)\}/b^3_{2,2}$$
$$\vdots \qquad \vdots \qquad \vdots \qquad \vdots$$
$$\gamma(v_j) = \{\sigma_j^{3}\gamma_j - (a_j\sigma)^3\gamma - \sum_{k=1}^{j-1} b^3_{j,k}\gamma(v_k)\}/b^3_{j,j} \quad \ldots\ldots \ (6.4.18)$$

It was oberved during the computations, that the last term of the matrix B(i.e. $b_{12,12}$) was always zero or very small. Because of this the twelfth random number had little or no effect on the generated streamflows. In other words the flow during month 12 depends only on the annual flow and the previous 11-month flow of a given year. In addition, $\gamma(v_{12})$ was undefined (or extremely large) because of zero denominator. Consequently, the 12^{th} month flows assumes an implied skew given by:

$$\gamma(v_{12}) = [\sigma a_{12}/\sigma_{12}]^3\gamma + (1/\sigma_{12}^{3})\sum_{j=1}^{11} b_{12,j}\gamma(v_j) \quad \ldots\ldots \ (6.4.19)$$

6.5 METHOD OF FRAGMENTS

Svanidze (1964) which uses the observed monthly flows to disaggregate the annual flows. This method is referred to as "the method of fragments" (Klemes, 1979, personal communication) and is described below.

In this method, the observed monthly flows are standardized year by year so that the sum of monthly flows in any year equals unity. This is done by dividing the monthly flows in a year by the corresponding annual flow. By doing so, from a record of n years, one will n fragments of yearly monthly flows. The annual flows obtained from any of the annual models can be disaggregated by selecting the fragments at random. This method also has the disadvantage that the correlation between the first month of a year to the last month of the previous year will not be preserved. This procedure was used with annual flows generated from Markov models.

It was found, applying this approach, that the seasonal monthly parameters were not satisfactorily presevéd. However, the monthly parameters can be improved by selecting a fragment appropriate to each flow in the annual flow series (Srikanthan and McMahon, 1982). This is done in the following manner.

The annual flows from the historical record (say N years long) are ranked according to increasing magnitude and N class N has no upper limit. The intermediate class limits are obtained by averaging two successive flows in the ranked series. The corresponding fragment are assigned to each class as follows. The fragment obtained from the monthly flows contributing to the smallest annual flows. The fragment obtained from the monthly flows contributing to the smallest annual flow is assigned to class 1, the fragment obtained from the monthly flows corresponding to the second smallest annual flow is assigned the class 2, and so on. The generated annual flows are then checked one by one for the class to which they belong and disaggregated using the corresponding fragment.

6.6 FIRST SPOLIA-CHANDER MODEL

Following Young and Pisano (1968), Spolia and Chander (1974) removed the periodicity in monthly streamflow sequences by using the cyclic linear transformation :

$$a_{i,j} = (Q_{i,j}-\bar{Q}_j)/s_j \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (6.6.1)$$

Since the resulting residual sequence, $\{a_{i,j}\}$, is cyclic free, all the elements $a_{i,j}$ could be considered to belong to the same population. They then proposed an m^{th}-order autoregressive model for modelling this residual sequence. Define :

$$u_k = a_{i,j} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6.6.2)$$

where

$$k = 12(i-1)+j,\ j = 1,\ldots,12\ ;\ i = 1,\ldots,n \quad \ldots\ldots \quad (6.6.3)$$

n being the length of the historical record in years, Then:

$$u_k = \sum_{l=1}^{m} b_l u_{k-l} + t_k(1-R^2)^{1/2} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (6.6.4)$$

in which b_l is the l_{th} regression coefficient and R is the multiple correlation coefficient. To determine the appropriate order of the autoregressive model employed, they simply applied the Anderson test on the serial correlation coefficient of the residual series. It turned out that either the first-or the second-order model is needed.

The removal of periodicities by means of Eq.(6.6.1) is commonly known as the nonparametric method (Tao et al., 1976). Another alternative is the parametric method also described by Tao et al. who claimed that it is more desireable than the previous one but little difference in the correlograms of both these two methods (Srikanthan and McMahon, 1982). In this study, the nonparametric method is prefered to the parametric method in removing the seasonalities because of its simplicity. Beside the introduction of the nonparametric method, attempts were also made to modify the model so as to account for the skewness coefficient.

Since only first- and second-order autoregressive models are expected to be required in modelling the residual series, only these are considered in the following. It should first be noticed that the residual series obtained by the removal of periodicities from the monthly sequence is in fact weakly stationary in the sense that it is stationary only in the mean and variance. This implies that the skewness coefficient of the residual series has still seasonality. Therefore, it is more convenient to use the notation $a_{i,j}$ rather than u_k.

6.6.1 For the first-order model:

$$a_{i,j} = \rho_1 a_{i,j-1} + t_j(1-\rho_1^2)^{1/2} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (6.6.5)$$

where ρ_1 is the lag one autocorrelation coefficient of the residual series. By cubing and taking the expectation, it follows from Eq. (6.6.5) that :

$$g(t_j) = \{E(a^3_{i,j}) - \rho_1^3 E(a^3_{i,j-1})\}/(1-\rho_1^2)^{3/2} \quad (6.6.6)$$

Since

$$E(a^3_{i,j}) = E(Q^3_{i,j}) = g_j \quad \ldots\ldots\ldots\ldots\ldots \quad (6.6.7)$$

one obtains from Eq. (6.6.6)

$$g(t_j) = (g_j - \rho_1^3 g_{j-1})/(1-\rho_1^2)^{3/2} \quad \ldots\ldots\ldots\ldots \quad (6.6.8)$$

6.6.2 For the second-order model :

$$a_{i,j} = b_1 a_{i,j-1} + b_2 a_{i,j-2} + t_j(1-R^2)^{1/2} \quad \ldots\ldots\ldots \quad (6.6.9)$$

Cubing Eq. (6.6.9) and taking the expectation, by noting that the terms :

$$E(a_{i,j-1}a_{i,j-2}t_j);\ E(a^2_{i,j-2}t_j);\ E(a_{i,j-1}t_j^2);\ \text{and}\ E(a_{i,j}t_j^2)$$

all vanish, one obtains the following expression :

$$g(t_j) = [g_j - b^3_1 g_{j-1} - b_2^3 g_{j-2} - 3b_1^2 b_2 E(a^2_{i,j-1}a_{i,j-2}) - 3b_1 b_2^2 E(a_{i,j-1})a^2_{i,j-2})]/(1-R^2)^{3/2} \quad \text{........ (6.6.10)}$$

By neglecting the third moments of $a_{i,j-1}$ and $a_{i,j-2}$, Eq. (6.6.10) reduces to

$$g(t_j) = (g_j - b_1^3 g_{j-1} - b_2^3 g_{j-2})/(1-R^2)^{3/2} \quad \text{....... (6.6.11)}$$

6.7 SECOND SPOLIA-CHANDER MODEL

This model is based on canonical expansions. Canonical expansion was used by Spolia and Chander (1977) as a representation of a stochastic process in the form of a linear combination of uncorrelated random variables. Let Q_j, j = 1,...,12, denoted the streamflow in month j, then :

$$Q_j = \bar{Q}_j + \sum_{k=1}^{j-1} b_{j,k} C_k + C_j \quad \text{............ (6.7.1)}$$

where $\{C_j\}$ is a sequence of random variables of zero mean which are uncorrelated with one another, and $b_{j,k}$ are real coefficients. For the model of Eq.(6.7.1) to preserve the mean, variance and the entire correlation-cross-correlation matrix of the historical monthly streamflows, the variance of C_j and the coefficients $b_{j,k}$ must be computed :

$$Var(C_1) = Var(Q_1)$$

$b_{1,k} = 1$, for all $k=j$; $b_{j,k} = 0$, for all $k > j$

$b_{j,1} = Cov(Q_j,Q_1)/Var(C_1)$

$$b_{j,k} = [Cov(Q_j,Q_k)-\sum_{l=1}^{k-1} b_{j,l}b_{k,l}Var(C_l)]/Var(C_k), \quad \text{for } k = 2,3,\ldots,j-1 \quad \ldots\ldots. (6.7.2)$$

and

$$Var(C_j) = Var(Q_j)-\sum_{k=1}^{j-1} b^2_{j,k}Var(C_k)$$

In order to preserve the skewness coefficient of the historical monthly streamflows, Phien (1979) showed that the third moment of C_j must be as follows :

$$E(C^3_1) = E(Q^3_1)$$

$$E(C^3_j) = E(Q^3_j)-\sum_{k=1}^{j-1} b^3_{j,k}E(C^3_k), \quad j > 2 \quad \ldots. (6.7.3)$$

Knowing the third and second (central) moments of C_j, one can obtain its skewness coefficient by taking :

$$g(C_j) = E(C^3_j)/[Var(C_j)]^{3/2} \quad \ldots\ldots\ldots (6.7.4)$$

6.8 SEN MODEL

The model proposed by Sen (1978) is a mixture of the stationary lag one autoregressive model and the seasonal Thomas-Fiering model. It can preserve the historical sequences in terms of mean, standard deviation, first serial correlation coefficient between the successive years for the same month and lag-zero cross-correlation coefficient between the successive months of the same year. The model is written as:

$$W_{i,j} = \alpha_j W_{i,j-1} + \beta_j W_{i-1,j} + t_j \qquad \text{.............. (6.8.1)}$$

where

$$W_{i,j} = Q_{i,j} - \bar{Q}_j \qquad \text{.............. (6.8.2)}$$

α_j, β_j = parameters which reflect the relationships between successive months of the same year and between successive years for the same month, respectively:

t_j = random variable, independent of $W_{i,j-1}$ and $W_{i-1,j}$ and having zero mean. When α_j = 0, Eq.(6.8.1) gives the lag-one autoregressive (Markov) model, and when β_j = 0 ,it reduces to that of Thomas and Fiering(1962).

Besides the mean, $\bar{Q}_j$, and the standard deviation, S_j, the other model parameters and related constants are as follows:

1. Lag-one serial correlation:

$$\rho_j(1) = \sum_i (W_{i,j} W_{i-1,j}) / (\sum_i W^2_{i,j})^{1/2} \qquad \text{........ (6.8.3)}$$

2. Lag-zero cross-correlation coefficient :

$$\rho_{j,j-1}(0) = \sum_i (W_{i,j-1} W_{i,j}) / [\sum_i (W^2_{i,j-1})(\sum_i W^2_{i,j})]^{1/2} \text{(6.8.4)}$$

3. Lag-one cross-correlation coefficient :

$$\rho_{j,j-1}(1) = \sum_i (W_{i-1,j} W_{i,j-1}) / [\sum_i (W^2_{i-1,j})(\sum_i W^2_{i,j-1})]^{1/2}$$

.... (6.8.5)

4. Model parameters:

$$\alpha_j = (S_j/S_{j-1})[\rho_{j,j-1}(0) - \rho_j(1)\rho_{j,j-1}(1)] / [1-\rho^2_{j,j-1}(1)] \qquad \text{............... (6.8.6)}$$

$$\beta_j = \rho_j(1) - [\rho_{j,j-1}(0)\rho_{j,j-1}(1)] / [1-\rho^2_{j,j-1}(1)] \quad \ldots\ldots\ldots\ldots\ldots \text{(6.8.7)}$$

5. Variance of the random variable :

$$Var(t_j) = S_j^2 - S_j^2[\rho^2_{j,j-1}(0) - 2\rho_j(1)\rho_{j,j-1}(0)\rho_{j,j-1}(1) + \rho_j^2(1)]/[1-\rho^2_{j,j-1}(1)] \quad \ldots\ldots\ldots\ldots \text{(6.8.8)}$$

To preserve the skewness coefficient of each historical month of each historical monthly sequence, the random variable t_j must have a skewness coefficient which is determined below. Cubing Eq. (6.8.1) and taking the expectation, one obtains:

$$E(t^3_j) = g_j S_j^3 - \alpha_j^3 S_j^3 g_{j-1} - \beta_j^3 S_j^3 g_j - 3\alpha_j^2 \beta_j E[W^{*}_{i,j-1} W_{i-1,j}] + 3\alpha_j \beta_j^2 E[W_{i,j-1} W^2_{i-1,j}] \quad \ldots\ldots\ldots\ldots \text{(6.8.9)}$$

If the expectation on the right-hand side are neglected, Eq. (6.8.9) reduces to :

$$E(t_j^3) = g_j S_j^3 - \alpha_j^3 S^2_{j-1} g_{j-1} - \beta_j^3 S_j^3 g_j \quad \ldots\ldots\ldots \text{(6.8.10)}$$

Finally, the skewness coefficient of t_j is determinated by dividing its third moment by $[Var(t_j)]^{3/2}$

6.9 APPLICATION FOR ACTUAL DATA

Using the monthly models with modification, 1000 years of streamflows were generated for each river. The various parameters of the generated monthly flows from each model were estimated and given in Table 6.1-6.10. The following symbols are used to denote the parameter obtained from the historic and generated sequences.

