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TIME SERIES ANALYSIS OF SPRINGFLOW

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PREFACE

Springflow is a dependable source of clean water specially for the inhabitants of hilly and mountainous area. Springs usually gets recharged during monsoon period. As landuse change affect infiltration capacity in the recharge area of a spring, the spring's recharge could undergone change leading to variation in flow. Further, climatic variability and fluctuation can affect the precipitation and recharge to spring's flow domain.

In order to develop and harness springflow, the fluctuations of springflow need to be studied by stochastic time series analysis techniques for formulating appropriate strategies to rejuvanate/augment/conserve the springflow. The time series analysis techniques are powerful tools to understand causal mechanism of the flow series and their fluctuation. Also generated springflow data with random component of the springflow identified helps a hydrologist to recommend a sustainable and dependable flow avilable for community's use. As the continuous long record of springflow fulfilling the requirement of time series analysis are not available in our country, the 70-year monthly flow data available from Sulkovy Prameny springs in Czechoslovakia have been used to demonstrate the techniques and their utilities in planning and development of springwater.

This report entitled "Time series analysis of springflow" is part of the work-programme of the Groundwater Assessment Division of this Institute for the year 1993-94. The study was carried out by Shri A.K.Bhar, Scientist-E, under the guidance of Dr.G.C.Mishra, Scientist-F of the Division.

(S.M.Seth)

Director

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ABSTRACT

Springs are natural outlets through which the groundwater emerges at the ground surface as concentrated discharge from an aquifer. Discharge rate from a spring depends on precipitation and other hydrometeorological factors, the geology and geomorphology of the area, the aquifer geometry and its characteristics. Fluctuation of spring flow are due to variation in precipitation, hydrolmeterological parameters like temperature,changes in land use. Springs with a low discharge in variability are normally found in volcanic and sandstone formations.Springs located in mountains usually exhibit fluctuations.

Further, atmospheric processes induce randomness into the precipitation and temperature series affecting recharge to springs and subsequent spring flow. Land use change affect infiltration characteristics over the catchment area of the spring. A spring flow time series consist of trend, periodicity autoregressive and random residual components. As such, in order to improve the modelling efforts to predict springflow, a time series analysis of springflow is necessary. For time series analysis of springflow, a fairly long time series of flow data is necessary. As a long duration flow data is not available in any Indian spring, the 70 - year of monthly data of springflow data from Sulkovy Prameny Spring emanating from sandstone strata in Czeckoslovakia has been used. It was found that first order autoregressive model though simulate the field flow data,but it cannot take care of month to month dependence especially between rising and falling limb of spring hydrograph. Thomas Fiering Model is used to generate data which obviates this difficulty and the model simulate the data reasonably well except for cases when flow data differs sharply between month to month.

1.0 Introduction

1.1 Time series and its importance in hydrology

A time series may be defined as a sequence of values collected over time on a particular variable. Though it is usually taken as a sequence of observation ordered in time but it could be according to some other dimension. The daily hydrograph of a stream is an example of hydrologic time series. Examples of sequence ordered by distance rather than time are the width, particle size of the bed material etc. A hydrologic time series, say annual floods of N years is denoted as x_1, x_2, x_3,....x_N. A time series can be composed of a quantity either observed at discrete times averaged over a time interval, or recorded continuously with time. Further, a time series could be made up of only deterministic events or only stochastic events or a combination of the two. A hydrologic time series generally composed of a stochastic component superimposed on a deterministic component.

The objectives of time series analysis may be classified as description, explanation, prediction and control of a hydrological event. The main reason of studying hydrologic time series is to understand the mechanism that generates the data with properties of the observed historical record so that the further sequences may be simulated or forecasted. Time series analysis helps to describe and identifying the pattern of data which could be extended or extrapolated for the generation of future time series. Basic assumption which is in-built in such an endeavour is that the identified pattern will continue to prevail in future. If the data pattern does not persist in the future, the forecasting technique being used will give inaccurate prediction. For understanding the properties of historical data, the time series is divided into individual components and then analysed to know the causal mechanism of different components.

Some of the terms often used in time series analysis are stated herein(Garrick,1987).

Variable:

A variable is a characteristic of the system which is sufficiently well defined to enable us to measure it and which may take different values when measured at different times.

Parameter:

Also a quantity characterising a hydrological system but a parameter does not in the strictest sense change in time or at least in the time span which interests us. The area of a river catchment is a parameter, as is any properly defined index of its soil composition, or its range of elevation etc.

Hydrologic Process:

In general a process is any phenomenon that shows a continuous change in time or indeed in an area, or volume or along a line. The variation in soil moisture due to percolation is an activity, or a process, as is the evaporation and transportation of moisture from vegetation.

A Hydrologic System:

A hydrologic system as a set of physical, chemical or indeed biological processes which act upon an input variable (or variables) to produce an output variable (or variables).

Stochastic Variable:

The American Society of Civil Engineers defines a stochastic variable as a "chance variable or one whose value is determined by a probabilistic function". This twinning of the terms "Stochastic" and "probabilistic" is widespread in the literature but the two terms are not identical in meaning. "Probabilistic" is a term which has connotations in ranking, the study of extreme events and generally suggest statistical independence. "Stochastic" however retains the possible, linkage, or dependance, between successive values of the same time series. In other words, the fact that the values of the variable have been sequentially generated in time is implicit in the work "Stochastic". The study of Time Series concentrates in a particular way on stochastic variables where successive values of the variable have a dependence structure.

Deterministic Process:

In a deterministic process a definite relation exists between the value of the variable and time and successive observations does not improve information content. The instantaneous unit hydrograph (IUH) and a perfectly sinusoidal variables are examples.

2.0 Characteristics of Hydrologic Time Series

Time series can be classified into two types; i)stationary and ii) non stationary.

In a stationary time series, the general structure and statistical parameters of the series do not change from one segment of series to another i.e. by a shift in the time origin. This will not be valid for monthly series as these cannot be stationary due to the effect of season. Further the joint probability distribution in such a time series made at t_1, t_2,.... would be identical to another set of N observations made at time t_1+ k, t_2+ k, ... t_N + k for all k. The statistical relationships between N observations at origin t are the same as the statistical properties of N observations at origin t+k. Relationship is measured by correlation between any two time series observations separated by a lag of k time units. So, stationarity implies statistical equilibrium.

In a non stationary series, different segments are dissimilar in one or more aspects. Due to effects of seasons, and trends on the values of time series, the hydrologic time series are non stationary.

It is important to transform the non stationary time series values into values that could be described by the stationary time series. The approach to analyse a time series could be a) identification, quantification and removal of the deterministic trend and periodic components and thus isolating the stationary stochastic component and b) selecting an appropriate stationary stochastic process to describe the generating mechanism of the stochastic component.

Let, a variable be described as,

$$x_t = m_t + \varepsilon_t \qquad ...(1)$$

Where, m_t is the deterministic while ε_t is the stationary stochastic component. Again, m_t can be decomposed into three components: (1) trend or long term movement, (2) oscillations or fluctuations - short term movement, and (3) periodic component or a component due to seasonality.

This break up of the structure of a hydrologic series and the physical explanation for its components may be compared with the analysis of a communication time series. The signal components of a communication time series are equivalent to deterministic (periodic, transient) component of hydrologic time series. Its noise can be compared with the stochastic component of hydrologic series. Often, the physical description and explanation of signal and noise components, and their connection is simpler in communication branch than in hydrology. The interaction between periodic and stochastic components are still far from being well understood. Although periodicities are explained by astronomic cycles, and consequently by the periodicity in the energy supply from the sun over various areas of the earth's surface, and further interactions and responses of various earth's environments, the complexity of periodic components needs a much better physical analysis than is presently available. Similarly, though the stochastic component may be explained by various random processes in the air, over oceans and at the continental surfaces, that is over various geophysical environments, many more efforts are needed to improve its physical understanding, explanation and description. Analysis of the structure of hydrologic time series is considered here as a necessary initial step for a comprehensive physical explanation of composition of time and space hydrologic stochastic processses.

Let a typical hydrological time series is examined with a view to recognising reasonably quantifiable features and characteristics.

Events such as increasing urbanisation of a catchment or the active encouragement of forests or particular crops may also alter the nature of the rainfall to runoff conversion process within a catchment. Due to this the examination of a long sample record of streamflow from such a catchment could indicate a trend. Trend may also result from a slow change in the earth's overall climate, but in this respect, it is often difficult to distinguish between a trend and a long, slow oscillation. While we frequently picture trend as a progressive change in the level of the mean, we should remember that trend in the variance (and higher moments) is also possible, e.g. where a catchment tends to become more "flashy" with passage of time and with urbanisation(Garrick,1987).

Thus, trend indicates a long term growth or decline in the time series owing to various factors such as urbanisation deforestation of the catchment etc. Trend represents smooth motion of the series over a long period of time. But, a difficulty arises to decide upon what is meant by 'long term'. Climatic variation sometimes exhibit cyclic variation over a very long time period of about 50 years or so. If the data of only about 20 years are available, the long term cyclic variation would appear to be a trend. Sometimes it may be quite likely that there is an adhoc change in mean flow due to some abstraction, such phenomenon is known as jump.

A time series may be composed of oscillations about a trend. The amplitude and time interval between the maximum and minimum values in such oscillations are distributed about mean values. If the minimum and maximum values occur with constant amplitude at equal intervals of time, the series is called a cyclical time series. Thus, a cyclical time series is oscillatory but an oscillatory time series is not necessarily cyclical. This cyclicity, also known as periodicity, could be of either long range (more than a year) or short range (seasonality). A flow series may be obtained as an annual, monthly, or as a daily observed data. The annual data may not follow any long term periodic behaviour, but the seasonal cyclic effects could be present in the other series mostly as a monsoon effect.

Practically, everywhere on earth, any hydrologic time series show seasonal variation because of energy incident per unit area of the earth's surface varies substantiallly throughout the year. The energy input to the hydrological cycle effects moisture state, evaporation, transportation, temperature etc. and the overall effect is clearly visible in a hydrologic time series. Some hydrologists correlated the cyclic variation in sunspot intensity with climatic changes on the earth which produce oscillation in hydrologic time series. While this effect is likely to be present, the period of oscillation is itself variable and when relatively short samples are required to provide estimates of both the period and amplitude of oscillations, the results are often wrong.

A hydrologic time series may also contain a catastrophic event such as an extreme flood or drought. It will be important to recognise outlying events particularly in short sample records to avoid introduction of any bias.

Finally the remaining component is the random variation inherent in the hydrologic time series as the output from a stochastic process. This is the component which is primarily responsible for our inability to forecast exactly. Atmospheric turbulence and weather system are probabilistic in nature and they produce the "noise" background in all hydrologic time series. This component not only frustrates accurate forecasting, but may also mask the weaker signals such as trend or cycles other than annual cycle.

There is an inherent sluggishness or inertia in most hydrologic time series. Springflow rarely revert back to low flows within a day and hydrograph will have characteristic recessions indicating smooth transitions from one flow range to another.

While pure random component is avoidable, characteristics such as strong seasonality and/or persistence are aids to forecasting and the methods of time series analysis centre mostly in identifying and modelling these effects.

The terms "forecasting" and "prediction" are often used synonymously. From the time dependent nature of hydrology it follows that one never knows what will happen next. The degree of uncertainity depends on how fast the variable changes. If the future is dependent on the present situation, one can tell this forward looking as "forecasting". If the present situation is less relevant and estimates of the future situation depend more on statistical studies, this may be called "the prediction" and is largely a stochastic process which means that it is based on laws of probability. But, in reality, "forecasting" includes some probability or stochastic elements and prediction includes some deterministic elements.

3.0 Time Series Analysis of Springflow:

3.1 General Characteristics of runoff data

Natural annual runoff from river basins and sequences of annual precipitation, annual effective precipitation (precipitation minus evaporation) are approximately stationary time series or with properties independent of the absolute time. Annual runoff are either independent or dependent stochastic variables. For the dependent stochastic variables, the variables are usually of a simple linear dependence, approximately of the first and the second order autoregressive linear model.

The series of monthly runoff as well as monthly series of many other hydrologic variables, have periodic components of 12 months in both monthly means and monthly standard deviations. If these periodic components are removed from a monthly series, the remaining component could be considered approximately an independent stationary stochastic process for monthly precipitation and approximately a linearly dependent stationary stochastic process for monthly runoff. Similar patterns appear in series of daily river flows(Yevjevich,1972).

3.2 Work done earlier

a)Karstic springs

Large parts of Turkey are covered by soluble carbonate rock formations with karst springs significantly affecting the water resources of that country. As such, there were quite a few investigations on the structural models to understand the karst-hydrologic processes of these springs.

Investigation (Ozis and Keloglu, 1975) of a karstic spring named Sarikiz springs in Western Turkey were made for autocorrelation, spectral analysis, lag cross correlation. The spring water is used for urban water supply. The spring usually has two peaks in a year. A comparison of histogram of these peaks with that of precipitation revealed a time lag of approximately 2.5 months for the first and of 7.5 months for the second peak. A lag cross correlation between monthly precipitation and the spring discharges provide time lags of 3 to 8 month. With respect to topographical and geological conditions, it was assumed that the first lag was indicative of the water travel through karst formations, the second lag of the flow through alluvium from flooded surface areas.The apprarent propagation velocity to karst formations was estimated to be 0.13 cm/sec. This is substantially lower than velocity in karstic channels. The large time lags were considered as an indication of extremely large underground water retention.

The spring discharge series showed a significant periodicity, which is of complex nature, although the fundamental annual harmonic was predominent.

The dependence function of the stochastic component may be expressed by linear autoregressive schemes of first order for monthly data, and of first or second order for daily data. However, the correlograms display for certain time lags - a peak significantly departing from the autoregressive model, which need further investigation.

The standard deviations of stochastic residuals usually had an inherent periodicity, which distorted the second order stationarity.The random element of the stochastic component of the annual data is fitted satisfactarity in the normal probability distribution

Another time series analysis of 3 Karstic springs were made by Knisel (1972) in USA. The three springs are from the limestone area of Texas and Missouri. The Goodenough spring near Comstock, Texas and San Folipe springs at Deh Rio are maintained by U.S. Department of State and the Big springs near Van Buren, Missouri (Index No. 7-0675) are maintained by USGS and data for Big springs are published in Water Supply papers, part 7 from 1944 to 1964.

The recession plottings indicate considerable difference between aquifer systems in the same limestone and between different limestone formations. Limestone groundwater discharge may vary with depth of water in the aquifer system such that a single constant does not adequately describe the recession. The springflow time series contain significant periodicities. The karst aquifer system was assumed to be represented by a linear, time-invariant system of finite memory with lumped input.

Based on these assumptions, several methods of system identification, proven satisfactory in surface water hydrology were applied to these karst groundwater systems. The two parameter gamma function was applied as an IUH to convolute with recharge for springflow determination. System constants were determined from hydrograph analysis. Estimation of springflow contributing area enabled determination of a functional relation between area and system constant. Spring flow was simulated by convolution of rainfall and by convolution of estimated recharge with a optimised response function. Recharge as input gave the best fit with observed springflow. The investigator pointed out the inadequacy of 1 day time series and suggested analysis of 12 hr and 6 hr interval time series of springflow from limestone aquifers due to rapid response of limestone aquifers to recharge.