Hist. - Historical values

TF	-	Thomas-Fiering monthly model
TT	-	Two-Tier model using the annual flows from Markov model
TTM	-	Modified Two-Tier model using the annual flows from a Markov model
FM	-	Method of Fragments using the annual flows from a Markov model
FMM	-	Modified Method of Fragments using the annual flows from a Markov model
FSC	-	First Spolia-Chander monthly model
SSC	-	Second Spolia-Chander monthly model
SEN	-	Sen monthly model

6.10 DISCUSSION OF RESULTS

The statistical parameters for comparison are the central moments (mean, standard deviation and skewness coefficient) and the lag one autocorrelation coefficients. They are computed for each 1000 years of generated sequences. Based on the results in Table 6.1 to 6.10 the models are classified into three groups and the performance of the models with respect to the rivers in each of these groups are discussed below.

6.10.1 Thomas-Fiering and Sen Models

Although, Thomas-Fiering model is a very old technique for generated streamflows, it has been favourably used due to its simplicity in form and it can be preserved well the seasonal monthly parameters. From Table 6.1 to 6.10 are shown that the both models give similar results for the mean, standard deviation and the lag-one autocorrelation coefficient for most of the rivers. For the skewness coefficient, both models can preserve for most of the rivers except a few cases. The Thomas-Fiering model results in positive skewness where as the historical value is negative in August for Nan river and overestimates the skewness in Febuary and March for Nam Mae Taeng. The Sen model overestimates the skewness in April and March for Ping River. For both models, maximum events are more than the historic records except a few cases while the minimum events are smaller than those from historical records. A small amount of zero flows were generated for most of the moments for the both models, which the maximum being 23.8 % for Thomas-Fiering model in March for Nam Mae Khan and 25.9 % for Sen model in April for Wang River.

6.10.2 Disaggregation process, Two-Tier model and Method of Fragments

The advantage of using the Two-Tier model and method of fragments for a single site is that they are simple and can be applied to almost all rivers. The modified diaggregation scheme does not preserve the skewness of the last month of flow and its used is limited in certain cases where the skewness of the random variables obtained from Eq.(6.4.18) becomes large (> 10), Srikanthan and McMahon (1982). From calculations the values of the skewness of the random variables are found to be more than 10, so the disaggregation process can not be applied to generate streamflows sequence for each river. Therefore, the Two-Tier model and method of fragments are adjusted to preserve the annual parameters at the slight expense of the seasonal monthly parameters. It is observed that the Two-Tier and method of fragments preserve the seasonal monthly parameters well for most of rivers except a few cases. So both models should be modified to adjust for the seasonal monthly parameters if there is a large different from historic records. The maximum and minimum events trend to be similar to the first group but the amount of zero flow is more than the first group.

6.10.3 First and second Spolia-Chander model

Inspections from Table 6.1 to 6.10 show that both models presented in this study can preserve all first three moment, i.e. mean, standard deviation and skewness coefficient for most of the rivers except the second Second Spolia-Chander model, which can not preserve the standard deviation and skewness coefficient for Nam Mae Taeng and Nam Mae Chaem. Both models can not preserve the lag-one autocorrelation for all of the rivers. The maximum and minimum events trend to be similar in both groups mentioned above but the amount of zero flow is lower.

6.11 SUMMARY

Even though the Thomas-Fiering is an old techique, however, it can preserve the seasonal monthly parameters better than other models and is simple to use. The Sen model can preserve well the seasonal monthly parameters well but the model is complicated. The Two-Tier model and method of fragments can preserve the annual parameters and the seasonal monthly parameters except a few cases, they should be modified to improve the seasonal monthly parameters. The disaggregation model can not be applied for all rivers. First and Second Spolia-Conical models preserve mean, standard deviation and skewness well but fail to preserve lag-one autocorrelation.

TABLE 6.1 MONTHLY (SEASONAL) PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR PING RIVER, (P.1)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Mean	Hist.	39.183	78.707	128.864	157.625	342.784	456.860	317.854	181.883	132.195	84.366	52.851	44.890
x 10^6 cu.m	TF	39.715	78.649	124.969	150.802	333.841	453.454	316.246	183.551	134.792	86.036	53.642	45.505
	TT	43.161	85.406	126.577	155.089	339.543	468.661	333.460	191.535	142.511	90.560	56.689	47.099
	TTM	37.790	74.535	103.539	112.901	253.320	356.859	269.324	154.175	118.017	76.937	47.495	38.889
	FM	44.215	82.068	126.428	161.372	338.914	474.584	333.504	187.126	136.485	88.116	57.389	50.088
	FMM	44.206	84.984	107.637	141.000	356.927	465.615	339.875	191.958	143.497	91.306	54.180	59.105
	FSC	39.705	79.192	130.600	153.781	340.031	458.272	317.667	184.064	135.211	86.060	53.417	45.123
	SSC	38.723	77.484	121.563	159.126	332.043	470.608	320.253	182.248	133.838	84.401	50.826	43.898
	SEN	38.778	80.592	127.759	156.755	332.112	447.707	316.764	180.149	132.886	84.108	52.693	45.024
Standard	Hist.	20.779	40.936	111.755	107.265	201.970	193.662	115.942	79.913	49.795	31.933	24.746	26.720
Deviation	TF	20.540	42.395	98.862	100.540	191.581	190.477	115.705	80.525	50.346	31.717	24.917	25.812
	TT	29.841	56.479	84.290	87.723	154.609	201.636	152.639	97.837	69.627	45.438	32.960	30.409
x10^6 cu.m	TTM	18.804	39.930	52.965	65.469	120.142	128.813	99.345	67.520	46.046	31.515	23.308	22.050
	FM	27.910	45.940	85.599	103.876	150.306	206.235	138.296	91.255	55.512	38.659	30.441	34.997
	FMM	28.669	38.447	56.625	89.044	175.640	201.214	143.365	105.111	77.578	56.304	43.313	67.046
	FSC	20.631	41,800	112.356	101.538	202.075	195.185	117.272	81.131	50.381	31.406	24.835	25.636
	SSC	21.625	40.969	86.914	109.524	180.104	198.455	109.456	76.965	48.733	31.130	21.810	23.259
	SEN	14.961	41.035	90.635	106.169	181.825	177.835	115.052	74.648	46.685	27.387	18.800	19.878
Skewness	Hist.	1.259	1.083	4.291	1.948	1.854	1.099	0.733	0.989	0.670	0.431	0.853	1.406
	TF	1.330	1.139	3.482	2.087	1.911	1.014	0.808	1.071	0.699	0.548	1.021	1.233
	TT	1.860	1.763	2.532	1.373	1.213	1.623	1.401	1.366	1.209	1.160	1.347	1.331
	TTM	1.003	1.267	2.729	2.785	2.260	1.309	0.836	0.864	0.592	0.161	0.662	0.783
	FM	1.264	1.796	4.760	1.831	1.234	1.189	1.354	2.098	1.337	1.281	1.365	2.171
	FMM	0.899	0.942	1.452	1.270	1.732	0.634	1.750	1.277	1.418	1.493	2.214	2.118
	FSC	1.209	1.101	3.055	1.835	1.971	1.013	0.810	1.076	0.661	0.538	1.029	1.334
	SSC	1.317	1.046	3.391	2.013	2.340	0.663	0.466	0.718	0.267	0.184	1.415	3.884
	SEN	2.561	1.144	3.186	1.871	1.712	0.913	0.724	1.194	0.884	0.661	1.920	4.141
Lag one	Hist.	0.779	0.284	0.219	0.314	0.688	0.701	0.424	0.564	0.749	0.707	0.735	0.869
auto-	TF	0.771	0.285	0.281	0.272	0.707	0.682	0.438	0.522	0.757	0.732	0.721	0.909
correlation	TT	0.428	0.550	0.496	0.224	0.690	0.566	0.498	0.680	0.793	0.776	0.800	0.932
coefficient	TTM	0.059	0.326	0.465	0.256	0.691	0.553	0.378	0.557	0.718	0.650	0.737	0.918
	FM	0.101	0.598	0.336	0.370	0.473	0.466	0.405	0.641	0.787	0.776	0.828	0.884
	FMM	0.027	0.451	0.643	0.272	0.403	0.166	0.466	0.744	0.725	0.713	0.661	0.955
	FSC	0.566	0.566	0.595	0.581	0.575	0.585	0.609	0.554	0.603	0.614	0.570	0.594
	SSC	-0.005	0.035	-0.076	0.029	0.040	-0.047	-0.047	-0.001	-0.005	0.025	0.020	-0.026
	SEN	0.761	0.243	0.249	0.299	0.721	0.654	0.412	0.490	0.669	0.670	0.649	0.696

TABLE 6.1 (CONT.) MONTHLY (SEASONAL) PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR PING RIVER, (P.1)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Maximum	Hist.	125.453	207.939	803.352	642.384	1158.278	1173.312	610.330	415.597	270.518	167.789	122.774	148.954
	TF	166.422	299.059	840.868	964.424	1526.024	1304.412	898.775	677.161	374.325	215.159	186.704	198.812
	TT	234.638	392.076	861.337	655.805	1118.672	2052.927	1285.081	660.907	529.124	335.123	243.319	211.021
	TTM	131.886	326.525	531.827	654.428	1115.316	1044.010	621.773	430.683	306.607	196.115	158.178	142.635
	FM	181.936	494.156	1121.232	738.293	1069.597	1484.811	1454.731	864.618	391.862	300.098	225.978	312.419
	FMM	127.736	294.366	358.176	429.171	1291.691	1347.222	1231.042	661.272	462.317	336.504	222.157	307.137
	FSC	164.627	323.140	951.122	828.555	1648.488	1313.833	917.783	662.739	323.148	219.769	180.011	192.692
	SSC	184.129	265.396	821.253	954.572	1653.188	1492.137	713.501	532.873	294.899	179.982	163.893	211.062
	SEN	181.322	268.823	849.396	827.340	1514.119	1161.864	817.380	625.368	369.109	199.286	191.846	270.695
Minimum	Hist.	7.279	19.613	28.616	29.290	94.954	165.024	73.094	36.374	37.152	32.918	11.033	4.406
	TF	1.576	3.107	37.069	37.941	100.084	109.130	38.983	0.000	6.020	12.064	2.786	0.000
	TT	1.322	1.484	18.530	21.117	65.546	140.320	71.478	21.731	25.557	0.000	0.000	0.000
	TTM	3.076	1.264	40.828	38.608	96.711	115.883	80.071	19.601	21.880	0.000	0.000	0.000
	FM	1.917	12.191	29.098	14.438	93.961	125.665	101.890	61.615	41.424	22.600	8.996	3.829
	FMM	7.519	19.156	31.710	28.608	109.800	156.305	84.522	42.061	42.960	27.951	10.952	4.303
	FSC	3.508	0.000	0.000	4.819	58.273	121.873	54.540	1.298	9.527	10.722	6.713	0.719
	SSC	6.155	2.628	65.604	17.392	0.000	0.000	19.444	0.000	0.000	0.000	17.339	2.338
	SEN	0.000	8.993	36.018	34.701	90.666	108.618	56.267	40.296	36.935	17.357	11.389	0.000
Percentage of zero flows	Hist.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	TF	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.000	0.000	0.000	0.500
	TT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.400	1.200
	TTM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.500	1.200	2.500
	FM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FMM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FSC	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SSC	0.000	0.000	0.000	0.000	0.100	0.200	0.000	0.100	0.200	0.100	0.000	0.000
	SEN	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.200