Large parts of Turkey are covered by soluble, mainly carbonate rock formations with karst ,springs significantly affecting the water resources. As such there were quite a few investigations on the structural models of karst-hydrologic processes of these springs. Kelouglu (1985) introduced the exponential form of the recession hydrograph into the deterministic component and used autocorrelation and periodogram techniques, a comparatively new approach to model monthly river runoff processes receiving karst springs' discharge in Manavgat basin, Turkey. The deterministic component for the direct surface runoff is represented is by an intermittent Fourier series type sinusoidal Function for wet period. The stochastic elements are obtained by substracting the deterministic periodic components from the observed runoff series. By using this two part deterministic component model, it was possible to make a fairly well distinction between karst and surface runoff types. The autocorrelation analysis of remaining stochastic components showed that an autoregressive model of second order Markov chain can adequately represent the stochastic dependence. The independent stochastic element is assumed to follow the normal probability distribution. The analysis carried out with the runoff records at the Homa gauging station of Manavgat river yielded an average runoff of 113 cu.m/s for the karst effluents, of 34 cu.m/s for direct surface runoff. A comparison with the annual average precipitation, computed from an isohytel map based on the isodeviation - curve - approach, of 1750 mm/yr corresponding to 52 cu.m /s,whereas roughly two thirds can be expected as direct surface runoff, showed that such a two-part deterministic component enables a fairly well distinction between the karst and surface runoff types.

The autocorrelation analysis of remaining stochastic components showed that an autoregressive model of second-order Markov -chain can adequately represent the stochastic dependence. The independent stochastic element is assumed to flow the normal probability distribution, based on previous studies with annual series.

b) Springs from Sandstone

The Sulkovy Prameny springs together with certain other springs, form the main drainage of the sandstone strata of the Lower Turonian in Czechoslovakia in the valley of the Svitava river and in the surroundings of the town of Brezova nad Svitavou in north west Moravia. These springs are not influenced by pumping. The standstone contain large supplies of fissure groundwater which are fed in large catchment area. It is a syncline and the water bearing createaceous strata suddenly diminishes and the numerous springs occur as a result of an uplift on transversal tectonic fault. These springs were nurtured from more than a century back in order to supply water to the population for drinking purposes. Monthly discharge data of Sulkovy Pramery springs were available from 1901-70 (Kriz, 1973). The water year for the area is from November to October.

The long term average of these discharge values indicate that the discharge is lowest in January and gradually increases due to melting of snow cover and later as a result of rainfalls. The highest average monthly discharges are observed generally in April and thereafter it is generally a recession till the next January. The probable error of the long term average of spring discharges found to be about 4% only. The highest and lowest discharges that were noted during the 70 year period had been 242.2 lit/sec (March,1941) and 35.7 lit/sec(June 16, 1954). The characteristic discharge or the most frequent discharge in terms of discharge exceeding for a period in days, has been evaluated by frequency analysis and using Pearson's Curve III.

The classification of these springs on the basis of share of discharges exceeded by 10% and 90% had been done ($Q_{10\%}/Q_{90\%}$) and according to 5-unit scale on the basis of ten points sugested in ranking springs for discharge variabidity (1 to 2.5 extraordinary balanced, 2.6-5.0 well balanced, 5.1-7.5 balanced,7.6-10.00 unbalanced and more than 10 extraordinary unbalanced), the Sulkovy Prameny springs are ranked as "extraordinary balanced" with a ratio value of 2.2. The discharge of the water years 1901 to 1970 had been classifed in 5 groups.Those years where the average discharge of springs was exceeded with a probability lower than 11% is termed as extra-ordinary yielding, yielding with a probability of 11 to 40% as average yielding, dry years to 90 %, extraordinary dry years with a probability of excess over 90% .

The discharge of the springs varied on the precipitation. It was seen that the recurrence of the increases and decreases of the average annaul discharges occur as a rule in a 3 to 6 year cycle. It was found that a 3 year running average of discharge data smoothed out the periodicity of fluctuations in them.

3.3 Analyses of Sulkovy Prameny springflow data

Ozis and Keloglu (1975) stated that large data of spring discharge are available in the two previous studies, one in United States (Knisel, 1972) and the other in Czechoslovakia (Kriz, 1974). As a large time series data are sparse, the Czechoslovian data reported by Kriz for the Sulkovy Prameny springs in his paper has been taken for analysis.

The monthly springflow data is available for 1901-70 for the spring and is incorporated in Appendix I. Other details about the springflow data reported by Kriz is summarised earlier.

3.3.1 Depletion time (t_o)

The variation of spring discharge during recession with time can be plotted in a semilog paper (discharge in the log scale). The slope of such a plot could vary. Any change in the slope of the line from year to year is indicative of any change or interference or otherwise in the groundwater system. A progressive flattening and steepening of the slope indicate the replenishment of the aquifer and groundwater abstraction from the aquifer respectively. The springflow during recession has been expressed as (Mandal and Shiftan, 1981):

$$q(t+\Delta t) = q(t) \exp(-\Delta t/t_o) \quad \ldots(2)$$

where t_o is the depletion time The depletion time is a parameter of the spring and is the time that will be required to empty the live storage of the spring at the present flow rate i.e., dynamic storage at any time t is equal to $q(t)\, t_o$.

The values of discharge for all the 70 years data for the recession period were plotted in semilogarithm sheet. The depletion time and peak springflow discharge for each year are estimated/observed. Mean values for each decade is given in Table

Table 1. Mean values of depletion time and peak discharge

Years	Depletion time (months)	Peak springflow (litre/sec.)
1901-10	19	150
1910-20	16	162
1921-30	13	112
1931-40	18	132
1941-50	16	122
1951-60	18	105
1961-70	14	135

It may be seen that the mean values of each decade for depletion time and peak springflow does not vary widely. This means that the dynamic reserve of the springs at a given year did not change much during a span of seven decades. As such, the time series for dynamic reserve for the springs could be assumed to be stationary. A time series is said to be stationary if the joint distribution of $X(t_1),...x(t_n)$ is the same as the joint distribution of $x(t_1+\tau),... x(t_n+\tau)$ for all $t_1,...t_n$. In other words, shifting the time origin by an amount has no effect on joint distributions which are only depended on the intervals between t_1, $t_2...t_n$. This implies that the statistical parameters of the series, such as mean and variance, remain constant over time. Generally, hydrologic time series defined on an annual time scale are stationary. This assumption could be at times incorrect due to large scale climatic variability, natural disruptions like a volcanic eruption and human induced changes such as the effect of construction of reservoir on downstream flow. Hydrologic time series defined at the time scales smaller than a year, such as monthly series, are typically non-stationary (Salas, 1992). The dynamic reserve of the springs are plotted on a probability paper. The dynamic reserve at 30, 60,and 90 percent probabilities are 700 $*10^3$, $460*10^3$, $225*10^3$ Cu.m.(Fig.1).

4.0 Applications of models for time series analysis of springflow

4.1 Autoregressive model (AR model)

If a time series x_t at time t depend linearly on x's at time t-k, for k=1,2...., the time series is called autocorrelated, serially correlated or correlated in time. Otherwise it is uncorrelated or independent. Autocorrelation or dependence in some hydrologic time series of flow are influenced by effect of storage such as groundwater and surface soil storages. Basins with significant storage in the form of lakes, swamps, glaciers produce streamflow series showing significant autocorrelation. Groundwater storage produces significant autocorrelation in the streamflow derived from groundwater outflow.

Hydrologic time series defined at time intervals smaller than a year (say,a monthly series) genearally exhibit distinct seasonal or periodic patterns. These result from the annual revolution of the earth around the sun which produces the annual cycle in most hydrologic events.

Removing the seasonality in the mean is accomplished by taking the difference($y_t - \bar{y}_t$), where $\bar{y}_t$ is the monthly mean for January, February, etc. When this difference is plotted the series fluctuates about zero with a particular pattern. If the variability is measured by the variance S_t^2 in each time interval in the year (i.e. monthly) and a plotting of S_t with this time

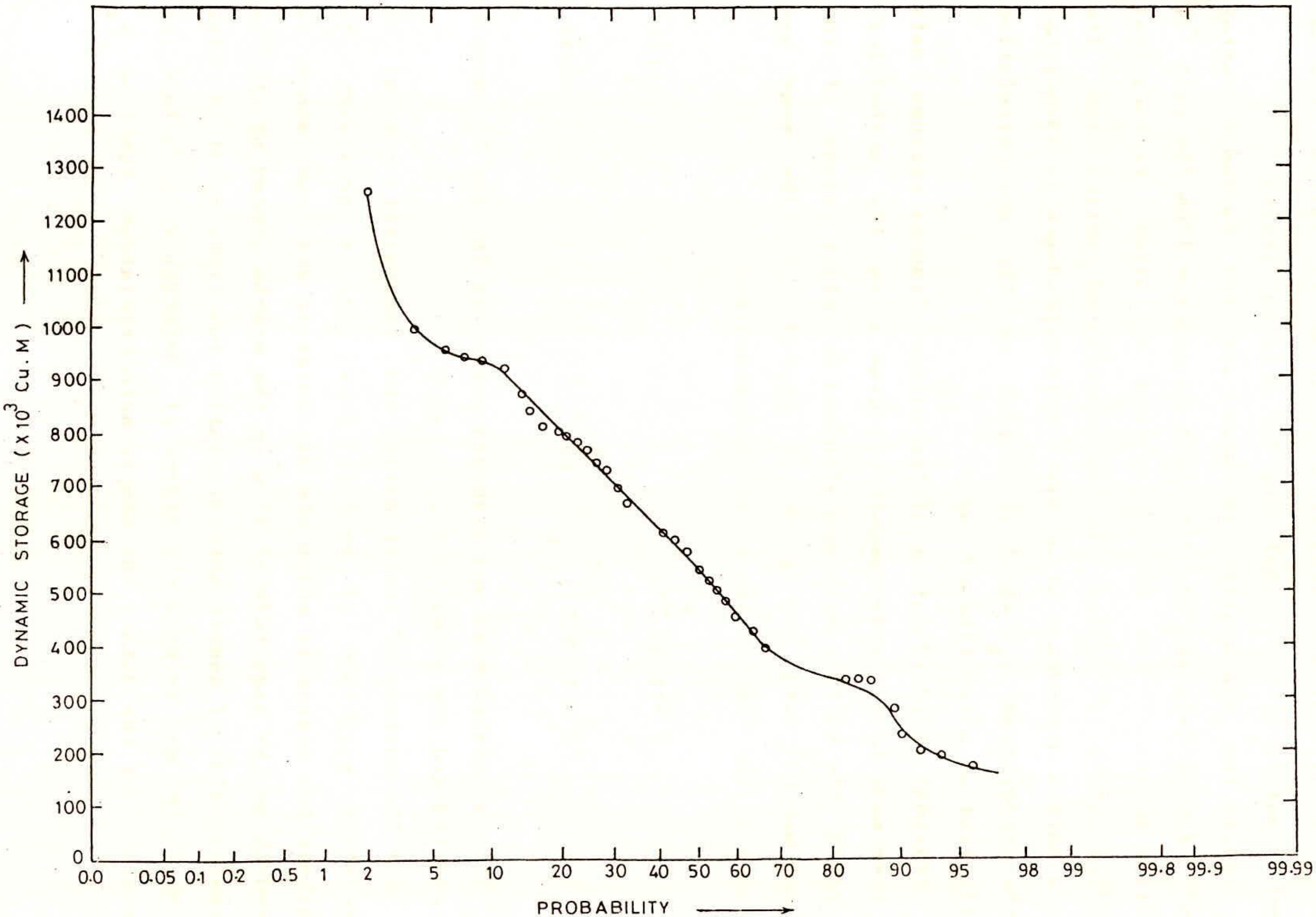

FIG.1 PROBABILITY OF OCCURRENCE OF DYNAMIC STORAGE IN SULKOVÝ PRAMENY SPRINGS

interval will show a seasonal (periodic) pattern similar to mean. The seasonality in the variance can be removed and $Z_t = (y_t - \bar{y}_t)/S_t$ is the autocorrelated series. This operation is called seasonal standardisation or deseasonalising the original series.

Unlike the seasonality in mean and the variance, other remaining seasonalities are difficult to observe from the plot of the time series. The series arrived at after the seasonal standardisation is called the autocorrelated series i.e. the series have a dependence structure. This dependence is described by the correlogram r_k, which is a plot of the autocorrelation coefficient as a function of lag k.

Seasonal standardisation of the Sulkovy Prameny springs data has been made by a simple computer program using the methodology described. The monthly mean and standard deviation values of the 70 year monthly data are given in Appendix I. The mean and variance of the time series y_t are estimated by,

$$\bar{y} = (1/N) \sum_{t=1}^{N} y_t \qquad \ldots(3)$$

$$S_t^2 = (1/(N-1)) \sum_{t=1}^{N} (y - \bar{y})^2 \qquad \ldots(4)$$

The calculated mean and standard variation for the 12 months are plotted and are shown in Figs.2 and 3.

For the purpose of investigation and subsequent removal of correlation structure of monthly flow, it is necessary to ascertain the degree to which the discharge in any one month is dependent on the magnitude of flow in the months preceding it. The estimated value of sample autocorrelation function, r_k of a time series is the way to know the degree of dependence structure or persistence of the data. The sample autocorrelation function r_k