TABLE 6.2 MONTHLY (SEASONAL) PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR WANG RIVER, (W.16)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Mean	Hist.	2.048	8.924	11.378	21.912	56.386	71.955	43.378	22.619	8.070	4.918	2.012	1.484
x 10^6 cu.m	TF	1.992	8.973	11.321	21.277	56.697	72.613	43.381	23.042	8.309	5.031	2.052	1.593
	TT	2.514	9.876	11.725	21.469	50.787	74.163	46.737	25.546	9.441	5.663	2.361	1.738
	TTM	2.028	8.026	9.082	13.850	30.979	52.405	35.327	20.264	7.594	4.604	1.965	1.454
	FM	2.383	9.326	11.941	19.133	52.911	76.707	46.267	25.415	8.757	5.442	2.143	1.597
	FMM	2.125	9.850	18.190	14.814	45.872	97.238	42.432	18.753	7.202	3.196	1.519	0.829
	FSC	2.130	9.104	11.257	21.245	55.419	72.226	43.333	22.995	8.305	5.028	2.025	1.527
	SSC	2.035	8.744	10.454	23.666	55.391	75.802	43.700	22.350	14.220	4.769	3.939	3.261
	SEN	2.365	9.387	11.780	22.635	54.573	70.942	43.499	22.434	8.095	4.774	2.007	1.617
Standard	Hist.	1.465	7.651	11.309	25.790	54.866	39.077	21.580	12.869	3.493	3.681	1.193	1.142
Deviation	TF	1.396	7.993	11.402	23.789	55.605	39.653	21.636	13.179	3.471	3.640	1.132	1.044
	TT	2.607	9.759	11.799	23.130	35.736	43.142	31.360	19.718	6.826	5.772	1.980	1.597
x10^6 cu.m	TTM	1.369	6.969	8.289	17.256	27.522	24.427	18.399	11.553	3.355	3.709	1.121	0.996
	FM	2.335	7.901	12.267	21.951	37.189	45.545	27.470	19.604	5.406	4.999	1.420	1.473
	FMM	1.418	9.969	17.986	12.244	28.403	52.423	26.285	14.800	4.500	1.461	0.919	0.699
	FSC	1.416	7.246	10.371	23.106	50.454	38.629	21.582	13.058	3.487	3.643	1.180	1.057
	SSC	1.458	7.570	8.744	25.158	55.410	40.701	20.185	12.445	1.391	3.413	0.560	0.534
	SEN	2.155	7.965	10.655	24.360	53.436	35.993	21.508	12.849	3.325	3.048	0.987	1.427
Skewness	Hist.	0.483	2.212	2.872	1.665	2.328	1.131	0.733	1.072	0.228	1.698	0.551	0.518
	TF	0.870	2.423	2.405	1.956	2.527	1.124	0.786	1.184	0.468	2.436	1.269	1.279
	TT	2.954	2.716	2.454	1.673	1.474	2.248	1.920	1.932	1.761	4.068	2.174	2.153
	TTM	0.648	2.602	2.258	2.115	2.465	0.863	0.740	0.860	-0.018	2.270	1.168	1.313
	FM	2.074	1.813	2.598	2.366	2.005	1.673	1.765	1.928	2.062	2.781	1.841	2.023
	FMM	0.962	1.548	1.574	2.166	0.841	0.788	2.746	3.368	2.874	1.915	1.855	1.878
	FSC	0.572	2.274	2.494	1.954	2.329	1.012	0.822	1.185	0.294	2.317	0.813	0.671
	SSC	0.688	1.893	2.789	1.639	2.074	0.806	0.384	0.959	5.233	2.275	2.590	2.627
	SEN	0.522	1.976	1.984	1.920	2.476	1.225	0.794	1.155	0.355	1.890	0.645	0.505
Lag one	Hist.	0.632	0.077	0.729	0.262	0.253	0.742	0.369	0.243	0.769	0.510	0.797	0.946
auto-	TF	0.597	0.075	0.771	0.237	0.268	0.746	0.397	0.199	0.790	0.528	0.810	0.941
correlation	TT	0.184	0.397	0.880	0.207	0.211	0.360	0.417	0.465	0.833	0.627	0.837	0.953
coefficient	TTM	0.013	0.166	0.914	0.243	0.302	0.446	0.234	0.217	0.718	0.435	0.786	0.938
	FM	-0.045	0.166	0.757	0.182	0.147	0.400	0.437	0.555	0.905	0.636	0.887	0.921
	FMM	-0.019	0.090	0.954	0.610	0.140	0.282	0.390	0.696	0.940	0.842	0.894	0.827
	FSC	0.489	0.322	0.547	0.468	0.527	0.491	0.535	0.482	0.540	0.539	0.512	0.501
	SSC	0.024	0.032	-0.064	-0.007	0.028	-0.036	-0.024	-0.008	-0.005	0.000	0.028	-0.041
	SEN	0.894	0.212	0.791	0.216	0.241	0.713	0.352	0.244	0.745	0.474	0.613	0.585

TABLE 6.2 (CONT.) MONTHLY (SEASONAL) PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR WANG RIVER (W.16)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Maximum	Hist.	4.736	33.609	50.648	86.995	227.590	163.987	83.549	54.842	14.740	15.379	3.925	3.427
	TF	8.671	69.857	85.500	203.420	481.952	264.628	154.449	99.822	25.455	36.947	11.022	9.444
	TT	29.237	81.538	89.875	136.610	255.411	486.326	282.558	139.103	50.464	73.037	16.515	13.638
	TTM	7.618	61.821	65.988	131.201	253.808	181.892	99.223	72.406	18.234	32.834	10.035	8.541
	FM	19.139	49.842	86.261	153.374	382.256	415.073	208.169	122.620	49.219	38.797	9.597	11.845
	FMM	6.144	36.282	72.316	59.021	161.980	307.316	228.890	128.865	41.002	12.632	5.889	3.217
	FSC	7.920	66.630	73.511	190.561	420.088	245.451	155.948	103.308	20.822	35.826	8.511	5.715
	SSC	9.132	53.264	73.455	180.510	445.958	280.323	117.766	91.779	30.218	28.769	7.910	7.769
	SEN	9.597	52.872	69.688	171.560	459.989	243.741	145.172	93.113	22.591	24.953	6.740	6.889
Minimum	Hist.	0.103	1.153	0.851	1.664	12.828	25.672	16.408	4.880	2.424	1.351	0.643	0.083
	TF	0.000	1.033	0.410	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	TT	0.000	0.439	0.234	0.000	1.066	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	TTM	0.000	1.092	0.478	0.000	1.951	2.050	0.000	0.000	0.000	0.000	0.000	0.000
	FM	0.091	0.898	0.749	0.848	7.389	10.782	8.801	4.540	1.831	0.938	0.341	0.073
	FMM	0.096	1.075	0.794	2.038	11.659	22.731	16.072	4.321	2.146	1.196	0.637	0.077
	FSC	0.000	0.000	0.000	0.000	4.266	5.914	0.000	0.000	0.000	0.000	0.000	0.000
	SSC	0.000	0.164	4.207	0.000	0.000	0.000	0.000	0.000	13.563	0.000	2.397	1.858
	SEN	0.000	0.000	0.000	0.000	0.000	0.000	1.129	0.000	0.000	0.000	0.000	0.000
Percentage of zero flows	Hist.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	TF	7.700	0.000	0.000	17.000	0.100	0.300	0.300	0.300	0.900	2.300	3.100	6.500
	TT	4.800	0.000	0.000	17.400	0.000	0.100	0.200	0.200	1.400	3.500	3.200	7.600
	TTM	6.500	0.000	0.000	24.600	0.000	0.000	0.700	0.700	1.900	5.600	4.000	7.100
	FM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FMM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FSC	0.000	3.700	0.000	0.000	0.000	0.000	0.000	0.500	0.000	2.500	1.800	0.000
	SSC	7.700	0.000	0.000	18.200	6.300	1.500	0.800	0.900	0.000	0.900	0.000	0.000
	SEN	25.900	0.700	1.000	14.400	0.100	0.300	0.000	0.200	1.100	0.900	1.600	23.800

TABLE 6.3 MONTHLY (SEASONAL) PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR YOM RIVER, (Y.6)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Mean	Hist.	11.709	72.992	123.118	200.605	595.483	938.780	441.720	147.266	54.293	24.332	12.736	8.684
x 10^6 cu.m	TF	11.439	72.865	122.810	191.193	597.444	948.398	442.889	151.091	56.081	24.760	12.556	8.867
	TT	14.179	82.569	130.914	186.067	582.197	955.269	480.601	162.476	63.933	28.405	14.747	9.869
	TTM	11.205	66.701	99.909	116.451	410.714	658.130	371.539	124.685	51.609	23.134	12.283	8.152
	FM	17.417	79.180	141.808	176.996	575.232	978.070	485.499	150.896	57.490	25.588	13.641	9.410
	FMM	22.943	99.072	184.623	165.594	554.015	892.481	523.628	160.208	60.018	27.603	12.620	8.422
	FSC	11.459	72.524	122.513	191.363	599.604	949.805	443.391	151.058	55.970	24.764	12.580	8.637
	SSC	11.424	71.854	121.363	197.944	592.560	978.827	446.197	145.402	55.756	22.685	12.007	7.599
	SEN	10.975	74.870	126.844	204.958	588.310	929.140	443.619	145.957	54.501	23.652	12.467	8.646
Standard	Hist.	13.371	58.635	88.259	231.915	403.961	506.532	199.889	107.429	24.568	14.466	9.210	6.327
Deviation	TF	11.122	60.785	91.175	215.183	396.188	511.136	198.917	111.324	24.202	13.579	8.238	5.736
	TT	22.976	82.779	106.945	183.199	350.274	529.815	311.097	144.238	47.339	25.134	14.484	9.466
x10^6 cu.m	TTM	12.558	54.400	69.203	131.402	289.773	346.722	184.290	89.000	21.173	13.095	8.181	5.700
	FM	30.798	70.194	140.726	171.779	342.467	490.726	302.552	117.960	32.852	15.828	9.006	7.045
	FMM	37.168	71.419	164.089	195.410	322.560	471.272	298.099	112.872	33.505	21.522	7.133	5.955
	FSC	11.614	58.195	89.333	199.355	393.042	510.688	198.995	111.015	24.730	14.354	8.468	5.953
	SSC	12.263	58.013	84.763	195.939	403.478	525.692	185.108	103.081	23.430	11.867	8.382	5.203
	SEN	8.818	57.796	86.200	228.751	392.508	483.001	206.592	108.034	23.356	12.346	8.607	6.101
Skewness	Hist.	4.383	1.443	1.032	2.369	0.964	0.840	0.179	1.804	0.487	1.455	3.091	1.571
	TF	4.062	1.590	1.234	2.748	1.123	0.746	0.276	2.042	1.042	1.999	3.195	1.387
	TT	7.953	2.375	1.518	1.636	0.843	1.560	1.628	2.381	1.936	3.636	4.341	2.733
	TTM	5.382	1.501	0.938	2.569	0.944	0.902	0.306	1.326	0.219	1.847	2.568	1.545
	FM	4.820	1.887	3.048	2.571	1.040	0.790	1.736	2.355	1.636	1.734	2.043	2.180
	FMM	3.699	0.850	1.388	2.397	0.536	1.109	0.919	1.987	1.854	2.241	1.682	1.187
	FSC	3.923	1.438	1.214	2.457	1.054	0.741	0.276	2.094	0.533	1.806	3.037	1.446
	SSC	4.571	1.360	0.942	2.715	0.916	0.787	-0.128	1.834	-0.152	2.538	3.611	0.983
	SEN	2.889	1.506	1.023	2.376	0.947	0.814	0.187	1.909	0.855	1.390	3.787	2.043
Lag one	Hist.	0.009	-0.059	0.518	0.354	0.575	0.513	0.411	0.347	0.800	0.727	0.521	0.782
auto-	TF	0.028	-0.071	0.537	0.361	0.572	0.514	0.430	0.305	0.837	0.778	0.545	0.752
correlation	TT	-0.023	0.208	0.643	0.340	0.365	0.287	0.355	0.513	0.788	0.828	0.717	0.802
coefficient	TTM	0.036	-0.057	0.564	0.432	0.400	0.385	0.331	0.394	0.768	0.665	0.578	0.733
	FM	0.032	0.189	0.707	0.242	0.440	0.358	0.437	0.475	0.851	0.787	0.667	0.748
	FMM	0.016	-0.019	0.874	0.625	0.463	0.509	0.557	0.685	0.966	0.718	0.793	0.680
	FSC	0.487	0.382	0.447	0.496	0.432	0.459	0.476	0.416	0.485	0.484	0.489	0.420
	SSC	-0.034	0.029	-0.062	0.032	0.071	-0.035	-0.040	0.025	-0.021	0.021	0.010	0.005
	SEN	0.083	0.149	0.494	0.381	0.570	0.473	0.498	0.348	0.805	0.815	0.441	0.763

TABLE 6.3 (CONT.) MONTHLY (SEASONAL) PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR YOM RIVER, (Y.6)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Maximum	Hist.	82.935	262.670	323.103	1137.660	1527.552	2353.104	874.195	502.762	117.390	67.133	55.814	29.549
	TF	143.101	447.223	575.962	2288.069	3101.591	3058.441	1254.091	997.593	218.830	137.627	92.482	48.148
	TT	397.705	695.485	768.216	1087.936	2295.107	4943.076	2838.207	1155.781	347.710	289.911	198.334	96.955
	TTM	136.148	406.327	472.817	1259.090	1756.021	2269.237	938.394	562.561	135.778	118.959	63.206	39.716
	FM	261.697	496.655	1193.191	1350.732	2570.194	3013.937	2409.789	968.096	292.296	125.733	68.607	67.363
	FMM	193.209	274.692	655.398	852.947	1388.711	3266.722	1551.780	805.900	255.816	106.457	53.025	25.836
	FSC	155.010	397.581	539.786	2051.846	2525.331	3105.334	1250.969	1036.698	156.348	130.549	90.691	41.309
	SSC	171.696	385.741	496.614	1862.419	2406.553	3383.892	922.287	922.220	119.153	103.910	86.285	35.419
	SEN	73.718	357.572	494.737	1847.360	2540.723	3010.116	1138.253	949.378	192.344	102.872	90.880	54.163
Minimum	Hist.	1.348	8.381	28.512	13.220	102.384	276.739	114.048	22.844	13.332	5.443	4.234	1.814
	TF	1.198	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.274	0.000
	TT	0.637	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.385	0.000
	TTM	4.536	1.092	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.055	0.000
	FM	0.540	2.512	8.370	4.653	24.271	108.008	48.640	14.675	7.941	2.363	1.175	0.576
	FMM	1.357	11.130	24.900	13.077	107.496	113.847	44.356	14.449	5.185	2.117	1.647	0.706
	FSC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.891	0.213
	SSC	5.080	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	8.284	5.883	0.000
	SEN	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.541	0.000	0.000
Percentage of zero flows	Hist.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	TF	0.000	2.400	3.200	12.300	2.000	0.400	1.000	1.000	1.200	1.400	0.000	3.300
	TT	0.000	2.300	3.600	9.900	2.500	0.200	1.000	0.900	2.200	2.000	0.000	3.800
	TTM	0.000	2.900	5.100	15.600	6.000	0.200	1.900	1.200	1.700	2.400	0.000	4.000
	FM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FMM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FSC	0.000	0.000	0.000	0.000	0.000	0.400	1.000	0.000	0.000	0.000	0.000	0.000
	SSC	0.000	4.900	3.100	2.600	3.300	0.600	1.400	1.400	1.000	0.000	0.000	3.500
	SEN	0.800	3.000	3.200	9.300	2.900	0.400	1.500	1.500	2.000	1.600	0.000	4.100

TABLE 6.4 MONTHLY (SEASONAL) PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR NAN RIVER, (N.1)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Mean	Hist.	27.649	62.829	175.583	453.973	821.643	638.049	236.988	103.316	56.963	36.604	22.511	19.261
x 10^6 cu.m	TF	29.294	63.470	175.738	438.328	828.400	651.229	237.978	104.627	58.529	37.905	23.450	19.964
	TT	31.910	70.407	178.594	457.459	874.522	630.457	248.578	112.714	63.799	40.799	25.231	21.394
	TTM	26.131	58.203	139.098	343.121	711.471	430.770	188.656	89.723	52.100	33.231	20.550	17.409
	FM	29.360	67.075	178.800	446.355	899.897	621.641	249.114	112.243	62.940	40.547	25.405	22.487
	FMM	34.344	63.677	188.671	310.941	909.109	605.246	301.269	136.047	82.006	55.966	34.905	33.683
	FSC	28.210	63.644	175.981	440.150	825.526	649.943	237.935	104.771	58.650	37.586	22.788	19.361
	SSC	27.279	61.644	170.114	458.436	811.337	684.287	234.265	102.621	57.952	36.804	22.404	18.867
	SEN	27.504	64.223	181.502	460.387	812.418	631.000	233.946	101.992	57.019	38.800	24.056	20.594
Standard	Hist.	19.046	43.124	132.209	314.556	281.311	415.913	128.203	45.948	25.676	17.220	11.462	10.517
Deviation	TF	19.222	44.235	136.943	300.260	273.414	414.746	128.749	46.028	25.838	17.136	11.639	10.447
	TT	30.062	60.206	134.362	302.464	382.155	393.108	156.728	68.093	41.683	26.706	17.232	14.668
x10^6 cu.m	TTM	18.327	40.830	92.783	224.634	274.134	296.873	105.279	41.488	23.928	16.286	10.638	9.010
	FM	19.165	55.679	120.228	256.470	444.823	321.141	133.859	61.707	36.049	24.405	17.136	17.290
	FMM	16.174	46.649	96.207	116.594	367.989	300.474	165.774	76.892	39.766	25.709	18.505	19.640
	FSC	18.833	43.916	129.613	294.122	268.847	408.432	128.886	46.351	25.884	16.843	11.458	10.076
	SSC	19.548	42.996	109.235	323.121	279.882	417.610	117.382	44.005	25.456	16.931	10.508	7.847
	SEN	17.859	43.316	128.661	323.711	285.492	401.412	115.577	40.968	23.457	16.240	11.528	10.892
Skewness	Hist.	0.964	1.289	1.911	1.659	-0.012	1.035	1.387	0.906	0.450	0.364	0.715	1.389
	TF	0.916	1.334	2.014	1.756	0.112	0.979	1.598	0.916	0.529	0.510	0.982	1.243
	TT	2.711	2.008	1.494	1.355	0.597	1.205	1.920	1.562	1.684	1.487	1.809	1.848
	TTM	1.460	1.553	1.520	1.773	0.102	1.194	1.317	0.884	0.257	0.166	0.339	0.445
	FM	0.927	2.654	1.355	1.358	1.334	0.987	1.187	1.488	1.198	1.191	1.554	1.967
	FMM	0.301	2.273	0.195	-0.048	0.453	0.481	0.466	1.414	1.067	0.383	0.600	0.392
	FSC	0.926	1.357	1.753	1.801	0.130	1.011	1.624	0.953	0.474	0.516	0.876	1.309
	SSC	0.987	1.198	1.765	1.452	0.085	0.673	1.359	0.744	0.398	0.150	3.131	3.469
	SEN	0.774	1.169	1.825	1.501	0.020	1.083	1.364	1.107	0.683	0.951	0.911	0.896
Lag one	Hist.	0.058	0.516	0.349	0.423	0.314	0.426	0.516	0.728	0.763	0.956	0.952	0.906
auto-	TF	0.048	0.497	0.352	0.429	0.338	0.413	0.543	0.705	0.774	0.965	0.945	0.938
correlation	TT	0.068	0.664	0.545	0.434	0.249	0.348	0.406	0.755	0.835	0.967	0.970	0.969
coefficient	TTM	0.043	0.490	0.466	0.408	0.170	0.429	0.494	0.702	0.708	0.949	0.948	0.924
	FM	0.045	0.632	0.315	0.365	0.296	0.265	0.553	0.703	0.899	0.973	0.972	0.950
	FMM	0.065	0.707	0.545	0.100	0.568	0.759	0.924	0.584	0.979	0.968	0.925	0.958
	FSC	0.552	0.550	0.604	0.564	0.587	0.550	0.600	0.543	0.595	0.602	0.559	0.582
	SSC	0.008	0.031	-0.083	-0.041	0.020	-0.077	-0.059	0.014	0.011	0.025	0.000	0.027
	SEN	-0.049	0.501	0.273	0.471	0.363	0.436	0.523	0.650	0.683	0.951	0.911	0.896

TABLE 6.4 (CONT.) MONTHLY (SEASONAL) ANNUAL PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR NAN RIVER, (N.1)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Maximum	Hist.	72.058	184.788	592.272	1404.420	1236.210	1647.389	569.430	221.700	102.490	70.243	50.285	44.880
	TF	134.868	330.799	917.505	2684.296	1774.477	2727.116	1153.088	327.546	159.949	105.129	98.385	87.574
	TT	277.021	413.921	828.891	2111.693	2202.762	3170.673	1282.946	496.270	335.004	209.685	171.249	141.382
	TTM	134.024	321.276	738.640	1857.379	1597.922	1953.400	608.576	272.100	159.067	110.645	68.852	56.964
	FM	114.473	464.000	852.172	1742.255	3467.244	2370.294	899.342	404.159	216.553	169.028	129.242	149.195
	FMM	94.170	298.241	491.672	590.445	2299.444	1604.519	668.148	358.614	192.150	124.590	79.456	70.701
	FSC	124.537	331.756	867.522	2642.268	2214.448	2785.287	1176.633	353.407	149.841	108.879	76.780	77.020
	SSC	141.014	260.912	739.914	2380.762	1607.532	2238.812	1025.528	340.118	153.090	89.792	116.454	88.966
	SEN	94.817	251.169	925.942	2313.049	1768.772	2611.972	958.654	329.165	171.295	118.547	101.424	101.708
Minimum	Hist.	6.838	16.063	25.363	82.866	377.598	178.243	86.746	41.697	27.471	13.418	9.439	7.962
	TF	0.000	0.000	0.000	19.659	0.000	0.000	31.459	13.831	0.000	0.000	0.000	0.000
	TT	0.000	0.000	1.576	7.556	0.000	0.000	4.214	3.640	0.000	0.000	0.000	0.000
	TTM	0.000	0.000	1.247	5.573	0.000	0.000	9.857	8.236	0.000	0.000	0.000	0.000
	FM	0.190	0.697	3.263	11.884	29.366	16.129	4.209	2.137	1.070	0.729	0.399	0.286
	FMM	1.090	3.340	1.717	16.538	25.557	21.058	8.140	4.614	2.485	1.373	0.840	0.721
	FSC	0.000	0.000	0.000	2.163	0.000	0.000	30.690	13.682	0.000	0.000	0.795	1.107
	SSC	0.000	0.000	58.735	0.000	0.000	0.000	0.000	2.972	0.000	0.000	0.000	0.000
	SEN	0.000	0.000	1.048	0.000	0.000	0.000	21.906	27.686	0.867	0.000	0.000	0.000
Percentage of zero flows	Hist.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	TF	2.600	2.300	0.100	0.000	0.100	2.600	0.000	0.000	0.400	0.700	0.900	0.900
	TT	2.500	2.200	0.000	0.000	0.100	2.000	0.000	0.000	0.400	0.900	1.700	1.700
	TTM	2.900	1.900	0.000	0.000	0.400	4.900	0.000	0.000	0.700	1.400	2.500	2.500
	FM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FMM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FSC	0.000	0.000	0.600	0.000	0.200	0.000	0.000	0.000	0.200	0.500	0.000	0.000
	SSC	4.300	1.200	0.000	0.300	0.100	3.000	0.200	0.000	0.400	1.500	0.800	1.500
	SEN	2.400	1.700	0.000	0.500	0.300	3.200	0.000	0.000	0.000	0.100	0.400	0.600