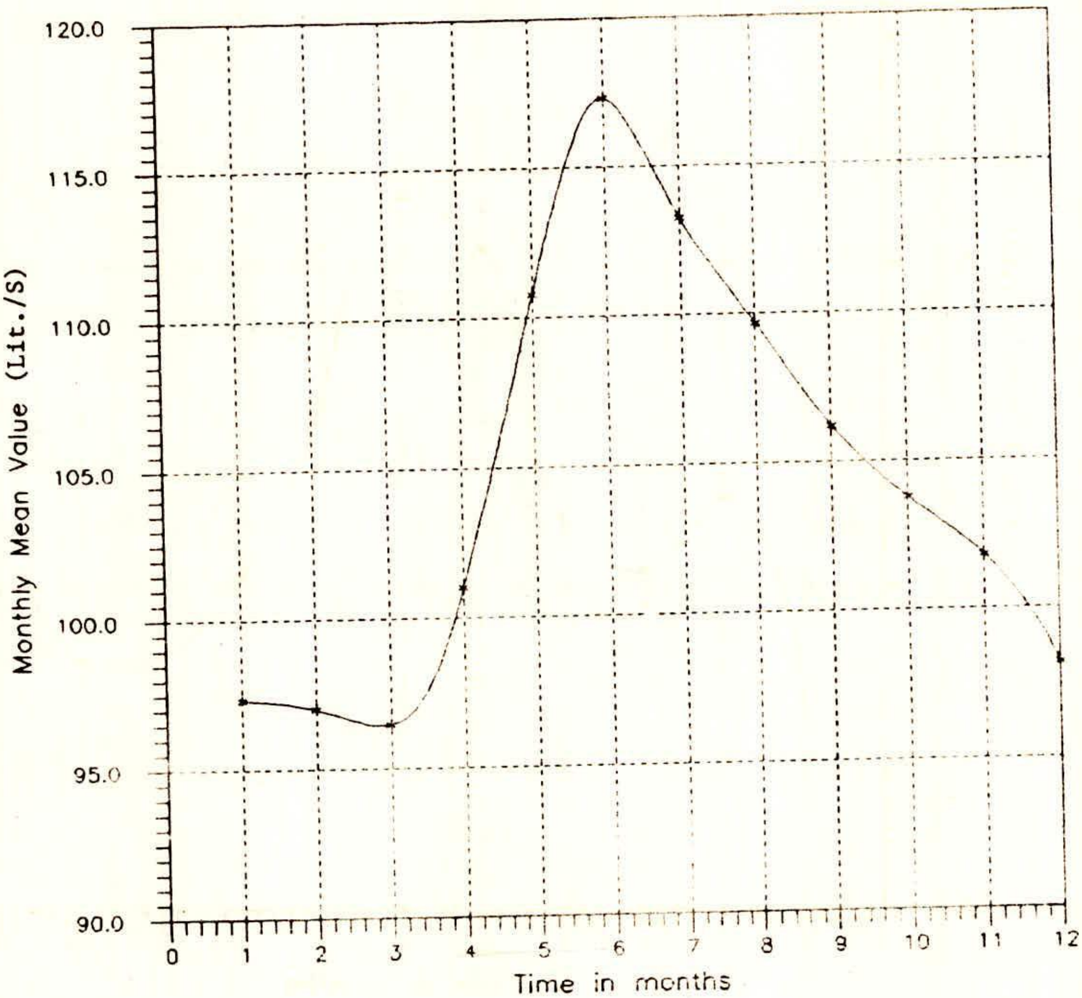

Fig. 2 : Mean Monthly Spring Discharge

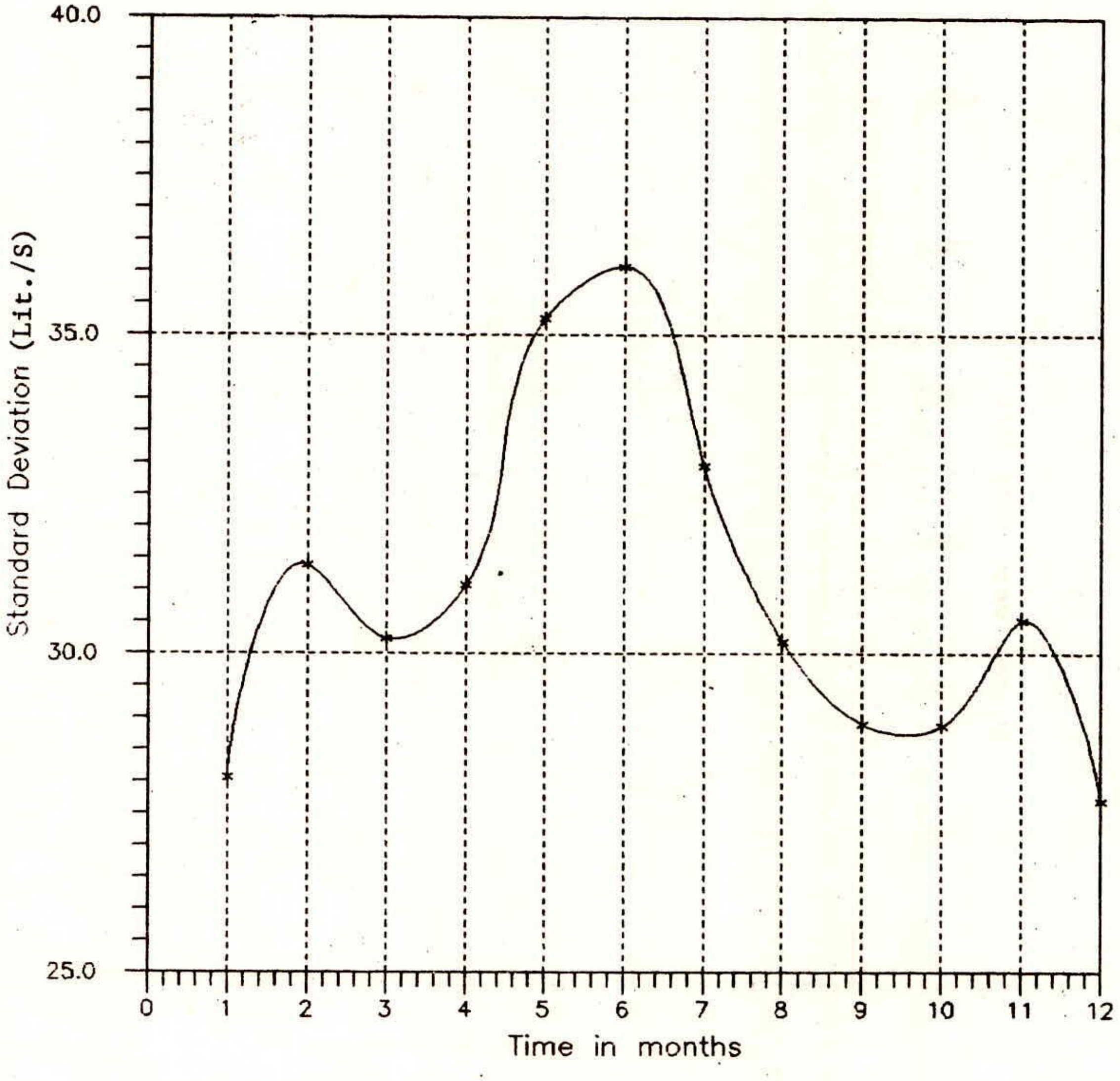

Fig. 3 : Variation of Standard Deviation with Time

of a time series could be estimated by,

$$r_K = C_k / C_o \qquad \ldots(5)$$

$$C_k = (1/N) \sum_{t=1}^{N-K} (y_{t+k} - \bar{y})(y_t - \bar{y}) \qquad \ldots(6)$$

$$C_o = \sum_{t=1}^{N} (y_t - \bar{y})^2 / N \qquad \text{for } k \geq 0 \qquad \ldots(7)$$

The estimator r_k is an estimator of the population autocorrelation and plot of r_k vs. k is the correlogram. The values of r_k should be close to 1 for time series sequences showing strong persistence. The r_k values for k = 1,.....20 were estimated and given in Appendix I. The variation of C(k) and r(k) with k are plotted and are given in Fig.4 and 5. A perusal of the values Of r_k shows slow decay as k increases, which indicates a "long memory" in the series. For time series showing strong persistence, the lag one autocorrelation coefficient is close to one. For the present case, the same is close to 0.9. Referring to eq.(2), the value of $\exp(-1/t_o)$ which is termed as recession constant or depletion factor (Singh, 1989), should always be less than unity and normally be greater than 0.9. As such the value obtained for the lag one autocorrelation coefficient for the springflow represents the recession constant of linear groundwater flow equation for springflow.

A k-order autoregressive model to fit a observed hydrologic sequence is (Clark,1973),

$$(y_t - \mu) = \beta_1(y_{t-1} - \mu) + \beta_2(y_{t-2} - \mu) + \ldots\beta_k(y_{t-k} - \mu) + \varepsilon_t(0, \sigma_E^2) \qquad \ldots(8)$$

The random variable ε_t are usually assumed to be normally and independently distributed with zero mean and variance σ_ε^2. μ, $\beta_{1,2....k}$, σ_E^2 are estimatd by $\bar{y}$, $r_{1,2....k}$ and s^2 respectively.

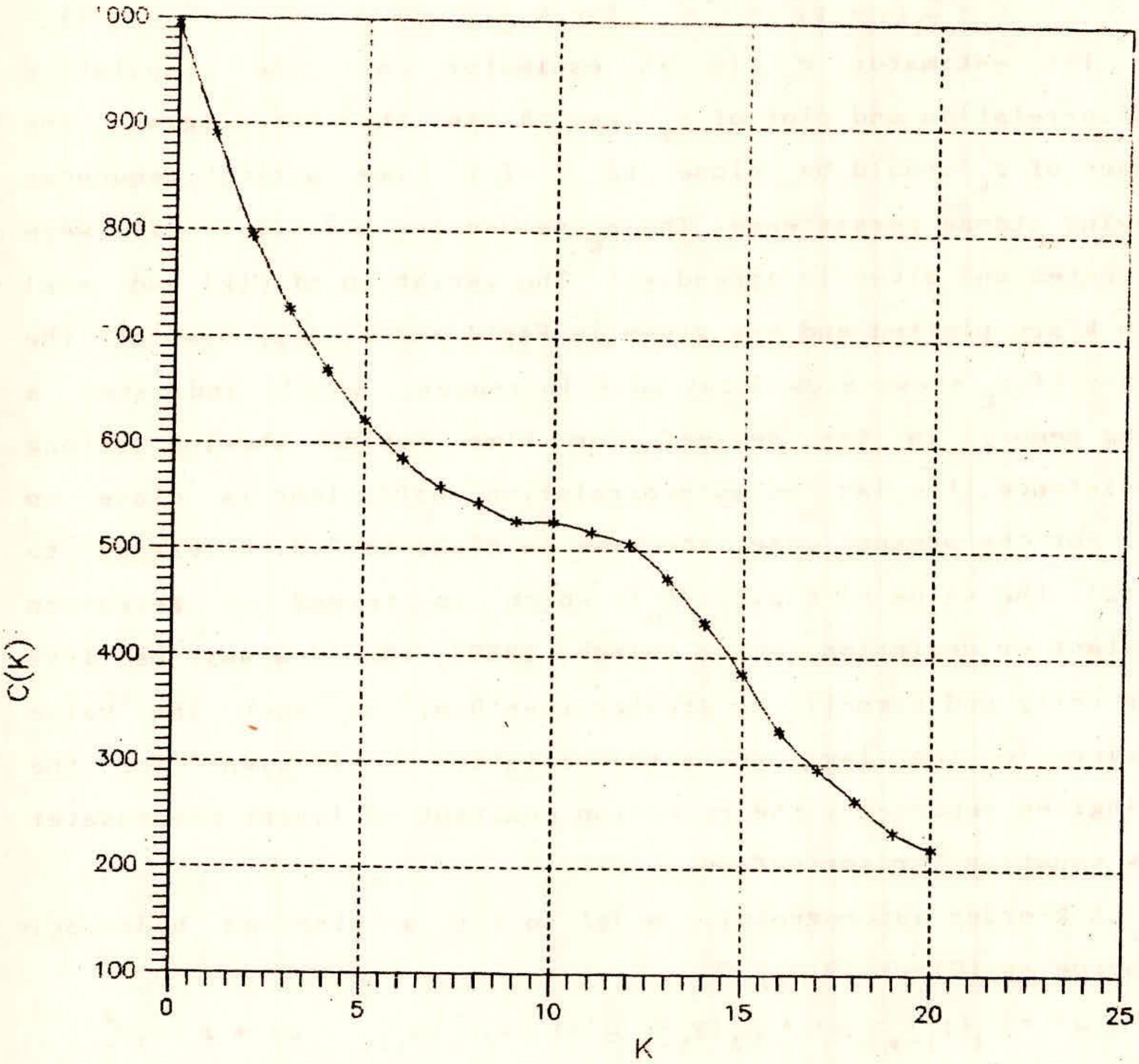

Fig. 4 : Variation of C(K) with K

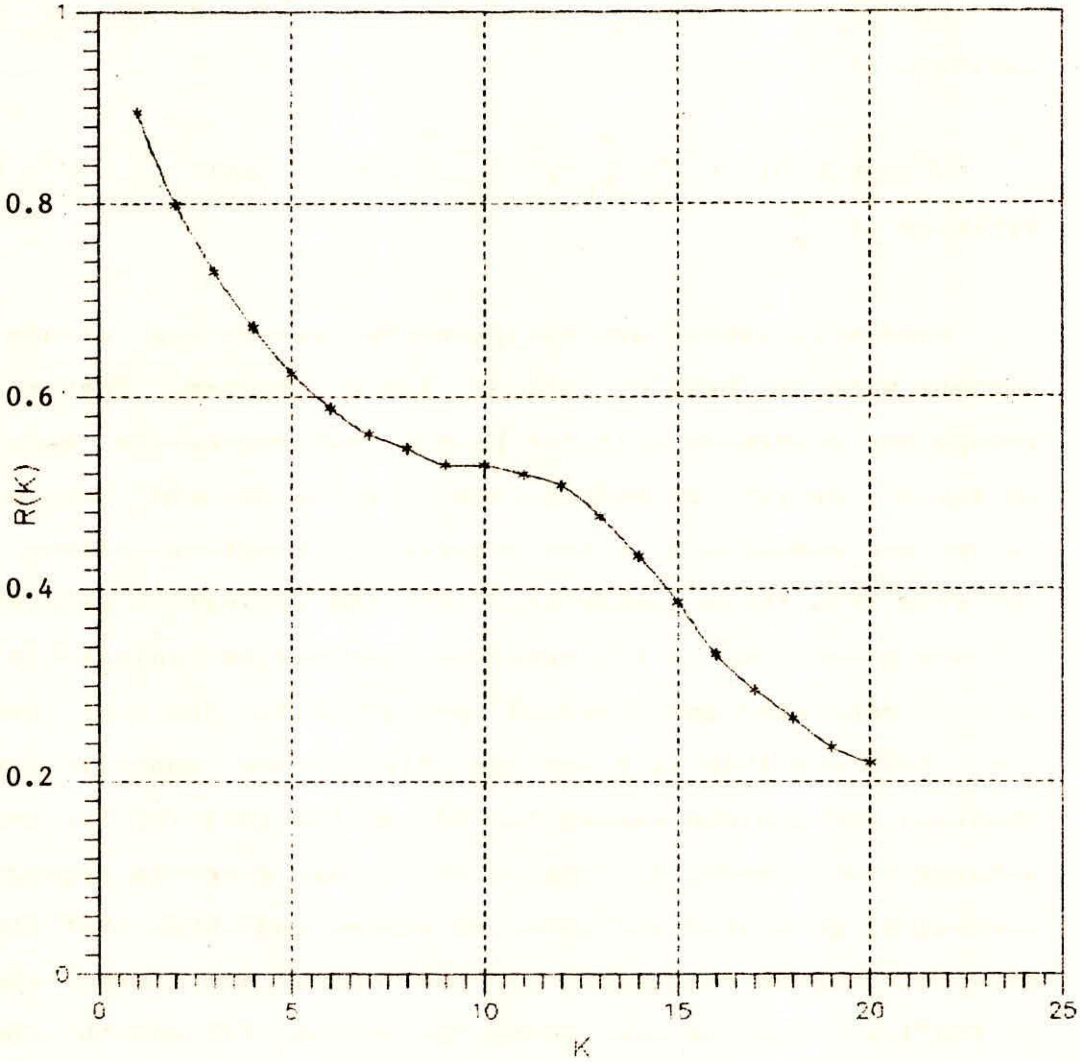

Fig. 5 : Variation of R(K) with K

The method to estimate $r_{1,2....k}$ is already stated in eqns. (5), (6) and (7).