TABLE 6.5 MONTHLY (SEASONAL) PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR NAM MAE TAENG, (P.4A)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Mean	Hist.	9.669	24.545	43.657	39.463	108.411	136.214	96.103	74.256	48.298	23.850	12.294	9.096
x 10^6 cu.m	TF	11.588	26.513	44.028	38.429	104.632	133.838	92.917	71.132	48.346	23.614	15.114	13.302
	TT	14.045	31.526	49.892	39.882	100.812	131.976	96.652	67.993	53.515	24.128	16.447	14.528
	TTM	10.271	24.728	40.166	28.368	66.784	87.350	67.681	43.034	40.482	16.478	12.057	10.923
	FM	10.075	27.700	47.454	41.983	106.467	141.199	98.722	71.530	51.885	22.772	12.333	9.274
	FMM	8.410	34.340	66.378	30.441	88.384	125.753	106.557	89.834	66.135	14.274	6.033	4.856
	FSC	9.946	24.538	43.518	38.563	105.541	133.543	93.466	72.592	48.613	22.991	12.280	9.386
	SSC	9.618	23.454	43.120	40.522	101.685	136.156	95.170	68.192	47.589	21.093	22.178	7.678
	SEN	10.669	23.370	44.630	39.808	105.023	131.090	92.825	70.003	48.360	23.037	14.582	10.689
Standard	Hist.	10.603	14.825	23.897	27.378	100.273	103.517	60.288	66.772	22.624	23.625	11.559	8.513
Deviation	TF	10.371	13.750	24.394	26.046	94.740	93.949	53.210	58.612	21.761	23.617	11.328	7.972
	TT	17.843	28.328	39.343	30.772	74.340	90.160	62.775	53.364	36.402	25.382	14.168	11.291
x10^6 cu.m	TTM	8.118	11.818	20.889	21.436	51.747	44.753	29.288	30.920	16.397	15.859	8.131	5.773
	FM	11.532	20.397	35.578	36.687	79.047	88.161	61.219	56.189	31.054	17.796	11.929	9.293
	FMM	11.017	25.695	57.125	30.945	69.444	69.096	72.947	72.586	43.551	14.380	6.102	5.396
	FSC	9.255	13.148	23.441	25.512	94.529	93.575	53.972	60.533	21.967	21.101	10.779	7.657
	SSC	11.019	11.971	23.014	27.255	86.982	107.396	57.804	56.366	21.983	0.000	14.298	6.495
	SEN	10.040	13.753	23.941	27.555	90.586	87.979	51.560	56.051	22.806	21.552	12.201	8.455
Skewness	Hist.	2.142	2.601	1.396	0.601	3.603	2.723	2.552	2.653	1.879	3.164	1.105	0.832
	TF	2.286	2.504	1.548	0.751	3.297	2.308	2.344	2.497	1.790	3.684	3.167	3.139
	TT	4.326	3.233	2.137	1.552	1.708	3.064	2.658	2.302	2.234	3.339	3.043	2.794
	TTM	2.249	2.801	1.583	1.023	1.856	2.060	2.074	2.025	1.876	2.196	2.566	2.458
	FM	2.280	1.942	2.360	2.272	3.260	1.852	2.104	2.938	1.704	1.820	1.972	1.990
	FMM	1.320	2.755	3.059	3.145	1.893	1.169	1.607	1.997	1.941	2.277	1.408	1.377
	FSC	2.018	2.666	1.521	0.824	3.351	2.263	2.526	2.677	1.800	3.266	1.517	1.064
	SSC	2.251	2.826	1.193	0.666	4.044	4.337	4.670	2.057	1.158	1.001	8.367	2.548
	SEN	2.389	2.117	1.236	0.690	2.859	2.510	2.347	2.503	2.176	2.178	4.721	4.180
Lag one	Hist.	0.420	0.718	0.177	0.139	0.562	0.501	0.779	0.691	0.582	0.776	0.858	0.947
auto-	TF	0.380	0.742	0.142	0.120	0.611	0.520	0.825	0.679	0.545	0.754	0.883	0.993
correlation	TT	0.088	0.839	0.620	0.264	0.812	0.491	0.794	0.740	0.492	0.718	0.838	0.980
coefficient	TTM	0.063	0.725	0.200	0.065	0.850	0.582	0.792	0.710	0.347	0.757	0.815	0.987
	FM	-0.008	0.506	0.713	0.291	0.560	0.503	0.684	0.600	0.613	0.469	0.858	0.964
	FMM	-0.023	0.572	0.894	0.580	0.260	0.120	0.448	0.455	0.919	0.445	0.530	0.934
	FSC	0.603	0.564	0.538	0.572	0.606	0.624	0.638	0.564	0.571	0.663	0.554	0.556
	SSC	-0.008	0.007	-0.067	0.016	-0.006	-0.082	-0.008	-0.019	-0.009	0.000	0.000	-0.023
	SEN	0.641	0.757	0.139	0.224	0.622	0.499	0.772	0.694	0.456	0.877	0.736	0.950

TABLE 6.5 (CONT.) MONTHLY (SEASONAL) PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR NAM MAE TAENG, (P.4A)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Maximum	Hist.	72.058	184.788	592.272	1404.420	1236.210	1647.389	569.430	221.700	102.490	70.243	50.285	44.880
	TF	134.868	330.799	917.505	2684.296	1774.477	2727.116	1153.088	327.546	159.949	105.129	98.385	87.574
	TT	277.021	413.921	828.891	2111.693	2202.762	3170.673	1282.946	496.270	335.004	209.685	171.249	141.382
	TTM	134.024	321.276	738.640	1857.379	1597.922	1953.400	608.576	272.100	159.067	110.645	68.852	56.964
	FM	114.473	464.000	852.172	1742.255	3467.244	2370.294	899.342	404.159	216.553	169.028	129.242	149.195
	FMM	94.170	298.241	491.672	590.445	2299.444	1604.519	668.148	358.614	192.150	124.590	79.456	70.701
	FSC	124.537	331.756	867.522	2642.268	2214.448	2785.287	1176.633	353.407	149.841	108.879	76.780	77.020
	SSC	141.014	260.912	739.914	2380.762	1607.532	2238.812	1025.528	340.118	153.090	89.792	116.454	88.966
	SEN	94.817	251.169	925.942	2313.049	1768.772	2611.972	958.654	329.165	171.295	118.547	101.424	101.708
Minimum	Hist.	6.838	16.063	25.363	82.866	377.598	178.243	86.746	41.697	27.471	13.418	9.439	7.962
	TF	0.000	0.000	0.000	19.659	0.000	0.000	31.459	13.831	0.000	0.000	0.000	0.000
	TT	0.000	0.000	1.576	7.556	0.000	0.000	4.214	3.640	0.000	0.000	0.000	0.000
	TTM	0.000	0.000	1.247	5.573	0.000	0.000	9.857	8.236	0.000	0.000	0.000	0.000
	FM	0.190	0.697	3.263	11.884	29.366	16.129	4.209	2.137	1.070	0.729	0.399	0.286
	FMM	1.090	3.340	1.717	16.538	25.557	21.058	8.140	4.614	2.485	1.373	0.840	0.721
	FSC	0.000	0.000	0.000	2.163	0.000	0.000	30.690	13.682	0.000	0.000	0.795	1.107
	SSC	0.000	0.000	58.735	0.000	0.000	0.000	0.000	2.972	0.000	0.000	0.000	0.000
	SEN	0.000	0.000	1.048	0.000	0.000	0.000	21.906	27.686	0.867	0.000	0.000	0.000
Percentage of zero flows	Hist.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	TF	2.600	2.300	0.100	0.000	0.100	2.600	0.000	0.000	0.400	0.700	0.900	0.900
	TT	2.500	2.200	0.000	0.000	0.100	2.000	0.000	0.000	0.400	0.900	1.700	1.700
	TTM	2.900	1.900	0.000	0.000	0.400	4.900	0.000	0.000	0.700	1.400	2.500	2.500
	FM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FMM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FSC	0.000	0.000	0.600	0.000	0.200	0.000	0.000	0.000	0.200	0.500	0.000	0.000
	SSC	4.300	1.200	0.000	0.300	0.100	3.000	0.200	0.000	0.400	1.500	0.800	1.500
	SEN	2.400	1.700	0.000	0.500	0.300	3.200	0.000	0.000	0.000	0.100	0.400	0.600

TABLE 6.6 MONTHLY (SEASONAL) PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR NAM MAE CHAEM. (P.14)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Mean	Hist.	23.919	46.615	61.423	91.999	182.137	256.225	197.551	108.101	69.396	50.805	32.028	25.046
x 10^6 cu.m	TF	23.314	46.216	61.035	89.487	181.633	257.650	195.606	108.456	69.391	50.693	31.620	24.695
	TT	25.547	50.033	64.109	95.088	188.006	261.034	201.462	113.378	73.199	53.463	33.040	25.336
	TTM	21.844	44.242	54.895	77.753	151.467	197.442	155.808	92.916	61.113	44.529	26.893	19.946
	FM	25.782	49.040	65.004	96.317	190.257	265.718	199.623	110.904	71.464	52.335	32.336	24.914
	FMM	25.296	44.393	67.740	94.599	169.978	245.641	215.631	129.457	76.791	57.189	32.360	24.617
	FSC	23.241	45.837	60.711	89.231	180.919	256.651	194.146	107.947	70.139	50.964	31.722	24.261
	SSC	23.806	45.959	60.853	92.858	180.763	265.493	188.374	107.135	68.239	50.967	30.102	22.928
	SEN	23.298	47.105	62.360	92.465	179.950	253.634	191.846	106.155	68.510	49.781	31.348	24.557
Standard	Hist.	14.647	21.863	25.966	44.289	75.868	112.738	90.663	39.347	22.985	18.559	14.589	14.248
Deviation	TF	12.821	21.614	26.449	42.290	75.400	114.312	84.042	37.973	21.620	17.309	12.876	12.253
	TT	17.791	29.827	32.176	46.056	77.313	112.211	84.530	48.295	29.822	22.618	15.251	13.372
x10^6 cu.m	TTM	12.663	20.203	20.673	32.582	62.819	86.897	54.431	33.802	18.618	15.112	11.192	10.553
	FM	15.595	24.607	32.025	44.452	77.379	111.282	78.238	46.662	24.899	18.864	11.942	10.350
	FMM	11.580	20.441	34.033	45.240	58.917	105.183	71.848	45.013	26.273	18.212	9.511	9.379
	FSC	12.366	20.950	25.973	40.095	73.283	113.216	83.938	37.788	22.901	18.559	13.909	11.971
	SSC	15.345	21.881	24.710	45.662	76.293	112.957	71.889	38.796	20.219	16.183	0.000	0.000
	SEN	12.225	21.377	26.037	44.865	74.230	109.228	77.178	35.971	20.700	14.611	11.068	10.557
Skewness	Hist.	2.569	1.241	1.160	1.663	0.774	0.395	2.415	0.716	0.991	1.566	2.274	2.638
	TF	2.213	1.210	1.325	1.783	0.882	0.342	2.319	0.484	0.621	0.964	0.970	0.992
	TT	2.441	1.738	1.247	1.260	0.859	0.985	1.512	0.968	1.033	1.154	1.182	1.183
	TTM	2.982	1.307	0.967	1.573	0.864	0.635	1.364	0.355	0.465	0.882	0.887	0.945
	FM	2.526	1.486	1.320	1.410	1.118	1.262	1.054	1.391	0.925	1.018	1.370	1.801
	FMM	1.271	1.019	1.149	1.300	1.046	0.551	0.745	0.980	1.543	0.966	1.075	1.574
	FSC	2.302	1.095	1.193	1.617	0.765	0.308	2.053	0.363	0.846	1.937	2.376	2.083
	SSC	2.732	1.044	0.978	1.555	0.684	0.157	2.467	0.218	2.520	4.413	1.002	1.002
	SEN	1.510	1.142	1.017	1.620	0.760	0.343	2.347	0.707	1.274	1.276	2.703	2.436
Lag one	Hist.	0.583	0.530	0.384	0.408	0.572	0.520	0.502	0.621	0.875	0.941	0.947	0.977
auto-	TF	0.590	0.456	0.367	0.417	0.580	0.530	0.588	0.557	0.908	0.957	1.000	1.000
correlation	TT	0.381	0.649	0.617	0.524	0.572	0.446	0.559	0.598	0.933	0.974	0.990	0.987
coefficient	TTM	0.031	0.450	0.407	0.439	0.472	0.392	0.710	0.465	0.920	0.927	1.000	0.999
	FM	0.132	0.517	0.500	0.449	0.585	0.496	0.400	0.655	0.894	0.924	0.910	0.934
	FMM	0.236	0.369	0.809	0.708	0.704	0.504	0.512	0.610	0.906	0.845	0.887	0.913
	FSC	0.657	0.577	0.627	0.698	0.638	0.653	0.751	0.595	0.654	0.672	0.701	0.728
	SSC	0.000	0.027	-0.084	-0.001	0.052	-0.049	-0.037	-0.007	-0.001	0.041	0.000	1.000
	SEN	0.651	0.470	0.375	0.437	0.566	0.494	0.528	0.526	0.852	1.000	0.901	0.967

TABLE 6.6 (CONT.) MONTHLY (SEASONAL) PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR NAM MAE CHAEM, (P.14)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Maximum	Hist.	79.073	110.765	132.564	224.687	368.755	473.990	576.115	211.939	138.413	111.024	82.166	74.909
	TF	141.446	161.608	178.390	416.493	578.494	645.980	946.790	258.020	155.278	157.520	111.140	100.554
	TT	173.213	195.413	227.058	306.855	570.025	861.223	642.620	335.313	208.244	177.746	120.733	104.549
	TTM	134.827	172.913	157.314	297.165	435.784	545.126	425.096	223.755	134.665	135.890	94.740	84.498
	FM	149.174	160.950	214.508	313.675	590.980	893.062	609.138	370.598	175.911	151.314	100.885	91.974
	FMM	56.874	138.318	226.588	256.310	366.654	505.031	621.875	378.829	226.938	152.602	82.119	60.390
	FSC	131.769	161.701	184.895	387.650	586.057	674.214	981.374	262.695	176.526	194.255	141.267	102.740
	SSC	175.168	142.154	173.752	378.847	497.653	682.100	711.763	247.166	217.382	202.150	30.102	22.928
	SEN	110.092	135.833	179.138	362.490	523.313	624.118	865.013	338.419	194.237	138.566	162.906	145.598
Minimum	Hist.	10.480	17.060	31.004	32.296	83.722	95.230	85.269	45.585	30.266	22.740	13.807	11.336
	TF	1.319	8.956	15.736	26.316	0.000	0.000	51.254	0.000	10.465	5.381	0.000	0.000
	TT	1.563	5.511	10.572	19.664	21.932	0.000	46.080	9.768	14.863	8.533	0.000	0.000
	TTM	2.714	6.673	12.052	19.048	31.772	1.078	56.685	8.833	13.441	7.716	0.000	0.000
	FM	4.647	11.098	14.837	23.633	47.867	57.546	58.404	35.073	21.494	14.321	8.574	6.173
	FMM	9.651	12.328	23.686	29.224	51.681	81.184	56.423	29.871	20.546	15.868	8.419	6.912
	FSC	6.950	6.888	13.900	17.307	0.000	0.000	36.956	0.000	11.868	11.266	8.503	7.602
	SSC	11.087	4.638	11.140	26.580	5.391	0.000	126.140	2.294	52.033	44.258	30.102	22.928
	SEN	0.000	8.090	13.408	24.748	5.621	0.000	52.671	23.863	25.714	19.588	6.262	0.000
Percentage of zero flows	Hist.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	TF	0.000	0.000	0.000	0.000	0.100	0.500	0.000	0.100	0.000	0.000	0.200	0.600
	TT	0.000	0.000	0.000	0.000	0.000	0.100	0.000	0.000	0.000	0.000	0.100	0.600
	TTM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.400
	FM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FMM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FSC	0.000	0.000	0.000	0.000	0.000	0.400	0.000	0.100	0.000	0.000	0.000	0.000
	SSC	0.000	0.000	0.000	0.000	0.000	0.800	0.000	0.000	0.000	0.000	0.000	0.000
	SEN	0.600	0.000	0.000	0.000	0.000	0.300	0.000	0.000	0.000	0.000	0.000	0.300

TABLE 6.7 MONTHLY (SEASONAL) PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR NAM MAE RIM, (P.21)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Mean	Hist.	2.408	7.996	11.822	13.707	29.300	35.124	23.963	15.032	9.969	5.726	2.957	2.190
x 10^6 cu.m	TF	2.415	8.104	11.835	13.315	29.184	34.687	23.792	15.228	10.165	5.732	2.953	2.206
	TT	2.692	8.457	12.167	13.501	29.427	35.231	25.712	15.977	11.150	6.207	3.262	2.355
	TTM	2.131	6.463	9.232	9.518	21.004	25.396	20.038	12.209	9.142	4.998	2.675	1.943
	FM	2.580	7.694	12.214	13.856	30.319	37.311	25.476	15.132	10.574	5.713	3.120	2.148
	FMM	2.690	7.387	11.171	16.512	27.636	33.982	29.315	16.312	10.977	5.124	3.090	1.941
	FSC	2.440	8.055	11.813	13.334	28.986	34.684	23.771	15.054	10.574	5.713	3.120	2.148
	SSC	2.372	7.810	11.747	13.936	28.794	34.607	24.189	14.978	9.990	5.437	2.920	2.127
	SEN	2.404	8.173	12.174	13.964	28.794	34.045	23.779	14.795	10.029	5.597	2.928	2.191
Standard	Hist.	1.528	6.543	7.109	10.067	16.989	20.300	9.685	8.927	3.995	3.579	1.512	1.477
Deviation	TF	1.497	6.632	7.172	9.568	17.063	18.781	9.561	9.149	4.078	3.436	1.443	1.381
	TT	2.265	7.568	8.317	9.587	14.976	18.554	14.272	10.790	6.455	4.452	2.171	1.802
x10^6 cu.m	TTM	1.322	5.116	5.713	7.516	11.380	11.406	7.677	7.033	3.416	3.092	1.362	1.238
	FM	1.755	5.391	8.887	9.574	15.925	20.063	13.765	9.734	5.507	3.089	1.768	1.445
	FMM	1.827	6.182	8.081	12.484	14.520	13.109	15.355	11.512	4.554	3.281	1.630	1.090
	FSC	1.508	6.187	6.943	9.347	16.751	18.787	9.480	8.568	3.959	3.351	1.496	1.410
	SSC	1.586	6.464	6.602	10.319	17.219	17.739	9.096	8.711	3.878	3.302	1.520	1.414
	SEN	1.436	6.568	6.976	10.125	15.476	17.661	9.375	8.755	4.014	3.166	1.326	1.315
Skewness	Hist.	1.080	1.849	0.796	1.291	1.558	2.078	1.023	1.644	1.147	1.879	1.240	1.008
	TF	1.236	2.185	1.022	1.509	1.699	1.595	1.042	1.870	1.220	1.902	1.326	1.171
	TT	2.417	2.110	1.415	1.385	1.474	2.276	1.871	1.881	1.522	2.184	1.627	1.506
	TTM	1.010	1.854	0.816	1.320	1.898	1.824	1.033	1.403	0.859	2.090	1.107	0.987
	FM	1.255	1.517	2.502	1.505	1.794	2.058	1.905	2.415	2.359	1.690	2.178	1.719
	FMM	1.281	1.726	1.109	0.887	1.051	1.449	1.393	1.454	1.310	2.081	1.549	1.262
	FSC	1.095	1.879	0.862	1.530	1.726	1.643	0.950	1.627	1.095	1.965	1.491	1.032
	SSC	1.107	2.026	0.616	1.272	1.784	2.052	0.628	1.465	0.946	2.956	0.295	0.844
	SEN	0.720	1.864	0.810	1.353	2.067	1.852	1.033	1.790	1.291	1.480	0.956	0.879
Lag one	Hist.	0.727	0.566	0.594	0.580	0.528	0.712	0.511	0.476	0.741	0.770	0.887	0.850
auto-	TF	0.711	0.523	0.585	0.585	0.524	0.770	0.508	0.426	0.755	0.837	0.879	0.843
correlation	TT	0.387	0.717	0.629	0.570	0.514	0.738	0.523	0.632	0.767	0.830	0.885	0.852
coefficient	TTM	0.024	0.631	0.549	0.607	0.555	0.792	0.404	0.511	0.671	0.756	0.845	0.820
	FM	0.146	0.560	0.490	0.326	0.464	0.570	0.467	0.527	0.641	0.673	0.790	0.704
	FMM	0.105	0.425	0.735	0.462	0.867	0.684	0.599	0.052	0.654	0.803	0.899	0.752
	FSC	0.643	0.671	0.627	0.655	0.640	0.706	0.652	0.650	0.656	0.715	0.634	0.656
	SSC	0.010	0.020	-0.089	-0.039	0.056	-0.056	0.031	0.005	0.031	-0.014	0.029	0.009
	SEN	0.748	0.544	0.564	0.599	0.460	0.758	0.461	0.435	0.684	0.861	0.843	0.791

TABLE 6.7 (CONT.) MONTHLY (SEASONAL) PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR NAM MAE RIM, (P.21)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Maximum	Hist.	7.109	29.163	30.185	44.187	79.229	112.925	48.246	46.742	23.273	19.008	7.591	5.939
	TF	11.422	57.502	53.320	80.036	132.059	142.864	77.754	84.426	33.567	33.168	14.034	10.892
	TT	22.116	60.885	58.709	71.478	108.847	204.967	134.768	77.542	41.058	42.092	15.787	12.869
	TTM	9.916	42.832	41.183	55.698	99.804	98.591	53.999	50.282	25.384	31.092	12.134	9.366
	FM	10.351	42.464	100.022	59.323	131.582	190.425	106.473	89.875	58.385	24.323	18.321	12.046
	FMM	10.576	31.772	44.246	65.134	94.684	118.079	80.043	55.725	34.864	25.345	10.361	8.180
	FSC	10.975	51.748	51.145	80.700	129.646	148.162	72.242	78.424	29.373	32.383	11.793	8.775
	SSC	12.196	45.457	41.318	69.576	141.668	154.122	60.389	79.129	27.834	31.351	8.423	8.830
	SEN	9.053	46.850	40.883	69.886	143.950	143.426	71.195	79.245	31.532	23.436	9.794	8.479
Minimum	Hist.	0.243	0.286	1.772	2.331	9.879	13.824	6.547	3.134	3.386	1.223	0.962	0.134
	TF	0.000	0.000	0.000	0.000	3.507	7.399	5.013	0.000	2.344	0.000	0.000	0.000
	TT	0.000	0.000	0.000	0.000	4.178	9.158	4.207	1.976	2.014	0.000	0.000	0.000
	TTM	0.000	0.000	0.000	0.000	4.181	7.618	5.668	0.476	2.996	0.000	0.000	0.000
	FM	0.154	0.170	1.543	1.388	5.141	7.834	5.515	2.973	2.740	1.147	0.658	0.127
	FMM	0.419	0.286	1.686	2.330	9.855	13.450	6.443	3.084	2.874	1.163	0.943	0.132
	FSC	0.000	0.000	0.000	0.000	2.395	7.962	2.943	0.000	2.173	0.000	0.352	0.000
	SSC	0.000	1.017	0.000	0.000	3.934	12.635	3.877	1.095	2.674	2.618	0.000	0.000
	SEN	0.000	0.000	0.000	0.000	5.442	0.923	5.092	0.975	3.082	0.221	0.000	0.000
Percentage of zero flows	Hist.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	TF	1.800	3.100	1.300	3.900	0.000	0.000	0.000	0.100	0.000	0.100	0.600	3.200
	TT	0.900	2.900	1.200	2.800	0.000	0.000	0.000	0.000	0.000	0.100	0.700	3.300
	TTM	1.700	6.200	2.400	6.600	0.000	0.000	0.000	0.000	0.000	0.200	1.200	5.300
	FM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FMM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FSC	0.000	3.500	1.400	3.600	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.300
	SSC	1.200	0.000	1.700	2.500	0.000	0.000	0.000	0.000	0.000	0.000	1.900	4.600
	SEN	2.900	3.600	1.600	2.900	0.000	0.000	0.000	0.000	0.000	0.000	0.500	3.200