Assuming that the given monthly time series is $(y_1, y_2, ..y_t, .. y_n)$, the equations for estimating μ, β_1, and σ_ε^2 are given below.

$$\bar{y} = (1/N) \sum_{t=1}^{N} y_t \text{ and } \bar{y} \text{ is the estimator of } \mu. \quad ...(9)$$

$$r_1 = \sum_{t=1}^{N-1} (y_t - \bar{y})(y_{t+1} - \bar{y}) / \sum_{t=1}^{N} (y_t - \bar{y})^2 \text{ and } r_1 \text{ is the estimate of } \beta_1. \quad ...(10)$$

$$s^2 = ((N-1)/N)(1-r_1^2) \sum_{t=1}^{N} (y_t - \bar{y})^2 / (N-3) \text{ and } s^2 \text{ is the estimate of } \sigma_\varepsilon^2. \quad ...(11)$$

Random variables are estimated by generating pseudo random numbers with the help of central limit theorem. The springflow values are generated with the help of Autoregressive model given in eq.(8) for various combination of r_k values and the generated values are compared with the observed springflow values. It is inferred from these comparisons that the springflow generated with r=1 are most close to the observed springflow values. A sample plot of generated and observed springflow for the last two years i.e., 1969 and 1970 is given in Fig.6. The monthly generated, observed and residue values for 840 months(1901-70) for r=1 using Autoregressive model for lag 1, AR(1), are given in Appendix-I. A perusal of generated and observed values indicates that the model does not respond reasonably for the sudden and large change of springflow values between/among the months. For smooth change of values in the observed springflow values, the model though generate values with low and negligible residues, the generated values at times showed reverse trend during the period of this

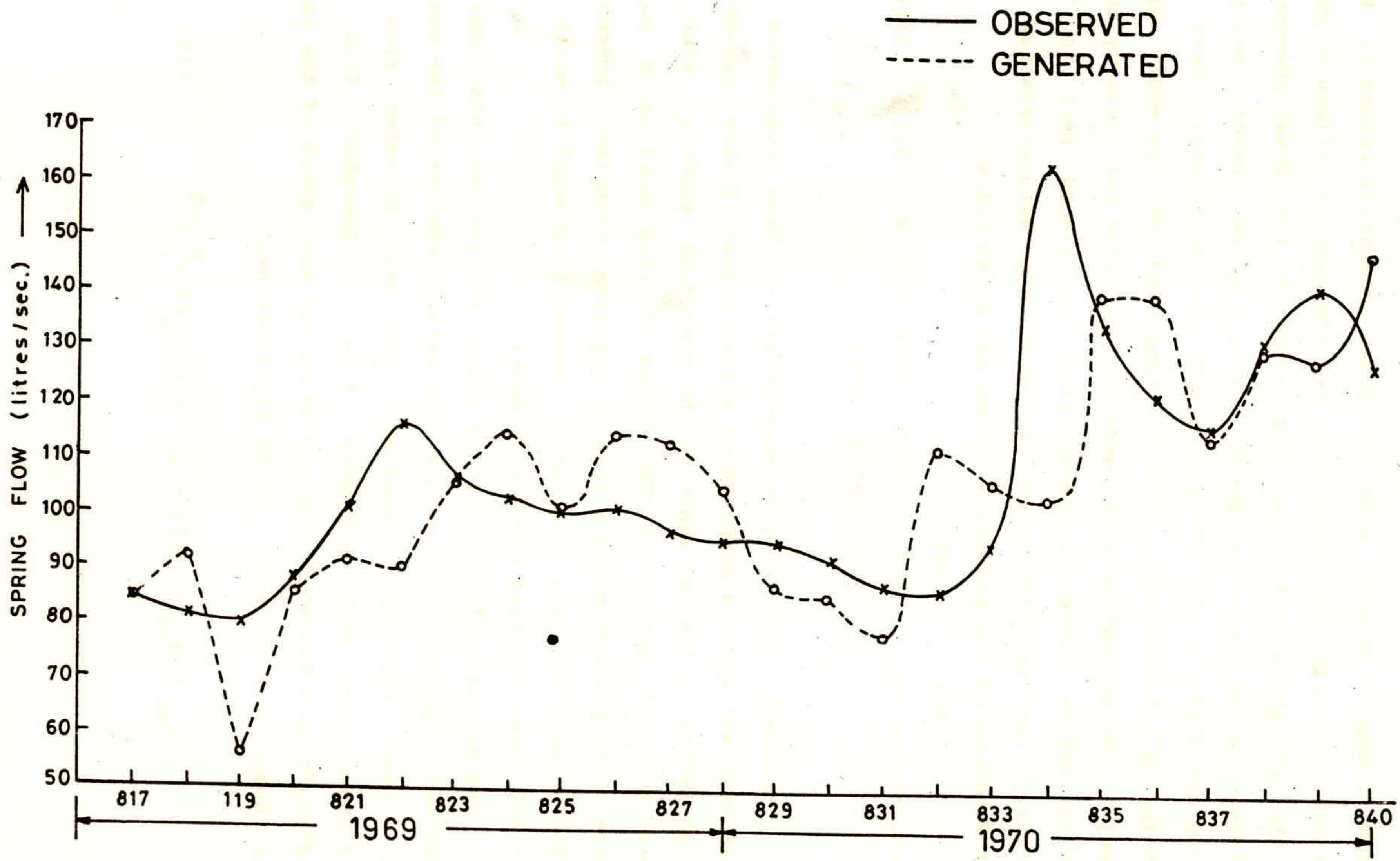

FIG. 6. OBSERVED AND GENERATED SPRING FLOW (AUTO-REGRESSIVE MODEL)

smooth change. The AR(1) model generates springflow values of the present month with the assumption that the same is influenced only by the springflow of the preceding month. As the causal phenomena influencing the preceding month's value on the present month's value are different for the rising part and the recession part of the spring's hydrograph, it is not unexpected that the model will generate the springflow with large residue value particularly when the springflow hydrograph changes from the rising part to the recession part and vice versa. The mean and autocorrelation of the Residues of the generated values are given below.

Mean : -1.0910

Autocorrelations : -.0503, -.0827, .0328, -.0214, -.0112, -.0169, -.0435, .0218, .0571

Therefore, it it will be appropriate to take cognigence of this fact and apply a model which allows a quantifiable parameter incorporated in the influence of the preceding month's value on present month's springflow. The Thomas -Fiering model is a model wherein the present month's flow is regressed upon the preceding month's value and this correlation changes from month to month.

4.2 The Thomas-Fiering model (T-F model)

The method of Thomas-Fiering allows for the non stationarity observed in monthly flow values. The method consists of the use of 12 linear regression equations. The mean November flow is regressed upon mean september flow ; December flow is regressed upon November flow and so on for each month of the year. The Thomas -Fiering model can be expressed as,

$$q_{i+1} = \bar{q}_{j+1} + b_j(q_i - \bar{q}_j) + z_i S_{j+1}(1-r_j^2)^{0.5} \quad ..(12)$$

q_i, q_{i+1} are the springflows during i th and (i+1) th months,

$\bar{q}_j$, $\bar{q}_{j+1}$ are the mean monthly springflows during j th and (j+1)th months,

b_j is the regression coefficient for estimating flow in the (j+1)th month from the jth month ,

z_i is the random normal deviate (0,1),

S_{j+1} is the standard deviation of springflow in the(j+1)th month, and

r_j is the correlation coefficient between flows in the jth and (j+1)th months.

Given N years of springflow data, the calculation for Thomas Fiering model is as follows,

(i) For each month, j=1,2,..12,

(a) the mean flow $\bar{q}_j = \sum_i q_{ji}/N$; (i=j, 12+j, 24+j ...)

(b) the standard deviation $S_j = \{\sum_i (q_{ji} - \bar{q}_j)^{0.5} /(N-1)\}$

(c) the correlation coefficient with flow in the preceding month,

$$r_j = \frac{\sum_i (q_{ji} - \bar{q}_j)(q_{j+1,i} - \bar{q}_{j+1})}{\{\sum_i (q_{ji} - \bar{q}_j)^2 \sum_i (q_{j+1,i} - \bar{q}_{j+1})^2\}^{0.5}}$$

The r_j values i.e, November springflow value regressed upon october(r_1), December springflow value regressed upon November(r_2) and so on for each month of the year, are plotted in Fig.7.

(d) the slope of the regression equation relating the month's flow to flow in the preceding month, $b_j = r_j S_{j+1} / S_j$

(ii) The new variables are $y_i = (q_i - \bar{q}_j)$ and a set of twelve regression equations are,

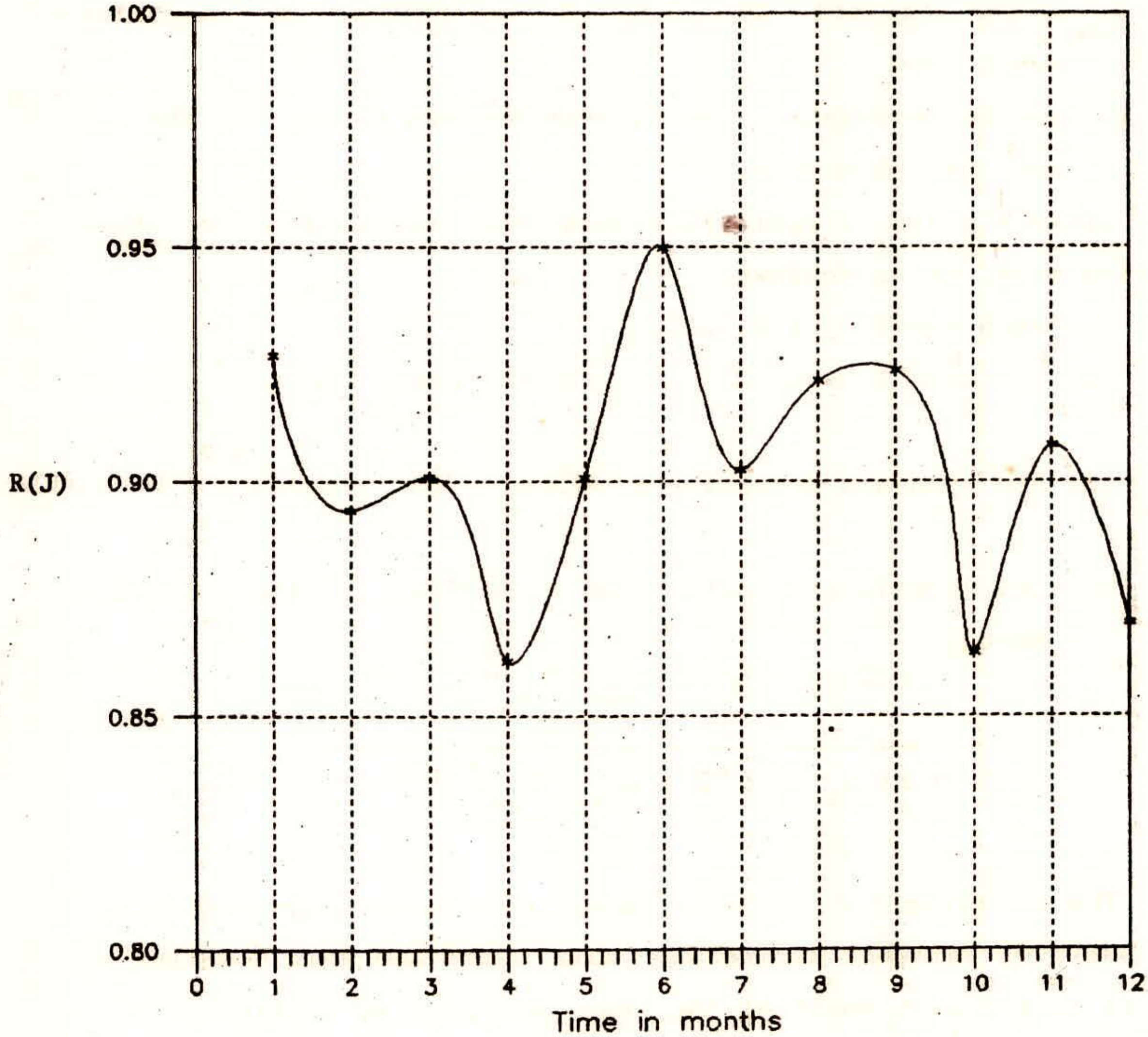

Fig. 7 : PLOTTING OF R(J)

$$q_{i+1} = \bar{q}_{j+1} + b_j(q_i - \bar{q}_j) + z_i S_{j+1}(1-r_j^2)$$

where z_i is a random normal deviate N(0,1).

(iii) Pseudo random number (z_1, z_2 ...) sequence is calculated using central limit theorem and is subsituted in the model to generate the sequential monthly springflows.

A simple Computer program is prepared incorporating the above mentioned procedures. The mean and autocorrelation of the generated springflow are given below.

Mean : -.7864

Autocorrelations : -.0100, -.0607, .0125, .0146, -.0187, -.0324, -.0555, .0699, -.0114

A comparison with the mean and autocorrelation of generated springflow by T-F Model with those from AR(1) model shows the mean and autocorrelation are more close to zero and the T-F model improves the data generation capabilities. Further the generated values could simulate the major peaks reasonably well compared to AR(1) model. However, there are some differences in simulating some local peaks. The observed, generated and residual and other results using T-F model are given in Appendix-II. The plotting of observed and generated springflow for 1901-10 and for 1961-70 are given in Figs. 8 and 9.

5.0 Conclusions and discussions

From the results obtained from the analysis of the 70 year monthly springflow data of Sulkovy Prameny springs by AR model and T-F model, it is inferred that the T-F model is capable of generating springflow data better. Further the T-F model could be generalised to improve its effieacy in predicting springflow.