TABLE 6.8 MONTHLY (SEASONAL) PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR NAM MAE KHAN, (P.23)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Mean	Hist.	3.062	16.883	22.265	21.345	55.311	97.094	70.450	48.446	28.375	13.298	5.182	2.959
x 10^6 cu.m	TF	3.130	16.944	22.336	20.309	55.061	97.698	70.536	49.602	29.472	13.921	5.343	3.109
	TT	3.727	18.658	23.527	20.881	54.810	99.934	74.544	50.506	31.898	14.856	5.920	3.292
	TTM	3.129	15.272	18.080	14.146	38.201	70.489	56.059	36.407	24.692	11.859	4.905	2.741
	FM	3.433	17.819	23.270	22.378	57.729	102.345	75.860	48.675	29.611	13.881	5.220	2.331
	FMM	2.483	13.233	21.839	14.353	54.479	90.704	87.095	65.143	30.912	18.090	3.645	0.575
	FSC	3.180	17.112	22.413	20.478	55.466	98.081	70.575	49.615	29.470	13.870	5.322	3.097
	SSC	3.096	16.585	22.071	22.171	54.483	101.340	71.066	47.489	28.668	13.411	5.090	3.004
	SEN	3.086	17.724	23.323	21.784	54.413	95.515	70.306	47.789	28.833	13.340	5.545	3.359
Standard	Hist.	4.098	15.435	17.668	22.794	41.200	53.780	32.574	34.076	16.720	12.200	5.826	4.783
Deviation	TF	4.043	15.986	17.945	21.346	41.296	54.289	32.606	35.161	16.853	11.876	5.862	4.031
	TT	6.210	19.616	20.867	20.583	37.302	57.577	45.138	38.569	24.166	15.817	7.546	4.837
x10^6 cu.m	TTM	4.168	14.090	13.715	15.359	28.988	34.742	29.027	26.196	15.310	11.919	5.893	3.629
	FM	5.196	15.901	18.554	21.411	37.748	54.048	44.180	34.859	19.539	16.698	5.091	3.537
	FMM	3.705	17.359	16.757	14.800	31.881	40.493	42.684	53.685	14.319	18.129	4.367	0.901
	FSC	3.646	15.543	17.789	21.118	41.212	54.383	32.526	35.115	16.832	11.816	5.866	4.037
	SSC	4.240	15.229	16.754	23.378	41.939	55.464	30.081	32.750	16.283	11.971	5.878	4.483
	SEN	3.596	15.759	17.205	22.772	40.511	51.526	32.462	33.809	17.090	11.158	6.207	4.507
Skewness	Hist.	2.518	1.729	0.998	2.192	1.448	1.321	0.404	1.647	0.819	1.257	1.963	2.526
	TF	2.597	1.905	1.243	2.457	1.605	1.210	0.467	1.861	0.818	1.680	2.430	2.321
	TT	4.310	2.206	1.582	1.777	1.326	1.769	1.419	1.809	1.605	2.789	2.982	2.693
	TTM	3.252	1.980	0.928	2.754	1.730	1.453	0.517	1.240	0.689	2.042	2.319	2.149
	FM	2.542	1.693	1.637	1.997	1.699	1.249	1.515	1.924	2.826	3.626	2.028	3.380
	FMM	2.433	2.058	1.664	1.162	0.888	0.590	0.290	2.046	0.717	1.869	2.332	1.890
	FSC	2.374	1.940	1.238	2.546	1.575	1.194	0.482	1.878	0.806	1.642	2.391	2.351
	SSC	2.730	1.643	0.952	2.070	1.687	1.204	0.007	1.606	0.706	1.760	3.513	4.895
	SEN	1.953	1.637	1.011	2.174	1.419	1.233	0.380	1.783	0.941	1.276	2.882	3.192
Lag one	Hist.	0.161	0.119	0.387	0.286	0.527	0.569	0.543	0.406	0.473	0.523	0.463	0.700
auto-	TF	0.136	0.094	0.401	0.284	0.525	0.572	0.559	0.365	0.496	0.537	0.430	0.789
correlation	TT	0.081	0.279	0.482	0.279	0.470	0.459	0.513	0.507	0.487	0.532	0.455	0.777
coefficient	TTM	0.059	0.131	0.415	0.276	0.492	0.524	0.443	0.518	0.394	0.425	0.473	0.821
	FM	−0.015	0.205	0.360	0.298	0.407	0.389	0.537	0.474	0.487	0.318	0.622	0.369
	FMM	0.057	0.390	0.374	0.455	0.132	0.542	0.594	0.452	0.856	0.293	0.899	0.283
	FSC	0.392	0.358	0.423	0.430	0.426	0.435	0.447	0.387	0.454	0.445	0.395	0.456
	SSC	0.059	0.029	−0.075	0.031	0.049	−0.038	−0.035	0.019	0.030	0.026	0.023	0.003
	SEN	0.253	0.121	0.332	0.343	0.530	0.560	0.558	0.383	0.426	0.542	0.388	0.735

TABLE 6.8 (CONT.) MONTHLY (SEASONAL) PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR NAM MAE KHAN, (P.23)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Maximum	Hist.	19.055	71.431	62.649	102.751	184.378	252.461	132.883	158.112	73.190	51.520	26.689	21.652
	TF	40.051	124.746	106.495	213.393	280.411	372.036	206.703	307.688	100.488	95.910	51.664	28.400
	TT	65.943	137.607	140.928	119.098	242.100	584.155	382.294	293.479	188.964	151.062	69.665	37.034
	TTM	39.025	127.371	91.515	137.114	221.445	266.101	154.264	176.410	84.675	95.319	39.763	23.466
	FM	34.023	105.010	124.668	152.199	324.581	382.324	285.778	238.356	207.069	187.099	45.590	31.830
	FMM	17.009	105.676	84.709	85.329	204.161	292.505	171.715	274.895	82.142	81.736	21.148	4.621
	FSC	35.553	122.611	106.556	219.556	287.663	381.731	216.684	312.956	99.374	93.926	50.994	31.190
	SSC	44.667	103.448	96.673	195.714	300.346	402.124	153.058	284.556	95.805	91.400	48.140	60.048
	SEN	22.449	98.253	93.983	180.192	289.537	368.550	195.757	294.112	114.155	69.216	55.868	42.994
Minimum	Hist.	0.000	0.105	1.987	0.000	11.721	27.970	27.306	9.557	4.538	0.010	0.202	0.000
	TF	0.000	0.000	0.000	0.000	0.000	12.032	0.000	0.000	0.000	0.000	0.000	0.000
	TT	0.000	0.000	0.000	0.000	0.000	8.413	0.000	0.000	0.000	0.000	0.000	0.000
	TTM	0.000	0.000	0.000	0.000	0.000	7.823	0.000	0.000	0.000	0.000	0.000	0.000
	FM	0.000	0.021	0.791	0.000	2.539	5.380	6.014	2.818	1.382	0.003	0.039	0.000
	FMM	0.000	0.022	0.692	0.000	4.465	7.162	9.440	5.285	2.551	0.492	0.113	0.000
	FSC	0.000	0.000	0.000	0.000	0.000	11.118	0.000	0.000	0.000	0.000	0.000	0.000
	SSC	0.000	0.000	0.000	0.000	0.000	6.098	0.000	0.000	0.000	0.000	0.019	0.000
	SEN	0.000	0.000	0.000	0.000	0.000	11.478	0.000	0.000	0.000	0.000	0.000	0.000
Percentage of zero flows	Hist.	18.182	0.000	0.000	3.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	18.182
	TF	16.800	4.200	6.400	7.800	0.600	0.000	0.800	0.700	1.200	7.400	11.500	23.800
	TT	13.600	3.900	6.700	6.700	0.600	0.000	0.900	1.100	1.500	10.200	11.100	25.600
	TTM	14.300	3.300	7.500	11.000	1.500	0.000	1.300	2.000	2.700	15.200	15.600	27.900
	FM	20.400	0.000	0.000	3.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	19.300
	FMM	30.000	0.000	0.000	21.600	0.000	0.000	0.000	0.000	0.000	0.000	0.000	39.800
	FSC	12.200	3.600	6.300	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	23.400
	SSC	21.600	6.500	6.900	8.100	1.100	0.000	0.900	0.600	1.800	8.100	0.000	0.400
	SEN	12.600	2.500	5.400	8.000	1.400	0.000	1.000	0.900	1.800	7.300	14.400	21.000

TABLE 6.9 MONTHLY (SEASONAL) PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR NGAO RIVER, (Y.13)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Mean	Hist.	1.313	4.500	5.053	8.991	19.409	24.434	17.068	7.603	3.379	2.393	1.218	2.959
x 10^6 cu.m	TF	1.390	4.535	5.077	8.510	19.504	24.623	17.080	7.838	3.457	2.463	1.296	1.317
	TT	1.634	5.205	5.434	9.065	19.357	25.345	18.335	8.153	3.672	2.476	1.324	1.292
	TTM	1.314	4.398	4.474	6.390	13.326	18.064	13.479	5.283	2.654	1.651	0.924	0.895
	FM	1.437	4.631	5.225	8.647	18.822	26.037	19.693	8.169	3.542	2.448	1.347	1.293
	FMM	1.601	2.945	3.927	8.000	18.495	24.959	22.620	10.060	4.268	1.845	1.256	1.313
	FSC	1.326	4.489	5.072	8.636	19.440	24.654	17.105	7.755	3.496	2.379	1.240	1.186
	SSC	1.308	4.396	5.013	9.443	19.091	25.379	17.345	7.566	3.344	2.441	1.260	1.235
	SEN	1.305	4.654	5.277	9.003	18.963	23.926	17.041	7.456	3.375	2.402	1.287	1.258
Standard	Hist.	1.404	4.330	5.257	9.276	13.672	13.867	9.344	6.781	2.768	3.012	1.525	1.561
Deviation	TF	1.396	4.513	5.355	8.812	13.753	13.876	9.311	7.124	2.782	2.796	1.403	1.415
	TT	2.260	5.749	6.102	8.801	11.967	13.579	12.293	7.207	3.046	2.797	1.454	1.452
x10^6 cu.m	TTM	1.350	4.221	4.421	6.572	9.714	8.980	8.398	4.570	1.917	1.845	0.962	0.962
	FM	1.514	4.424	5.674	7.786	11.019	13.401	13.403	6.803	2.645	2.594	1.361	1.446
	FMM	1.376	2.563	4.396	5.138	7.525	12.691	13.211	5.140	2.529	1.163	0.973	1.129
	FSC	1.341	4.073	5.250	8.653	13.562	13.946	9.360	6.524	2.751	2.695	1.412	1.329
	SSC	1.454	4.269	4.924	9.453	13.861	14.317	8.605	5.997	2.373	2.352	1.124	1.204
	SEN	1.252	4.445	5.165	9.272	13.438	12.617	8.894	6.794	2.715	2.868	1.443	1.452
Skewness	Hist.	2.063	2.452	1.706	1.935	1.205	1.485	0.695	2.160	1.909	2.829	2.646	2.427
	TF	2.207	2.727	1.917	2.065	1.356	1.384	0.761	2.384	2.011	2.122	2.036	2.036
	TT	3.732	2.596	1.951	1.496	0.820	1.165	1.423	1.795	1.734	1.879	1.954	1.972
	TTM	2.115	2.494	1.498	1.906	1.131	1.114	0.747	1.538	1.417	1.668	1.450	1.483
	FM	2.397	2.999	2.151	1.794	0.805	0.788	1.297	1.742	1.658	2.908	2.337	2.279
	FMM	1.502	1.517	2.727	0.689	-0.023	0.404	0.744	0.033	0.328	0.273	0.220	0.543
	FSC	2.109	2.508	1.937	2.228	1.324	1.340	0.781	2.200	1.770	3.108	2.913	2.191
	SSC	2.100	2.261	1.526	1.790	1.136	1.549	0.267	2.228	1.978	6.013	4.778	5.350
	SEN	1.663	2.215	1.614	1.862	1.217	1.285	0.721	2.436	2.215	2.457	2.267	2.289
Lag one	Hist.	0.511	0.173	0.127	0.050	0.350	0.658	0.441	0.089	0.858	0.941	0.967	0.986
auto-	TF	0.513	0.143	0.141	0.034	0.376	0.657	0.456	0.053	0.901	0.999	0.970	1.000
correlation	TT	0.311	0.360	0.235	0.032	0.242	0.546	0.385	0.185	0.873	0.965	0.949	1.000
coefficient	TTM	0.014	0.161	0.148	0.027	0.298	0.622	0.399	0.171	0.857	0.989	0.920	1.000
	FM	0.011	0.212	0.189	0.083	0.339	0.404	0.522	0.201	0.840	0.899	0.951	0.980
	FMM	0.134	0.594	0.159	0.540	0.362	0.300	0.603	0.669	0.800	0.843	0.966	0.982
	FSC	0.445	0.500	0.475	0.513	0.503	0.510	0.532	0.504	0.515	0.579	0.502	0.522
	SSC	0.022	0.025	-0.079	0.044	0.033	-0.062	-0.021	0.005	-0.004	-0.020	-0.016	-0.019
	SEN	0.544	0.194	0.117	0.118	0.357	0.677	0.379	0.032	0.832	0.969	0.958	1.000