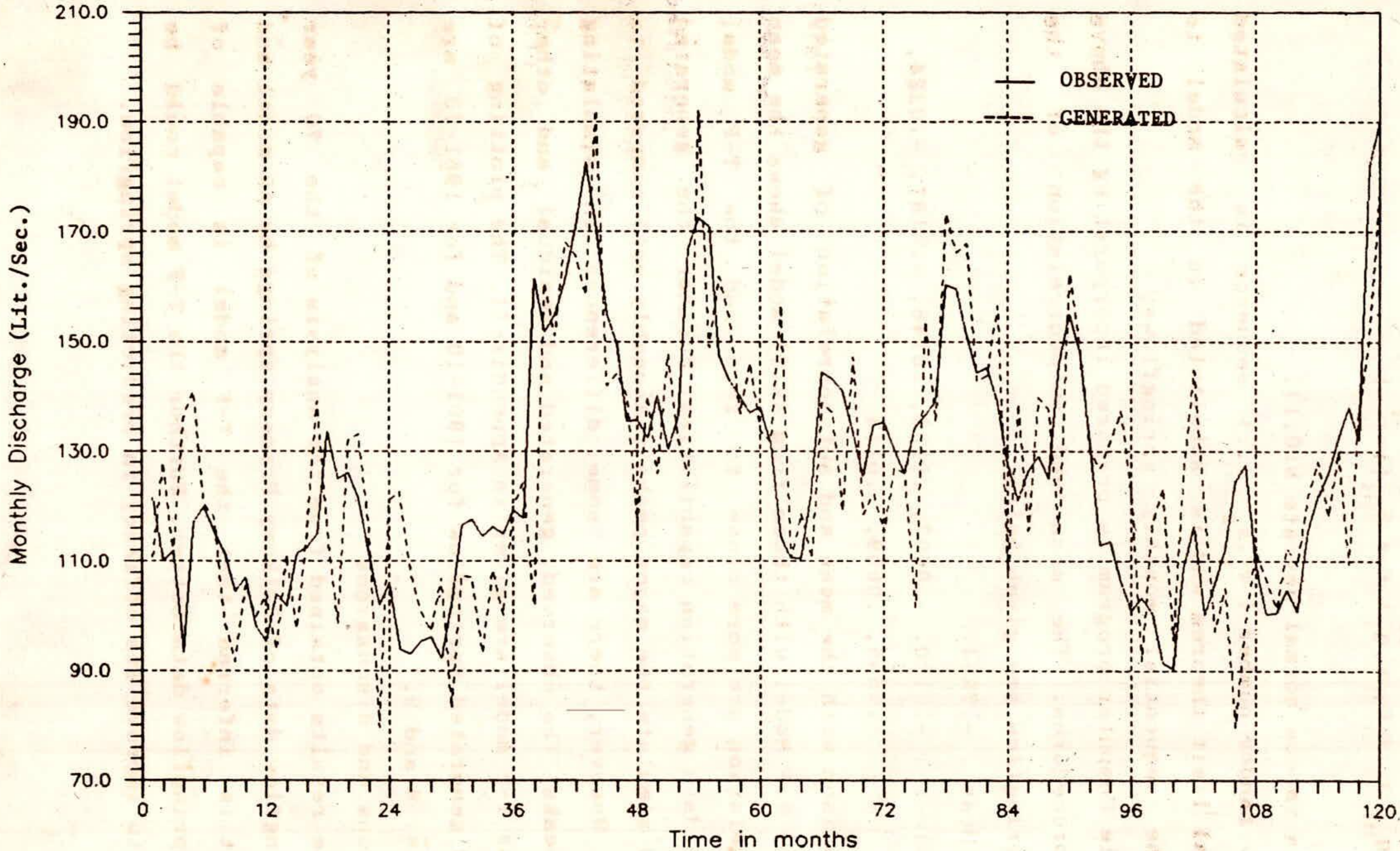

Fig. 8 : Mean Monthly Spring Discharge

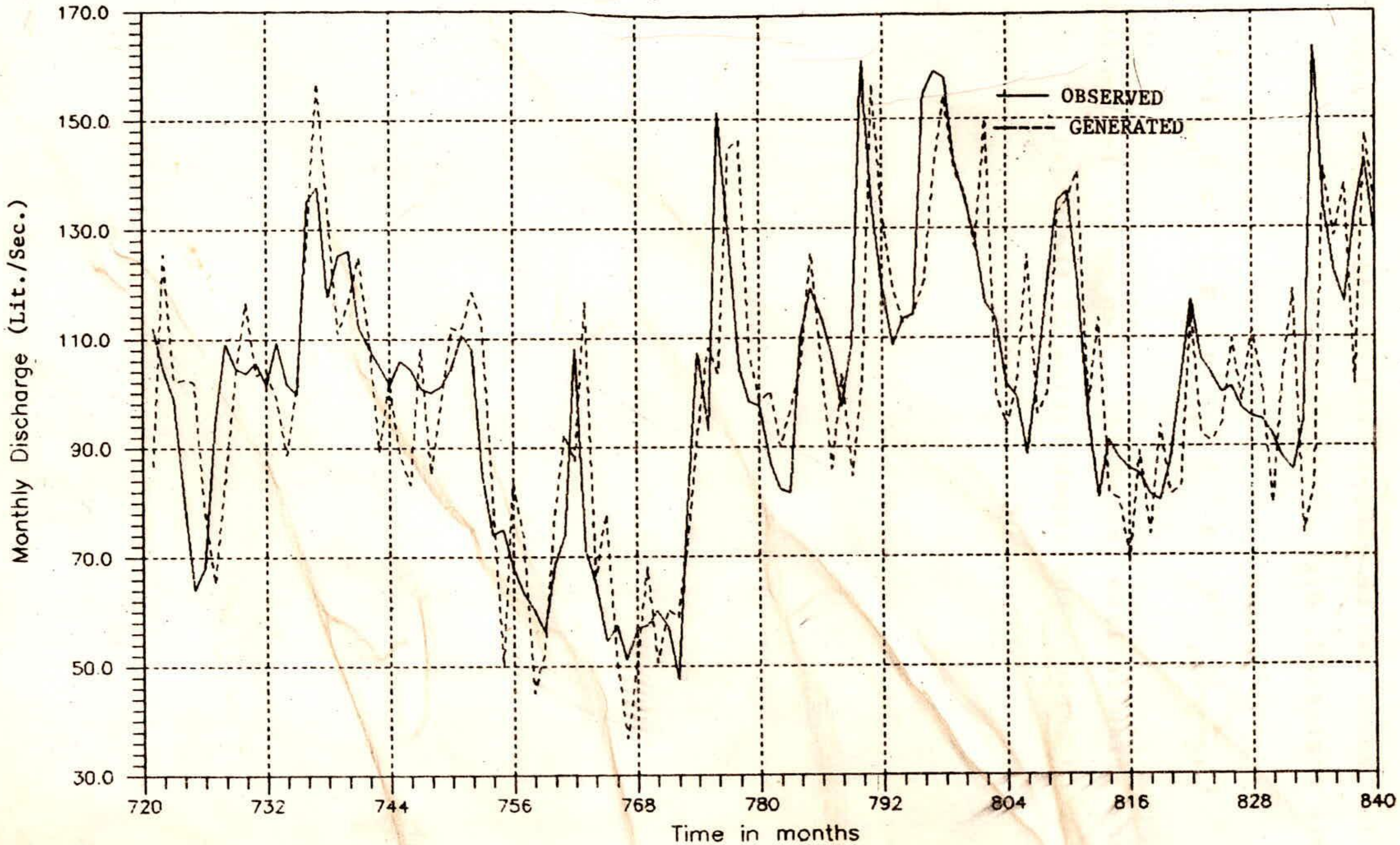

Fig. 9 : Mean Monthly Spring Discharge

The T-F model can be generalised by adding more terms to make it multiple regressed, e.g.,

$$q_{i+1} = \bar{q}_{j+1} + b_{1,j}(q_i - \bar{q}_j) + b_{2,j}(q_i - q_j) + z_i S_{j+1}(1-r_j^2)$$

Other variables like rainfall can also be included in similar way to improve the capabilities of the model.

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RESULTS FROM AUTOREGRESSIVE MODEL

MONTH	MEAN DISCHARGE	STANDARD DEVIATION
1	97.3443	28.0537
2	97.0114	31.3844
3	96.4686	30.2373
4	101.0143	31.0733
5	110.7729	35.2582
6	117.2986	36.0756
7	113.2529	32.9477
8	109.6757	30.1894
9	106.2014	28.8995
10	103.7714	28.8696
11	101.7900	30.5219
12	98.1729	27.7002

Water year: NOVEMBER TO OCTOBER

All values are in litres/sec.

K	C(K)	R(K)
0	.9947435E+03	
1	.8907093E+03	.8954160E+00
2	.7949617E+03	.7991624E+00
3	.7259290E+03	.7297650E+00
4	.6682242E+03	.6717553E+00
5	.6211224E+03	.6244045E+00
6	.5854534E+03	.5885471E+00
7	.5583828E+03	.5613334E+00
8	.5434971E+03	.5463691E+00
9	.5265361E+03	.5293185E+00
10	.5259361E+03	.5287153E+00
11	.5169999E+03	.5197319E+00
12	.5053361E+03	.5080065E+00
13	.4731251E+03	.4756252E+00
14	.4319035E+03	.4341858E+00
15	.3846513E+03	.3866839E+00
16	.3303135E+03	.3320590E+00
17	.2944212E+03	.2959770E+00
18	.2648280E+03	.2662274E+00
19	.2346784E+03	.2359185E+00
20	.2187313E+03	.2198872E+00

N	GENERATED	OBSERVED	RESIDUE
2	116.7866	110.0000	6.7866
3	131.2395	111.9000	19.3395
4	100.8200	93.4000	7.4200
5	92.0694	117.2000	-25.1306
6	105.9659	119.8000	-13.8341
7	128.3756	115.4000	12.9756
8	118.4425	111.5000	6.9425
9	118.4970	104.4000	14.0970
10	108.8236	107.0000	1.8236
11	96.1069	98.0000	-1.8931
12	100.7126	95.4000	5.3126
13	94.5296	104.0000	-9.4704
14	85.1056	101.8000	-16.6944
15	96.0073	111.5000	-15.4927
16	111.9688	112.5000	-.5312
17	103.2380	115.0000	-11.7620
18	112.0150	133.6000	-21.5850
19	139.3144	125.0000	14.3144
20	115.7134	126.0000	-10.2866
21	148.1611	121.4000	26.7611
22	124.6163	111.5000	13.1163
23	125.4792	102.0000	23.4792
24	118.8825	106.0000	12.8825
25	119.0254	94.0000	25.0254
26	100.3871	93.0000	7.3871
27	103.4803	95.3000	8.1803
28	59.4744	96.0000	-36.5256
29	107.3423	92.2000	15.1423
30	87.8204	102.0000	-14.1796
31	105.5885	116.6000	-11.0115
32	113.3684	117.5000	-4.1316
33	100.9687	114.5000	-13.5314
34	117.6930	116.2000	1.4930
35	116.3074	115.0000	1.3074
36	107.6674	119.3000	-11.6326
37	118.7773	117.8000	.9773
38	110.9879	161.5000	-50.5121
39	161.8078	151.8000	10.0078
40	130.1466	155.0000	-24.8534
41	153.8134	161.5000	-7.6866
42	159.6341	170.8000	-11.1659
43	157.3571	182.6000	-25.2429
44	168.3190	171.5000	-3.1810
45	145.5051	155.0000	-9.4949
46	143.9613	149.5000	-5.5387
47	115.6111	135.5000	-19.8889
48	157.4969	135.6000	21.8969

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N	GENERATED	OBSERVED	RESIDUE
49	141.5832	132.5000	9.0832
50	112.2734	140.0000	-27.7266
51	112.4690	130.4000	-17.9310
52	120.0185	136.5000	-16.4815
53	102.6413	166.8000	-64.1587
54	145.6837	172.5000	-26.8163
55	178.4411	171.0000	7.4411
56	178.5520	147.5000	31.0520
57	116.9696	142.8000	-25.8304
58	125.3977	139.8000	-14.4023
59	150.4120	137.0000	13.4120
60	120.7478	138.0000	-17.2522
61	151.6535	131.2000	20.4536
62	138.2406	114.5000	23.7406
63	105.3353	110.6000	-5.2647
64	116.0198	110.5000	5.5198
65	105.2794	122.5000	-17.2206
66	92.8808	144.3000	-51.4192
67	134.0750	143.2000	-9.1250
68	174.7621	141.0000	33.7621
69	125.7674	133.6000	-7.8326
70	140.4936	125.3000	15.1936
71	148.5043	134.8000	13.7043
72	123.9201	135.2000	-11.2799
73	130.1550	130.5000	-.3450
74	130.6529	125.8000	4.8529
75	91.9712	134.4000	-42.4288
76	109.8131	136.5000	-26.6869
77	141.1666	139.0000	2.1666
78	138.8659	160.3000	-21.4341
79	161.5446	159.6000	1.9446
80	160.4426	151.3000	9.1426
81	148.4669	144.3000	4.1669
82	147.8743	145.2000	2.6743
83	126.4880	139.0000	-12.5120
84	138.8236	127.6000	11.2236
85	122.4241	121.0000	1.4241
86	129.2156	126.3000	2.9156
87	107.7212	129.2000	-21.4788
88	152.6488	125.0000	27.6488
89	137.5543	145.8000	-8.2457
90	131.5090	155.0000	-23.4910
91	167.1920	148.4000	18.7920
92	147.4837	131.8000	15.6837
93	131.6093	113.0000	18.6093
94	126.2306	113.5000	12.7306
95	104.7644	106.3000	-1.5356
96	119.3088	101.0000	18.3088

N	GENERATED	OBSERVED	RESIDUE
97	112.2835	103.3000	8.9835
98	101.7973	100.6000	1.1973
99	114.9653	91.5000	23.4653
100	96.6868	90.3000	6.3868
101	105.3773	108.8000	-3.4227
102	136.9491	116.3000	20.6491
103	122.4196	100.3000	22.1196
104	101.2497	105.8000	-4.5503
105	114.7019	112.2000	2.5019
106	99.8073	124.4000	-24.5927
107	94.3392	127.5000	-33.1608
108	137.0049	109.5000	27.5049
109	122.9151	100.4000	22.5151
110	94.9457	100.5000	-5.5543
111	111.2580	104.8000	6.4580
112	109.1129	100.7000	8.4129
113	101.9916	115.4000	-13.4085
114	119.5448	121.8000	-2.2552
115	111.7112	126.0000	-14.2888
116	138.2437	132.5000	5.7437
117	144.1986	138.0000	6.1986
118	108.4242	132.0000	-23.5758
119	162.9059	182.0000	-19.0941
120	169.9978	190.0000	-20.0022
121	170.1420	184.4000	-14.2580
122	160.2966	194.0000	-33.7034
123	204.3421	180.9000	23.4421
124	189.8127	170.9000	18.9127
125	189.1534	204.0000	-14.8466
126	180.4907	197.8000	-17.3093
127	175.7244	187.2000	-11.4756
128	203.8415	193.6000	10.2415
129	181.1687	179.9000	1.2687
130	156.4895	167.4000	-10.9105
131	135.5988	150.4000	-14.8012
132	150.6974	138.3000	12.3974
133	151.1973	134.9000	16.2973
134	113.4936	134.1000	-20.6064
135	127.9038	128.6000	-.6962
136	123.4824	134.0000	-10.5176
137	146.5592	127.2000	19.3592
138	91.2739	132.4000	-41.1261
139	140.8111	124.9000	15.9111
140	117.2293	120.0000	-2.7707
141	90.9936	113.5000	-22.5064
142	98.0773	113.1000	-15.0227
143	107.1658	106.7000	.4658
144	108.9879	112.7000	-3.7121

N	GENERATED	OBSERVED	RESIDUE
145	131.2038	136.6000	-5.3962
146	129.4963	167.0000	-37.5037
147	145.7751	118.5000	27.2751
148	120.1697	104.0000	16.1697
149	75.1625	107.6000	-32.4375
150	90.0613	100.0000	-9.9387
151	78.5914	95.5000	-16.9086
152	72.8911	90.0000	-17.1089
153	91.8062	105.0000	-13.1938
154	85.7755	106.0000	-20.2245
155	109.9248	77.3000	32.6247
156	79.7816	84.6000	-4.8184
157	74.4269	94.8000	-20.3731
158	123.2241	115.5000	7.7241
159	110.6879	112.8000	-2.1121
160	103.4916	123.8000	-20.3084
161	120.3795	127.6000	-7.2205
162	129.0387	110.5000	18.5387
163	93.3267	117.0000	-23.6733
164	95.8823	108.8000	-12.9177
165	135.2573	107.0000	28.2573
166	101.4482	109.0000	-7.5518
167	117.7478	105.3000	12.4478
168	106.5603	124.8000	-18.2397
169	91.5647	110.6000	-19.0353
170	128.5327	92.0000	36.5327
171	77.1258	143.4000	-66.2742
172	142.3389	141.8000	.5389
173	147.1223	166.5000	-19.3777
174	161.1086	144.0000	17.1086
175	148.7408	150.8000	-2.0592
176	129.0973	117.0000	12.0973
177	87.4176	143.8000	-56.3824
178	154.8516	148.4000	6.4516
179	148.7875	140.3000	8.4875
180	151.0542	168.4000	-17.3458
181	154.4389	165.5000	-11.0611
182	150.9524	161.8000	-10.8476
183	149.3031	179.4000	-30.0969
184	193.8531	174.0000	19.8531
185	164.3761	212.3000	-47.9239
186	179.4191	214.8000	-35.3809
187	201.6037	188.5000	13.1037
188	180.4814	168.3000	12.1814
189	190.1916	167.8000	22.3916
190	160.5365	158.3000	2.2365
191	142.7544	148.0000	-5.2456
192	149.8106	139.0000	10.8106

N	GENERATED	OBSERVED	RESIDUE
193	138.6925	136.0000	2.6925
194	127.4835	134.4000	-6.9165
195	103.5790	155.6000	-52.0210
196	158.6735	169.3000	-10.6265
197	164.1050	158.3000	5.8050
198	126.2314	186.0000	-59.7686
199	171.0326	194.5000	-23.4674
200	180.6049	162.3000	18.3049
201	141.8633	147.6000	-5.7368
202	135.2327	130.0000	5.2327
203	154.3372	123.4000	30.9371
204	114.6795	125.0000	-10.3205
205	99.7112	130.5000	-30.7888
206	139.7720	119.0000	20.7720
207	131.9682	113.5000	18.4682
208	82.3086	107.5000	-25.1914
209	107.0962	96.0000	11.0962
210	78.1274	116.8000	-38.6726
211	119.9338	93.5000	26.4338
212	87.3784	91.8000	-4.4216
213	80.6649	86.0000	-5.3351
214	107.5611	90.0000	17.5611
215	110.7126	116.8000	-6.0874
216	123.8612	97.0000	26.8612
217	86.6649	84.0000	2.6649
218	67.6023	89.6000	-21.9977
219	93.3637	87.0000	6.3637
220	116.1531	105.5000	10.6531
221	101.2015	111.2000	-9.9985
222	105.6498	110.5000	-4.8502
223	118.3968	115.8000	2.5968
224	125.4864	103.0000	22.4864
225	107.5739	100.5000	7.0739
226	88.9284	93.6000	-4.6716
227	82.6621	84.0000	-1.3379
228	116.6607	88.0000	28.6607
229	91.1445	108.8000	-17.6555
230	111.4718	155.0000	-43.5282
231	151.7457	147.3000	4.4457
232	152.4779	159.0000	-6.5221
233	162.4745	160.8000	1.6745
234	134.5348	154.8000	-20.2652
235	129.4376	138.4000	-8.9624
236	98.2242	131.0000	-32.7758
237	118.1087	143.0000	-24.8913
238	135.1589	139.6000	-4.4411
239	131.8152	130.8000	1.0152
240	116.6865	122.0000	-5.3135

N	GENERATED	OBSERVED	RESIDUE
241	129.3209	99.0000	30.3209
242	100.4257	103.3000	-2.8743
243	77.6978	125.2000	-47.5022
244	131.6689	131.0000	.6689
245	119.7966	127.5000	-7.7034
246	131.2245	127.5000	3.7245
247	111.7590	132.0000	-20.2410
248	148.9466	109.5000	39.4466
249	113.4838	95.4000	18.0838
250	113.1180	89.3000	23.8180
251	94.0222	95.0000	-.9778
252	97.9451	70.2000	27.7451
253	75.8163	51.5000	24.3163
254	52.2583	46.3000	5.9583
255	61.8915	59.8000	2.0915
256	78.8098	72.3000	6.5098
257	73.5576	68.3000	5.2576
258	67.9846	74.0000	-6.0153
259	91.4817	75.5000	15.9817
260	68.7367	80.0000	-11.2633
261	107.1572	64.4000	42.7572
262	75.1692	45.3000	29.8692
263	45.7042	64.3000	-18.5958
264	83.3023	71.5000	11.8023
265	80.0933	68.3000	11.7933
266	35.2945	76.8000	-41.5055
267	71.8483	76.4000	-4.5517
268	65.9386	109.5000	-43.5614
269	96.1599	111.0000	-14.8401
270	136.8039	106.2000	30.6039
271	100.0470	106.0000	-5.9530
272	90.4990	90.8000	-.3010
273	122.2660	75.8000	46.4660
274	100.8322	64.3000	36.5322
275	66.4387	69.0000	-2.5613
276	63.9679	68.5000	-4.5321
277	79.9849	64.3000	15.6849
278	71.6198	67.0000	4.6198
279	83.4969	66.0000	17.4969
280	65.7041	60.5000	5.2041
281	52.6173	67.4000	-14.7827
282	65.3970	81.0000	-15.6030
283	47.0318	82.0000	-34.9682
284	88.0543	86.2000	1.8543
285	83.9107	84.8000	-.8893
286	85.9137	82.4000	3.5137
287	78.2211	85.5000	-7.2789
288	76.8622	79.0000	-2.1378

N	GENERATED	OBSERVED	RESIDUE
289	82.8624	68.0000	14.8624
290	69.4174	67.8000	1.6174
291	37.6763	67.0000	-29.3237
292	73.7055	67.0000	6.7055
293	64.4174	76.0000	-11.5826
294	70.9974	83.3000	-12.3026
295	93.6938	85.2000	8.4938
296	95.6028	87.5000	8.1028
297	97.8108	126.0000	-28.1892
298	119.3869	120.6000	-1.2131
299	111.5657	86.0000	25.5657
300	71.2225	88.8000	-17.5775
301	93.0312	80.6000	12.4312
302	75.0911	83.8000	-8.7089
303	80.3075	86.4000	-6.0925
304	102.0615	91.8000	10.2615
305	115.5811	120.4000	-4.8189
306	133.6265	109.0000	24.6265
307	92.0178	96.6000	-4.5822
308	72.6818	116.8000	-44.1182
309	108.1466	139.5000	-31.3534
310	159.8802	151.0000	8.8802
311	145.2264	141.0000	4.2264
312	127.9702	115.0000	12.9702
313	99.7653	101.0000	-1.2347
314	104.3728	97.8000	6.5728
315	91.4951	105.0000	-13.5049
316	114.2970	101.5000	12.7970
317	116.3535	101.5000	14.8535
318	113.9511	133.0000	-19.0489
319	132.7611	130.0000	2.7611
320	132.1964	123.0000	9.1964
321	117.4212	111.0000	6.4212
322	128.9191	109.3000	19.6191
323	100.4301	100.8000	-.3699
324	102.9689	98.8000	4.1689
325	116.8026	99.2000	17.6026
326	102.6620	88.5000	14.1620
327	83.2635	84.8000	-1.5365
328	63.8462	99.8000	-35.9538
329	113.1200	98.5000	14.6200
330	86.7364	102.5000	-15.7636
331	105.2378	101.6000	3.6378
332	90.3032	101.5000	-11.1968
333	88.8200	87.0000	1.8200
334	88.0096	81.0000	7.0096
335	74.1157	84.8000	-10.6843
336	58.7814	73.2000	-14.4186

N	GENERATED	OBSERVED	RESIDUE
337	70.3791	67.5000	2.8791
338	72.6494	58.0000	14.6494
339	67.2093	55.2000	12.0093
340	57.8955	56.3000	1.5956
341	54.9962	64.3000	-9.3038
342	43.5175	59.8000	-16.2825
343	65.3738	69.0000	-3.6262
344	82.3092	74.5000	7.8092
345	81.6339	88.8000	-7.1661
346	72.6373	100.3000	-27.6627
347	92.4610	94.3000	-1.8390
348	96.6504	93.0000	3.6504
349	85.4847	90.5000	-5.0153
350	73.8208	81.5000	-7.6792
351	94.4513	82.2000	12.2513
352	89.0198	82.2000	6.8198
353	99.6668	83.8000	15.8668
354	86.2903	86.8000	-.5097
355	102.9195	85.0000	17.9195
356	89.9703	74.8000	15.1703
357	63.2840	76.8000	-13.5160
358	69.9505	78.0000	-8.0495
359	87.6775	77.3000	10.3775
360	101.6525	96.5000	5.1525
361	110.8126	135.3000	-24.4874
362	120.9140	125.6000	-4.6860
363	124.5977	103.1000	21.4977
364	103.6004	111.2000	-7.5996
365	113.6325	134.8000	-21.1675
366	139.9007	141.3000	-1.3994
367	144.6124	129.0000	15.6124
368	127.0575	115.9000	11.1575
369	103.5223	108.4000	-4.8777
370	91.4578	113.3000	-21.8422
371	115.3901	114.2000	1.1901
372	78.2737	112.0000	-33.7263
373	88.3625	107.0000	-18.6375
374	114.5998	104.7000	9.8998
375	109.6663	121.7000	-12.0337
376	117.6861	105.1000	12.5861
377	119.3133	97.5000	21.8133
378	95.1005	103.7000	-8.5995
379	89.9859	104.2000	-14.2141
380	95.7475	109.4000	-13.6525
381	95.3838	102.3000	-6.9162
382	86.6556	107.1000	-20.4444
383	101.0324	105.6000	-4.5676
384	114.4232	96.0000	18.4232

N	GENERATED	OBSERVED	RESIDUE
385	97.9774	94.8000	3.1774
386	96.8703	85.3000	11.5703
387	89.2321	80.3000	8.9321
388	43.0396	77.7000	-34.6604
389	74.4064	87.1000	-12.6936
390	109.0265	84.3000	24.7265
391	88.6441	86.1000	2.5441
392	95.1441	82.6000	12.5441
393	87.4856	81.3000	6.1856
394	75.8540	79.5000	-3.6460
395	102.1623	77.8000	24.3623
396	90.0607	75.5000	14.5607
397	86.2910	93.8000	-7.5091
398	109.0238	76.8000	32.2238
399	76.6545	81.8000	-5.1455
400	67.0764	67.1000	-.0236
401	81.2841	72.8000	8.4841
402	87.9271	71.5000	16.4271
403	75.0803	71.3000	3.7803
404	80.6928	68.9000	11.7928
405	37.2697	64.2000	-26.9303
406	84.7623	61.1000	23.6623
407	62.2238	65.1000	-2.8762
408	56.6852	65.0000	-8.3148
409	90.6712	62.5000	28.1712
410	48.3407	59.2000	-10.8593
411	100.6595	45.6000	55.0595
412	9.6420	61.3000	-51.6580
413	54.3750	76.0000	-21.6250
414	80.9615	89.6000	-8.6385
415	108.0617	86.1000	21.9617
416	82.1067	83.4000	-1.2933
417	107.5702	83.7000	23.8702
418	70.1129	80.3000	-10.1871
419	65.6145	78.2000	-12.5855
420	104.7455	78.9000	25.8455
421	92.0220	71.0000	21.0220
422	54.3464	59.5000	-5.1536
423	59.8931	55.8000	4.0931
424	41.2431	55.0000	-13.7569
425	90.3256	68.9000	21.4256
426	72.3697	76.3000	-3.9303
427	71.7134	80.5000	-8.7866
428	93.9013	107.3000	-13.3987
429	122.5768	94.0000	28.5768
430	84.1272	79.0000	5.1272
431	58.4269	75.5000	-17.0731
432	65.6441	64.7000	.9441

N	GENERATED	OBSERVED	RESIDUE
433	92.0711	60.4000	31.6711
434	47.6804	63.7000	-16.0196
435	51.1424	62.9000	-11.7576
436	62.3768	65.9000	-3.5232
437	58.2302	134.0000	-75.7698
438	118.3442	115.3000	3.0442
439	131.8819	104.1000	27.7819
440	104.6402	94.4000	10.2402
441	71.3634	99.9000	-28.5366
442	117.9783	79.0000	38.9783
443	96.8638	86.2000	10.6638
444	64.8444	88.3000	-23.4556
445	78.0393	99.8000	-21.7607
446	88.7903	85.5000	3.2903
447	72.5517	115.0000	-42.4483
448	114.1213	112.3000	1.8213
449	103.1467	113.8000	-10.6533
450	119.1427	111.6000	7.5427
451	133.2845	108.5000	24.7845
452	135.2068	111.4000	23.8068
453	98.5787	99.2000	-.6213
454	80.5225	122.9000	-42.3775
455	106.2596	206.2000	-99.9404
456	233.3976	128.8000	104.5976
457	108.3045	123.8000	-15.4955
458	135.6386	121.1000	14.5386
459	114.3608	120.6000	-6.2392
460	131.1652	137.0000	-5.8348
461	134.2724	131.9000	2.3724
462	125.5041	170.6000	-45.0959
463	173.7443	166.3000	7.4443
464	148.1550	167.9000	-19.7450
465	179.3435	167.8000	11.5435
466	157.6976	141.3000	16.3976
467	149.0419	128.9000	20.1420
468	129.7947	126.3000	3.4947
469	130.4892	132.0000	-1.5108
470	128.3928	158.1000	-29.7072
471	127.7205	113.3000	14.4205
472	85.6467	107.5000	-21.8533
473	93.1052	143.5000	-50.3948
474	129.8584	163.5000	-33.6416
475	145.3245	150.0000	-4.6755
476	143.0695	137.5000	5.5695
477	128.0119	131.8000	-3.7881
478	143.0300	124.0000	19.0300
479	106.9414	119.0000	-12.0586
480	91.0100	115.4000	-24.3900

N	GENERATED	OBSERVED	RESIDUE
481	129.0942	120.5000	8.5942
482	122.8962	114.9000	7.9962
483	103.5525	113.7000	-10.1475
484	116.8838	113.3000	3.5838
485	140.9409	215.3000	-74.3591
486	192.3935	218.5000	-26.1065
487	228.2541	196.7000	31.5541
488	172.0707	167.5000	4.5707
489	168.2718	159.1000	9.1718
490	152.6294	148.3000	4.3294
491	157.4211	143.1000	14.3211
492	144.8250	137.8000	7.0250
493	141.8130	141.8000	.0130
494	127.3147	135.7000	-8.3853
495	150.7330	135.4000	15.3330
496	122.8267	133.2000	-10.3733
497	145.5796	134.2000	11.3796
498	135.1585	165.9000	-30.7415
499	163.2778	150.5000	12.7778
500	160.3691	157.6000	2.7691
501	153.5013	155.6000	-2.0987
502	140.9887	145.0000	-4.0113
503	113.6792	135.2000	-21.5208
504	130.6519	121.3000	9.3519
505	100.8523	94.5000	6.3523
506	104.3793	81.9000	22.4793
507	81.9820	78.1000	3.8820
508	79.3246	83.3000	-3.9754
509	91.1420	83.0000	8.1420
510	114.3624	82.0000	32.3624
511	96.4219	81.1000	15.3219
512	86.0626	82.7000	3.3626
513	72.6758	72.9000	-.2242
514	86.7310	66.8000	19.9310
515	70.4484	67.2000	3.2484
516	76.2437	69.4000	6.8436
517	64.1174	65.5000	-1.3826
518	64.3029	61.0000	3.3029
519	31.2798	53.2000	-21.9202
520	55.1064	57.9000	-2.7936
521	73.3634	63.4000	9.9634
522	63.7063	104.1000	-40.3937
523	85.2066	91.4000	-6.1933
524	86.1418	71.1000	15.0418
525	67.8221	67.7000	.1221
526	72.8024	60.4000	12.4024
527	44.3071	54.3000	-9.9929
528	65.7620	59.6000	6.1620

N	GENERATED	OBSERVED	RESIDUE
529	55.5570	47.4000	8.1570
530	21.5184	49.0000	-27.4816
531	78.1876	48.4000	29.7876
532	62.6517	52.6000	10.0517
533	57.2961	73.1000	-15.8039
534	83.7080	75.5000	8.2080
535	65.9540	83.9000	-17.9460
536	66.9241	76.7000	-9.7759
537	82.1651	71.5000	10.6651
538	83.1558	78.8000	4.3558
539	52.4218	91.2000	-38.7782
540	111.5290	92.0000	19.5290
541	107.9784	93.9000	14.0784
542	107.1040	85.6000	21.5040
543	100.1431	83.4000	16.7431
544	52.6519	99.4000	-46.7481
545	91.2545	106.1000	-14.8455
546	114.2474	111.5000	2.7474
547	111.0837	102.8000	8.2837
548	118.1061	105.1000	13.0061
549	80.6560	97.4000	-16.7440
550	100.7900	77.3000	23.4900
551	63.0579	77.3000	-14.2421
552	103.1115	79.1000	24.0115
553	78.7088	83.5000	-4.7912
554	106.1815	92.3000	13.8815
555	102.1478	90.0000	12.1478
556	91.6495	80.3000	11.3495
557	75.5024	98.4000	-22.8976
558	117.3313	136.6000	-19.2687
559	133.9954	111.8000	22.1954
560	97.1689	98.0000	-.8311
561	123.8955	91.2000	32.6955
562	99.9137	80.8000	19.1137
563	84.5676	79.5000	5.0677
564	60.4290	77.7000	-17.2710
565	79.8496	71.0000	8.8496
566	71.1825	74.6000	-3.4175
567	70.0510	95.0000	-24.9490
568	94.2297	111.4000	-17.1703
569	94.0774	114.3000	-20.2226
570	121.9552	116.3000	5.6552
571	90.2009	107.5000	-17.2991
572	80.1610	97.5000	-17.3390
573	100.2584	100.3000	-.0416
574	92.4167	93.1000	-.6832
575	100.6146	84.4000	16.2146
576	78.0095	77.8000	.2095