TABLE 6.9(CONT.) MONTHLY (SEASONAL) PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR NGAO RIVER, (Y.13)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Maximum	Hist.	5.827	21.064	18.936	35.385	60.001	69.379	35.770	32.144	12.027	12.813	6.238	5.879
	TF	13.309	41.570	32.956	79.209	93.559	103.314	63.730	62.574	22.457	21.862	11.180	11.285
	TT	23.481	38.868	43.940	48.017	69.353	113.379	95.767	49.479	21.703	19.653	11.823	11.800
	TTM	10.786	38.454	25.258	51.469	63.626	64.674	43.208	34.862	12.217	11.339	5.593	5.598
	FM	9.976	36.722	35.560	43.078	61.980	86.077	78.848	46.800	17.511	18.655	10.064	9.485
	FMM	7.433	11.902	21.275	21.319	44.021	61.788	52.076	26.485	12.004	4.118	3.108	3.806
	FSC	12.431	36.657	33.857	81.657	88.769	102.688	64.506	62.483	21.016	28.214	13.303	10.076
	SSC	13.644	32.781	30.821	74.633	89.021	107.043	45.283	61.529	19.920	32.686	13.737	14.094
	SEN	8.806	30.608	33.634	67.474	92.576	93.395	55.230	64.269	22.009	21.950	10.734	10.776
Minimum	Hist.	0.069	0.557	0.521	0.769	4.076	8.916	3.105	0.457	0.499	0.176	0.000	0.000
	TF	0.000	0.000	0.000	0.000	0.000	3.775	0.000	0.000	0.140	0.000	0.000	0.010
	TT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	TTM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FMM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FSC	0.000	0.259	0.000	0.000	0.000	0.000	3.463	0.000	0.000	0.000	0.000	0.000
	SSC	0.000	0.065	0.000	0.000	0.000	5.061	0.000	0.000	0.000	0.000	0.000	0.000
	SEN	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.460	0.209	0.000	0.000	0.000
Percentage of zero flows	Hist.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.000	4.000
	TF	6.800	0.100	11.800	6.200	0.800	0.000	0.800	0.100	0.000	15.100	11.600	0.000
	TT	6.300	0.600	11.300	7.000	1.900	0.600	1.600	0.600	0.600	16.000	12.500	14.900
	TTM	6.700	0.600	11.300	8.800	3.400	0.600	2.500	0.600	0.600	21.000	16.800	19.400
	FM	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	3.700	3.700
	FMM	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	10.600	10.600
	FSC	0.000	0.000	9.800	0.000	0.000	0.000	0.000	0.000	0.700	8.800	0.000	11.000
	SSC	11.300	0.000	12.300	8.800	2.800	0.000	1.700	4.000	1.500	1.100	2.300	2.200
	SEN	5.900	0.600	10.400	7.500	2.300	0.100	0.600	0.000	0.000	12.400	9.700	12.100

TABLE 6.10 MONTHLY (SEASONAL) PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR NAM PAT, (N.33)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Mean	Hist.	5.551	22.063	29.994	47.207	91.751	128.474	48.219	11.497	4.794	2.510	1.386	2.134
x 10^6 cu.m	TF	5.805	22.144	29.964	45.628	89.268	128.776	48.453	11.670	4.908	2.543	1.442	2.108
	TT	7.090	26.368	34.123	40.812	79.178	133.932	56.888	14.386	6.167	3.190	1.793	2.437
	TTM	4.846	18.460	23.509	22.147	45.347	83.972	41.086	10.618	4.516	2.353	1.321	1.884
	FM	8.210	26.092	33.014	41.728	79.893	139.552	52.551	13.197	5.331	2.698	1.336	2.762
	FMM	5.303	28.344	36.725	32.637	76.008	128.261	67.308	17.118	6.848	2.866	1.489	3.457
	FSC	5.440	21.916	29.815	46.007	90.185	128.819	48.561	11.692	4.943	2.569	1.403	2.073
	SSC	5.513	21.699	29.498	50.435	82.715	135.820	48.676	11.590	4.779	2.435	1.374	1.771
	SEN	5.339	22.553	30.872	49.049	89.148	126.045	48.843	11.539	4.886	2.509	1.440	2.164
Standard	Hist.	6.466	18.767	20.650	64.485	106.315	93.235	27.312	5.446	2.234	1.568	1.244	3.417
Deviation	TF	5.922	18.924	21.245	58.890	97.634	92.220	26.405	5.219	2.197	1.499	1.219	2.687
	TT	11.241	30.937	30.737	47.101	70.568	109.919	51.287	12.878	5.601	3.323	2.178	4.076
x10^6 cu.m	TTM	5.154	15.885	14.907	33.050	51.199	52.677	24.902	5.124	2.107	1.439	1.097	2.319
	FM	13.994	30.778	32.247	54.294	65.479	107.482	46.467	10.902	3.841	2.154	1.250	7.221
	FMM	5.341	36.216	31.684	39.254	63.649	80.856	46.625	9.295	4.131	1.736	1.080	7.215
	FSC	5.458	18.494	21.085	54.546	95.755	91.264	26.209	5.301	2.223	1.549	1.265	2.760
	SSC	6.784	18.514	19.669	64.220	89.042	95.610	25.429	5.208	2.127	1.354	1.207	2.455
	SEN	5.156	18.306	19.969	62.180	94.327	79.530	26.270	5.198	2.189	1.410	1.246	2.939
Skewness	Hist.	3.073	1.572	1.383	2.280	2.499	1.989	0.089	-0.035	0.532	1.137	1.824	3.752
	TF	2.821	1.675	1.520	2.701	2.502	1.880	0.287	0.059	0.549	1.288	2.505	3.075
	TT	5.314	2.973	2.010	1.926	1.798	3.095	2.273	2.251	2.324	3.140	3.841	4.876
	TTM	3.955	1.825	1.192	3.749	2.807	2.284	0.316	0.024	0.364	1.189	1.897	2.597
	FM	5.186	4.539	2.784	3.314	2.264	2.050	2.849	2.093	1.891	2.385	3.441	8.149
	FMM	1.589	3.296	1.480	2.416	1.944	1.747	0.888	0.486	0.936	0.856	0.817	3.703
	FSC	2.835	1.661	1.528	2.507	2.509	1.867	0.296	0.070	0.511	1.416	2.188	2.857
	SSC	3.191	1.400	1.172	2.309	3.171	1.675	0.127	0.168	0.884	1.192	3.023	3.684
	SEN	2.164	1.527	1.363	2.421	2.264	2.104	0.213	0.093	0.859	0.961	2.799	3.845
Lag one	Hist.	-0.034	0.437	0.582	0.255	0.554	0.429	0.331	0.667	0.777	0.852	0.881	0.350
auto-	TF	-0.047	0.375	0.579	0.223	0.578	0.397	0.332	0.631	0.771	0.883	0.842	0.405
correlation	TT	-0.053	0.610	0.766	0.167	0.539	0.197	0.427	0.781	0.901	0.905	0.917	0.495
coefficient	TTM	-0.025	0.351	0.660	0.247	0.596	0.315	0.188	0.654	0.780	0.812	0.853	0.358
	FM	-0.027	0.820	0.609	0.215	0.281	0.328	0.545	0.700	0.894	0.868	0.819	0.517
	FMM	-0.029	0.417	0.694	0.597	0.192	0.500	0.329	0.740	0.920	0.909	0.930	0.392
	FSC	0.486	0.417	0.494	0.541	0.489	0.468	0.511	0.462	0.508	0.527	0.483	0.594
	SSC	0.016	0.024	-0.080	-0.004	0.037	-0.004	-0.016	0.014	0.006	0.019	-0.002	0.025
	SEN	0.001	0.359	0.536	0.258	0.587	0.371	0.347	0.650	0.711	0.914	0.756	0.386

TABLE 6.10 (CONT.) MONTHLY (SEASONAL) PARAMETERS FROM HISTORIC AND GENERATED SEQUENCES FOR NAM PAT, (N.33)

PARAMETER	MODEL	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH
Maximum	Hist.	31.203	68.065	95.403	248.085	456.538	438.156	90.266	22.766	10.058	6.538	4.942	16.552
	TF	62.847	142.984	141.468	596.273	796.302	742.341	150.225	29.131	14.626	13.259	12.440	25.210
	TT	138.083	265.434	220.840	301.627	513.458	1239.848	497.135	103.689	42.538	32.969	24.827	44.990
	TTM	54.796	130.339	114.819	344.292	449.222	474.820	116.669	26.284	12.782	12.509	8.256	21.853
	FM	201.935	440.493	306.672	444.762	681.158	974.250	489.963	85.684	33.768	18.923	14.545	111.030
	FMM	35.148	305.637	218.146	225.738	287.822	664.254	209.570	65.811	28.023	9.392	5.757	35.432
	FSC	59.462	134.607	135.480	545.978	809.329	724.638	138.984	29.712	13.769	12.640	10.999	24.617
	SSC	78.463	113.275	132.067	546.040	835.677	682.346	124.145	29.013	15.655	9.350	9.535	29.787
	SEN	35.227	109.210	126.245	495.114	793.800	737.625	131.902	27.620	17.311	10.264	12.727	31.258
Minimum	Hist.	0.295	3.141	1.979	1.439	14.333	32.050	11.012	1.920	1.299	0.555	0.104	0.109
	TF	0.393	0.000	0.000	0.000	0.242	24.760	0.000	0.000	0.000	0.000	0.000	0.000
	TT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	TTM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FMM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	FSC	0.741	0.000	0.000	0.000	0.000	25.670	0.000	0.000	0.000	0.000	0.000	0.000
	SSC	0.044	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SEN	0.419	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Percentage of zero flows	Hist.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	TF	0.000	3.100	0.400	19.800	0.000	0.000	3.600	1.700	0.600	2.700	7.300	11.300
	TT	0.400	2.900	0.700	20.000	0.400	0.400	4.400	1.800	0.600	2.700	8.600	12.600
	TTM	0.400	3.600	0.700	33.800	0.400	0.400	6.700	2.500	1.000	3.700	10.800	13.400
	FM	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400
	FMM	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400
	FSC	0.000	3.200	0.400	0.000	4.300	0.000	3.400	0.000	0.100	1.100	0.000	0.000
	SSC	0.000	7.000	0.700	21.600	1.800	0.600	3.400	1.000	0.500	0.800	1.300	14.800
	SEN	0.000	2.300	0.100	19.000	3.900	0.600	3.800	1.200	0.100	1.500	7.400	13.000