N	GENERATED	OBSERVED	RESIDUE
577	72.2713	81.2000	-8.9287
578	81.0192	81.9000	-.8808
579	61.8377	74.3000	-12.4623
580	94.3694	74.1000	20.2694
581	75.6553	75.2000	.4553
582	83.6339	79.8000	3.8339
583	53.6104	77.8000	-24.1896
584	88.3817	76.0000	12.3817
585	71.8827	77.6000	-5.7173
586	60.2977	84.9000	-24.6023
587	95.2652	74.6000	20.6652
588	79.7480	77.7000	2.0480
589	91.8117	74.6000	17.2117
590	89.2129	73.8000	15.4128
591	90.7569	84.7000	6.0569
592	91.6452	86.9000	4.7452
593	63.4734	91.4000	-27.9266
594	82.1200	79.5000	2.6200
595	74.6657	79.5000	-4.8343
596	115.6494	80.3000	35.3494
597	97.1595	77.1000	20.0595
598	75.9300	70.5000	5.4300
599	79.2081	74.6000	4.6081
600	71.1961	76.5000	-5.3039
601	84.6566	68.2000	16.4566
602	79.9732	69.0000	10.9732
603	74.0235	71.7000	2.3235
604	81.8074	75.2000	6.6074
605	62.3988	81.6000	-19.2012
606	81.6105	82.8000	-1.1895
607	84.4097	95.6000	-11.1903
608	75.1640	100.4000	-25.2360
609	62.4157	99.8000	-37.3843
610	108.5952	94.4000	14.1952
611	114.5861	82.0000	32.5861
612	61.0293	78.8000	-17.7707
613	89.1555	73.8000	15.3555
614	86.8721	75.9000	10.9721
615	51.6622	76.3000	-24.6378
616	94.9338	71.2000	23.7338
617	59.7572	86.1000	-26.3428
618	75.0762	88.2000	-13.1238
619	83.0619	88.1000	-5.0381
620	85.0844	86.8000	-1.7156
621	85.6942	86.5000	-.8058
622	90.7257	88.9000	1.8256
623	87.6762	89.3000	-1.6238
624	80.7484	88.7000	-7.9516

N	GENERATED	OBSERVED	RESIDUE
625	58.4074	97.9000	-39.4926
626	102.5995	113.7000	-11.1005
627	135.4213	83.0000	52.4213
628	92.2179	142.9000	-50.6821
629	124.9155	122.5000	2.4155
630	132.7374	112.4000	20.3374
631	118.8526	109.7000	9.1526
632	137.7225	144.5000	-6.7775
633	137.2852	102.5000	34.7852
634	102.0422	95.5000	6.5422
635	123.8179	90.0000	33.8179
636	69.1936	87.3000	-18.1064
637	71.8991	84.7000	-12.8009
638	113.4659	81.2000	32.2659
639	86.6303	79.9000	6.7303
640	88.9658	81.6000	7.3658
641	68.2303	77.6000	-9.3697
642	71.9962	75.9000	-3.9038
643	81.4107	58.7000	22.7107
644	46.3366	45.9000	.4366
645	62.2536	52.2000	10.0536
646	56.7451	56.6000	.1451
647	84.9260	55.0000	29.9260
648	45.4711	59.1000	-13.6289
649	52.1473	56.6000	-4.4527
650	32.8323	60.0000	-27.1677
651	75.9471	69.5000	6.4471
652	90.3452	72.9000	17.4452
653	95.6785	70.2000	25.4785
654	58.1942	71.2000	-13.0058
655	63.9584	68.9000	-4.9417
656	77.9894	79.1000	-1.1105
657	99.6011	86.1000	13.5011
658	85.0369	85.9000	-.8631
659	64.4699	87.5000	-23.0301
660	85.9252	84.6000	1.3252
661	84.4265	84.0000	.4265
662	117.1152	82.5000	34.6152
663	84.0958	80.8000	3.2958
664	79.4038	70.5000	8.9038
665	80.0884	85.4000	-5.3116
666	82.0002	92.0000	-9.9999
667	89.4440	108.3000	-18.8560
668	74.2484	97.5000	-23.2516
669	118.6737	94.5000	24.1737
670	90.4085	88.6000	1.8085
671	62.7149	60.0000	2.7149
672	68.3142	40.2000	28.1142

N	GENERATED	OBSERVED	RESIDUE
673	37.3857	115.9000	-78.5143
674	105.7812	109.4000	-3.6188
675	107.3290	82.3000	25.0290
676	88.5341	103.2000	-14.6659
677	97.3218	99.7000	-2.3782
678	91.1675	86.0000	5.1675
679	105.5046	79.4000	26.1046
680	75.4992	60.4000	15.0992
681	49.9258	59.7000	-9.7742
682	55.7986	57.4000	-1.6014
683	45.5358	57.5000	-11.9642
684	75.2066	53.0000	22.2066
685	49.1671	44.8000	4.3671
686	31.3560	41.1000	-9.7440
687	78.0363	43.3000	34.7363
688	63.9486	63.8000	.1486
689	61.8513	66.0000	-4.1487
690	66.2321	86.9000	-20.6679
691	65.1421	93.3000	-28.1579
692	107.8293	93.1000	14.7293
693	117.2173	106.8000	10.4173
694	102.2969	109.1000	-6.8031
695	109.1678	102.1000	7.0678
696	113.6783	103.6000	10.0783
697	110.4373	97.0000	13.4373
698	106.4499	88.0000	18.4499
699	76.6422	94.5000	-17.8578
700	85.9025	97.5000	-11.5975
701	126.5165	101.7000	24.8165
702	91.2154	95.7000	-4.4846
703	105.8209	104.0000	1.8209
704	112.6731	104.6000	8.0732
705	112.6073	102.9000	9.7073
706	109.6432	102.6000	7.0432
707	82.6481	89.6000	-6.9519
708	67.5508	83.0000	-15.4492
709	50.5941	82.0000	-31.4059
710	84.4722	84.4000	.0722
711	71.9571	89.5000	-17.5429
712	88.4397	91.1000	-2.6603
713	78.8619	107.6000	-28.7381
714	129.3900	100.3000	29.0900
715	84.7747	91.5000	-6.7253
716	68.6521	93.2000	-24.5479
717	112.0544	97.0000	15.0544
718	93.7487	101.3000	-7.5513
719	94.3260	105.5000	-11.1740
720	102.0118	106.9000	-4.8882

N	GENERATED	OBSERVED	RESIDUE
721	129.3336	112.1000	17.2336
722	107.1254	104.1000	3.0254
723	118.2027	98.9000	19.3027
724	107.9597	80.8000	27.1597
725	79.8433	64.1000	15.7433
726	67.9259	68.2000	-.2741
727	73.1466	94.4000	-21.2534
728	111.4982	109.1000	2.3982
729	120.1983	104.6000	15.5983
730	101.0310	103.6000	-2.5690
731	102.7582	105.6000	-2.8418
732	113.6916	101.4000	12.2916
733	98.6758	109.4000	-10.7242
734	126.8166	101.7000	25.1166
735	111.7745	99.8000	11.9745
736	95.8680	135.2000	-39.3320
737	144.2654	137.8000	6.4654
738	143.5935	117.7000	25.8935
739	69.5949	125.2000	-55.6051
740	121.6556	126.0000	-4.3444
741	107.3060	112.2000	-4.8940
742	109.4693	108.3000	1.1693
743	117.9041	105.0000	12.9041
744	109.0426	101.6000	7.4426
745	93.4147	106.0000	-12.5853
746	122.7809	104.3000	18.4809
747	128.2014	100.9000	27.3014
748	101.8537	100.0000	1.8537
749	95.8233	101.3000	-5.4767
750	103.0530	104.6000	-1.5470
751	108.3021	110.6000	-2.2979
752	122.8608	107.8000	15.0608
753	100.7881	84.7000	16.0881
754	78.0316	74.0000	4.0316
755	64.7453	75.1000	-10.3547
756	48.2170	67.9000	-19.6830
757	74.5081	63.3000	11.2081
758	68.0710	60.3000	7.7710
759	49.3008	56.3000	-6.9992
760	55.9711	68.6000	-12.6289
761	66.3549	74.3000	-7.9451
762	79.6371	108.1000	-28.4629
763	99.1944	71.1000	28.0944
764	56.9457	65.4000	-8.4543
765	62.3372	54.7000	7.6372
766	48.6252	57.5000	-8.8748
767	66.1821	51.1000	15.0821
768	64.2222	56.8000	7.4222

N	GENERATED	OBSERVED	RESIDUE
769	64.5804	57.5000	7.0804
770	76.5956	60.1000	16.4956
771	49.7072	57.0000	-7.2928
772	53.3129	47.5000	5.8129
773	48.8533	79.1000	-30.2467
774	88.0736	107.3000	-19.2264
775	92.5005	93.0000	-.4995
776	91.8768	151.1000	-59.2232
777	158.5917	129.9000	28.6917
778	141.6716	104.1000	37.5716
779	120.6484	98.3000	22.3484
780	75.1506	97.5000	-22.3494
781	80.2838	86.8000	-6.5162
782	94.0517	82.3000	11.7516
783	85.5870	81.6000	3.9870
784	100.4323	110.0000	-9.5677
785	86.2597	119.0000	-32.7403
786	111.6974	113.9000	-2.2026
787	118.2204	107.2000	11.0204
788	101.5670	97.4000	4.1670
789	117.4814	109.0000	8.4814
790	114.6951	160.9000	-46.2049
791	173.9895	134.5000	39.4895
792	118.3161	119.0000	-.6839
793	123.8946	108.6000	15.2946
794	105.0162	113.4000	-8.3838
795	135.9625	114.1000	21.8625
796	101.8412	155.4000	-53.5588
797	159.1437	159.6000	-.4563
798	174.4474	158.3000	16.1474
799	145.3774	142.4000	2.9774
800	125.9015	135.9000	-9.9985
801	121.5595	128.3000	-6.7405
802	122.6080	116.2000	6.4080
803	115.3615	113.7000	1.6616
804	105.1420	101.4000	3.7419
805	101.1663	99.1000	2.0663
806	82.5949	88.6000	-6.0051
807	95.2029	102.8000	-7.5971
808	80.0548	119.8000	-39.7452
809	94.8974	134.9000	-40.0026
810	129.0137	136.7000	-7.6862
811	137.8539	119.8000	18.0539
812	121.4311	95.9000	25.5311
813	89.8229	80.7000	9.1229
814	70.8391	91.2000	-20.3609
815	76.5374	87.9000	-11.3626
816	102.7721	85.9000	16.8721

N	GENERATED	OBSERVED	RESIDUE
817	83.9575	85.0000	-1.0425
818	92.6888	81.3000	11.3888
819	56.3164	80.1000	-23.7836
820	85.5814	87.6000	-2.0186
821	91.0923	101.9000	-10.8077
822	90.4844	116.8000	-26.3156
823	105.7712	106.0000	-.2288
824	114.2146	103.2000	11.0146
825	101.3054	99.8000	1.5054
826	114.7630	100.9000	13.8630
827	113.1083	96.9000	16.2083
828	105.2523	95.4000	9.8522
829	87.2971	94.9000	-7.6029
830	84.9406	92.1000	-7.1594
831	77.7556	87.8000	-10.0444
832	112.0116	85.6000	26.4115
833	106.3817	94.6000	11.7817
834	103.9220	163.4000	-59.4780
835	140.6423	134.3000	6.3423
836	140.3177	122.0000	18.3178
837	114.0635	116.4000	-2.3365
838	130.6892	132.3000	-1.6108
839	128.5958	142.5000	-13.9042
840	148.3580	128.3000	20.0580

VARIANCE= .1976593E+03

Results from Thomas Fiering Model

	MEAN(J)	STAND(J)	R(J)	B(J)
1	97.3443	28.0537	.9269	1.0370
2	97.0114	31.3844	.8937	.8610
3	96.4686	30.2373	.9010	.9259
4	101.0143	31.0733	.8616	.9777
5	110.7729	35.2582	.9008	.9217
6	117.2986	36.0756	.9499	.8676
7	113.2529	32.9477	.9024	.8269
8	109.6757	30.1894	.9215	.8822
9	106.2014	28.8995	.9237	.9227
10	103.7714	28.8696	.8634	.9128
11	101.7900	30.5220	.9077	.8238
12	98.1728	27.7002	.8697	.8808

All values are in litres/sec.

I	OBSERVED	GENERATED	RESIDUE
1	121.500	110.705	10.795
2	110.000	127.893	-17.893
3	111.900	111.230	.670
4	93.400	136.122	-42.722
5	117.200	140.946	-23.746
6	119.800	120.264	-.464
7	115.400	118.141	-2.741
8	111.500	98.888	12.612
9	104.400	91.618	12.782
10	107.000	105.450	1.550
11	98.000	99.945	-1.945
12	95.400	104.147	-8.747
13	104.000	93.700	10.300
14	101.800	111.083	-9.283
15	111.500	97.623	13.877
16	112.500	115.114	-2.614
17	115.000	139.157	-24.157
18	133.600	115.293	18.307
19	125.000	98.580	26.420
20	126.000	131.999	-5.999
21	121.400	133.184	-11.784
22	111.500	116.264	-4.764
23	102.000	79.557	22.443
24	106.000	121.042	-15.042
25	94.000	122.670	-28.670
26	93.000	108.211	-15.211
27	95.300	100.847	-5.547
28	96.000	97.154	-1.154
29	92.200	106.938	-14.738
30	102.000	83.121	18.879
31	116.600	107.307	9.293
32	117.500	107.064	10.436
33	114.500	93.128	21.372
34	116.200	108.373	7.827
35	115.000	100.029	14.971
36	119.300	119.754	-.454
37	117.800	124.271	-6.471
38	161.500	101.858	59.642
39	151.800	160.627	-8.827
40	155.000	150.966	4.034
41	161.500	168.157	-6.657
42	170.800	165.662	5.138
43	182.600	158.425	24.175
44	171.500	192.162	-20.662
45	155.000	141.886	13.114
46	149.500	144.161	5.339
47	135.500	140.181	-4.681
48	135.600	116.455	19.145

I	OBSERVED	GENERATED	RESIDUE
49	132.500	140.054	-7.554
50	140.000	125.805	14.195
51	130.400	147.796	-17.396
52	136.500	132.097	4.403
53	166.800	125.353	41.447
54	172.500	192.102	-19.602
55	171.000	148.907	22.093
56	147.500	161.858	-14.358
57	142.800	153.972	-11.172
58	139.800	136.738	3.062
59	137.000	146.018	-9.018
60	138.000	133.726	4.274
61	131.200	131.666	-.466
62	114.500	156.648	-42.148
63	110.600	110.561	.039
64	110.500	118.665	-8.165
65	122.500	110.431	12.069
66	144.300	138.809	5.491
67	143.200	137.069	6.131
68	141.000	119.110	21.890
69	133.600	147.118	-13.518
70	125.300	118.373	6.927
71	134.800	122.275	12.525
72	135.200	115.175	20.025
73	130.500	126.962	3.538
74	125.800	125.809	-.009
75	134.400	101.519	32.881
76	136.500	153.687	-17.187
77	139.000	135.420	3.580
78	160.300	173.241	-12.941
79	159.600	166.119	-6.519
80	151.300	167.826	-16.526
81	144.300	142.586	1.714
82	145.200	143.737	1.463
83	139.000	156.678	-17.678
84	127.600	108.046	19.554
85	121.000	138.722	-17.722
86	126.300	115.486	10.814
87	129.200	139.777	-10.577
88	125.000	137.453	-12.453
89	145.800	114.730	31.070
90	155.000	162.316	-7.316
91	148.400	149.184	-.784
92	131.800	130.127	1.673
93	113.000	126.807	-13.807
94	113.500	131.962	-18.462
95	106.300	137.354	-31.054
96	101.000	122.469	-21.469

I	OBSERVED	GENERATED	RESIDUE
97	103.300	91.827	11.473
98	100.600	116.874	-16.274
99	91.500	123.365	-31.865
100	90.300	95.604	-5.304
101	108.800	125.952	-17.152
102	116.300	144.776	-28.476
103	100.300	119.900	-19.600
104	105.800	97.172	8.628
105	112.200	105.103	7.097
106	124.400	79.696	44.704
107	127.500	99.245	28.255
108	109.500	111.786	-2.286
109	100.400	106.650	-6.250
110	100.500	101.271	-.771
111	104.800	112.391	-7.591
112	100.700	109.267	-8.567
113	115.400	121.705	-6.305
114	121.800	128.154	-6.354
115	126.000	118.176	7.824
116	132.500	129.922	2.578
117	138.000	109.380	28.620
118	132.000	137.485	-5.485
119	182.000	150.832	31.168
120	190.000	177.694	12.306
121	184.400	188.204	-3.804
122	194.000	156.467	37.533
123	180.900	203.060	-22.160
124	170.900	164.784	6.116
125	204.000	186.029	17.971
126	197.800	181.667	16.133
127	187.200	203.266	-16.066
128	193.600	170.310	23.290
129	179.900	165.860	14.040
130	167.400	174.160	-6.760
131	150.400	154.252	-3.852
132	138.300	141.486	-3.186
133	134.900	148.281	-13.381
134	134.100	142.312	-8.212
135	128.600	141.645	-13.045
136	134.000	152.792	-18.792
137	127.200	136.790	-9.590
138	132.400	129.217	3.183
139	124.900	138.753	-13.853
140	120.000	112.895	7.105
141	113.500	112.841	.659
142	113.100	99.949	13.151
143	106.700	102.350	4.350
144	112.700	94.198	18.502

I	OBSERVED	GENERATED	RESIDUE
145	136.600	118.617	17.983
146	167.000	144.341	22.659
147	118.500	153.860	-35.360
148	104.000	104.622	-.622
149	107.600	102.496	5.104
150	100.000	114.129	-14.129
151	95.500	114.671	-19.171
152	90.000	94.581	-4.581
153	105.000	79.806	25.194
154	106.000	97.462	8.538
155	77.300	109.698	-32.398
156	84.600	95.769	-11.169
157	94.800	110.208	-15.408
158	115.500	114.783	.717
159	112.800	87.826	24.974
160	123.800	114.576	9.224
161	127.600	155.366	-27.766
162	110.500	130.739	-20.239
163	117.000	118.093	-1.093
164	108.800	112.287	-3.487
165	107.000	106.222	.778
166	109.000	96.649	12.351
167	105.300	104.973	.327
168	124.800	105.278	19.522
169	110.600	118.241	-7.641
170	92.000	117.545	-25.545
171	143.400	68.525	74.875
172	141.800	141.003	.797
173	166.500	163.054	3.446
174	144.000	164.461	-20.461
175	150.800	130.578	20.222
176	117.000	133.596	-16.596
177	143.800	97.784	46.016
178	148.400	126.667	21.733
179	140.300	114.320	25.980
180	168.400	136.784	31.616
181	165.500	151.478	14.022
182	161.800	158.255	3.545
183	179.400	139.200	40.200
184	174.000	199.053	-25.053
185	212.300	163.046	49.254
186	214.800	201.482	13.318
187	188.500	182.010	6.490
188	168.300	175.875	-7.575
189	167.800	144.519	23.281
190	158.300	136.400	21.900
191	148.000	155.409	-7.409
192	139.000	141.299	-2.299

I	OBSERVED	GENERATED	RESIDUE
193	136.000	139.282	-3.282
194	134.400	137.993	-3.593
195	155.600	132.354	23.246
196	169.300	150.820	18.480
197	158.300	147.644	10.656
198	186.000	169.173	16.827
199	194.500	178.258	16.242
200	162.300	174.764	-12.464
201	147.600	161.482	-13.882
202	130.000	132.927	-2.927
203	123.400	117.681	5.719
204	125.000	113.335	11.665
205	130.500	146.638	-16.138
206	119.000	130.689	-11.689
207	113.500	106.537	6.963
208	107.500	126.114	-18.614
209	96.000	115.033	-19.033
210	116.800	101.290	15.510
211	93.500	108.008	-14.508
212	91.800	83.678	8.122
213	86.000	81.159	4.841
214	90.000	65.418	24.582
215	116.800	82.427	34.373
216	97.000	117.411	-20.411
217	84.000	86.379	-2.379
218	89.600	63.172	26.428
219	87.000	101.693	-14.693
220	105.500	108.080	-2.580
221	111.200	111.919	-.719
222	110.500	131.342	-20.842
223	115.800	99.133	16.667
224	103.000	86.487	16.513
225	100.500	117.079	-16.579
226	93.600	109.383	-15.783
227	84.000	63.061	20.939
228	88.000	86.794	1.206
229	108.800	94.865	13.935
230	155.000	107.903	47.097
231	147.300	164.034	-16.734
232	159.000	153.868	5.132
233	160.800	161.394	-.594
234	154.800	164.231	-9.431
235	138.400	136.546	1.854
236	131.000	115.147	15.853
237	143.000	131.113	11.887
238	139.600	139.310	.290
239	130.800	128.431	2.369
240	122.000	112.604	9.396

I	OBSERVED	GENERATED	RESIDUE
241	99.000	125.432	-26.432
242	103.300	110.023	-6.723
243	125.200	99.119	26.081
244	131.000	141.459	-10.459
245	127.500	147.490	-19.990
246	127.500	137.155	-9.655
247	132.000	145.074	-13.074
248	109.500	120.432	-10.932
249	95.400	109.611	-14.211
250	89.300	96.907	-7.607
251	95.000	101.348	-6.348
252	70.200	100.924	-30.724
253	51.500	81.737	-30.237
254	46.300	53.186	-6.886
255	59.800	34.227	25.573
256	72.300	30.563	41.737
257	68.300	87.662	-19.362
258	74.000	65.636	8.364
259	75.500	84.152	-8.652
260	80.000	86.002	-6.002
261	64.400	81.934	-17.534
262	45.300	67.433	-22.133
263	64.300	50.722	13.578
264	71.500	77.716	-6.216
265	68.300	61.450	6.850
266	76.800	69.234	7.566
267	76.400	61.071	15.329
268	109.500	80.883	28.617
269	111.000	118.390	-7.390
270	106.200	108.939	-2.739
271	106.000	131.542	-25.542
272	90.800	93.858	-3.058
273	75.800	74.164	1.636
274	64.300	75.400	-11.100
275	69.000	95.667	-26.667
276	68.500	75.720	-7.220
277	64.300	64.032	.268
278	67.000	70.788	-3.788
279	66.000	68.966	-2.966
280	60.500	73.988	-13.488
281	67.400	53.898	13.502
282	81.000	102.575	-21.575
283	82.000	89.323	-7.323
284	86.200	60.709	25.491
285	84.800	79.905	4.895
286	82.400	75.374	7.026
287	85.500	91.959	-6.459
288	79.000	86.985	-7.985

I	OBSERVED	GENERATED	RESIDUE
289	68.000	78.857	-10.857
290	67.800	59.641	8.159
291	67.000	62.562	4.438
292	67.000	65.082	1.918
293	76.000	60.961	15.039
294	83.300	84.895	-1.595
295	85.200	78.810	6.390
296	87.500	91.460	-3.960
297	126.000	103.000	23.000
298	120.600	120.845	-.245
299	86.000	115.098	-29.098
300	88.800	92.498	-3.698
301	80.600	98.254	-17.654
302	83.800	58.223	25.577
303	86.400	67.918	18.482
304	91.800	80.599	11.201
305	120.400	101.646	18.754
306	109.000	140.911	-31.911
307	96.600	105.765	-9.165
308	116.800	110.578	6.222
309	139.500	108.312	31.188
310	151.000	141.150	9.850
311	141.000	150.974	-9.974
312	115.000	121.278	-6.278
313	101.000	120.829	-19.829
314	97.800	91.744	6.056
315	105.000	100.510	4.490
316	101.500	101.724	-.224
317	101.500	114.954	-13.454
318	133.000	130.188	2.812
319	130.000	135.908	-5.908
320	123.000	124.801	-1.801
321	111.000	131.228	-20.228
322	109.300	119.212	-9.912
323	100.800	105.554	-4.754
324	98.800	95.730	3.070
325	99.200	99.407	-.207
326	88.500	105.107	-16.607
327	84.800	70.530	14.270
328	99.800	55.310	44.490
329	98.500	121.759	-23.259
330	102.500	126.216	-23.716
331	101.600	88.110	13.490
332	101.500	101.036	.464
333	87.000	118.505	-31.505
334	81.000	74.954	6.046
335	84.800	88.000	-3.200
336	73.200	94.596	-21.396

I	OBSERVED	GENERATED	RESIDUE
337	67.500	69.040	-1.540
338	58.000	71.358	-13.358
339	55.200	59.175	-3.975
340	56.300	58.246	-1.946
341	64.300	67.542	-3.242
342	59.800	71.165	-11.365
343	69.000	62.833	6.167
344	74.500	59.500	15.000
345	88.800	63.698	25.102
346	100.300	104.839	-4.539
347	94.300	120.310	-26.010
348	93.000	101.946	-8.946
349	90.500	83.569	6.931
350	81.500	113.936	-32.436
351	82.200	80.710	1.490
352	82.200	74.638	7.562
353	83.800	95.885	-12.085
354	86.800	86.919	-.119
355	85.000	110.346	-25.346
356	74.800	104.445	-29.645
357	76.800	105.514	-28.714
358	78.000	85.401	-7.401
359	77.300	76.308	.992
360	96.500	68.317	28.183
361	135.300	91.927	43.373
362	125.600	131.677	-6.077
363	103.100	129.077	-25.977
364	111.200	99.748	11.452
365	134.800	127.904	6.896
366	141.300	146.682	-5.382
367	129.000	130.110	-1.110
368	115.900	138.797	-22.897
369	108.400	131.041	-22.641
370	113.300	89.585	23.715
371	114.200	113.071	1.129
372	112.000	106.694	5.306
373	107.000	121.361	-14.361
374	104.700	124.498	-19.798
375	121.700	109.471	12.229
376	105.100	138.727	-33.627
377	97.500	116.783	-19.283
378	103.700	96.153	7.547
379	104.200	114.108	-9.908
380	109.400	121.301	-11.901
381	102.300	111.885	-9.585
382	107.100	109.270	-2.170
383	105.600	91.180	14.420
384	96.000	117.520	-21.520

I	OBSERVED	GENERATED	RESIDUE
385	94.800	88.330	6.470
386	85.300	100.027	-14.727
387	80.300	88.411	-8.111
388	77.700	95.021	-17.321
389	87.100	96.811	-9.711
390	84.300	82.497	1.803
391	86.100	107.892	-21.792
392	82.600	100.379	-17.779
393	81.300	79.853	1.447
394	79.500	73.707	5.793
395	77.800	62.592	15.208
396	75.500	80.291	-4.791
397	93.800	71.236	22.564
398	76.800	86.455	-9.655
399	81.800	82.054	-.254
400	67.100	74.540	-7.440
401	72.800	90.226	-17.426
402	71.500	108.549	-37.049
403	71.300	63.834	7.466
404	68.900	72.591	-3.691
405	64.200	78.366	-14.166
406	61.100	61.337	-.237
407	65.100	49.224	15.876
408	65.000	92.196	-27.196
409	62.500	48.552	13.948
410	59.200	67.725	-8.525
411	45.600	74.716	-29.116
412	61.300	92.566	-31.266
413	76.000	71.899	4.101
414	89.600	99.697	-10.097
415	86.100	92.630	-6.530
416	83.400	57.186	26.214
417	83.700	88.596	-4.896
418	80.300	96.359	-16.059
419	78.200	74.150	4.050
420	78.900	59.027	19.873
421	71.000	96.724	-25.724
422	59.500	89.907	-30.407
423	55.800	64.773	-8.973
424	55.000	54.242	.758
425	68.900	31.259	37.641
426	76.300	80.548	-4.248
427	80.500	87.341	-6.841
428	107.300	94.470	12.830
429	94.000	95.440	-1.440
430	79.000	102.545	-23.545
431	75.500	79.433	-3.933
432	64.700	58.020	6.680

I	OBSERVED	GENERATED	RESIDUE
433	60.400	43.959	16.441
434	63.700	85.479	-21.779
435	62.900	81.444	-18.544
436	65.900	76.594	-10.694
437	134.000	80.404	53.596
438	115.300	136.498	-21.198
439	104.100	105.940	-1.840
440	94.400	112.077	-17.677
441	99.900	99.011	.889
442	79.000	89.185	-10.185
443	86.200	86.009	.191
444	88.300	79.048	9.252
445	99.800	72.533	27.267
446	85.500	103.416	-17.916
447	115.000	72.895	42.105
448	112.300	141.631	-29.331
449	113.800	136.063	-22.263
450	111.600	112.381	-.781
451	108.500	104.974	3.526
452	111.400	105.643	5.757
453	99.200	115.723	-16.523
454	122.900	84.945	37.955
455	206.200	73.053	133.147
456	128.800	203.413	-74.613
457	123.800	132.297	-8.497
458	121.100	128.544	-7.444
459	120.600	121.805	-1.205
460	137.000	108.018	28.982
461	131.900	158.947	-27.047
462	170.600	131.364	39.236
463	166.300	142.168	24.132
464	167.900	164.013	3.887
465	167.800	155.769	12.031
466	141.300	149.237	-7.937
467	128.900	160.610	-31.710
468	126.300	114.755	11.545
469	132.000	108.487	23.513
470	158.100	143.049	15.051
471	113.300	172.888	-59.588
472	107.500	119.108	-11.608
473	143.500	92.456	51.044
474	163.500	148.544	14.956
475	150.000	162.690	-12.690
476	137.500	145.216	-7.716
477	131.800	113.529	18.271
478	124.000	129.287	-5.287
479	119.000	98.703	20.297
480	115.400	105.788	9.612

I	OBSERVED	GENERATED	RESIDUE
481	120.500	118.249	2.251
482	114.900	99.567	15.333
483	113.700	98.745	14.955
484	113.300	132.954	-19.654
485	215.300	109.589	105.711
486	218.500	220.558	-2.058
487	196.700	199.358	-2.658
488	167.500	183.737	-16.237
489	159.100	152.335	6.765
490	148.300	137.214	11.086
491	143.100	153.872	-10.772
492	137.800	123.992	13.808
493	141.800	128.783	13.017
494	135.700	145.000	-9.300
495	135.400	139.975	-4.575
496	133.200	139.838	-6.638
497	134.200	163.159	-28.959
498	165.900	128.819	37.081
499	150.500	157.257	-6.757
500	157.600	138.626	18.974
501	155.600	139.589	16.011
502	145.000	135.687	9.313
503	135.200	149.050	-13.850
504	121.300	131.090	-9.790
505	94.500	117.318	-22.818
506	81.900	87.092	-5.192
507	78.100	88.511	-10.411
508	83.300	91.046	-7.746
509	83.000	93.671	-10.671
510	82.000	102.139	-20.139
511	81.100	82.954	-1.854
512	82.700	100.620	-17.920
513	72.900	87.069	-14.169
514	66.800	62.116	4.684
515	6.7.200	81.880	-14.680
516	69.400	73.655	-4.255
517	65.500	81.918	-16.418
518	61.000	62.490	-1.490
519	53.200	85.166	-31.966
520	57.900	56.301	1.599
521	63.400	27.120	36.280
522	104.100	69.852	34.248
523	91.400	95.677	-4.277
524	71.100	78.673	-7.573
525	67.700	84.395	-16.695
526	60.400	72.191	-11.791
527	54.300	78.486	-24.186
528	59.600	47.638	11.962

I	OBSERVED	GENERATED	RESIDUE
529	47.400	52.480	-5.080
530	49.000	75.131	-26.131
531	48.400	33.712	14.688
532	52.600	45.998	6.602
533	73.100	58.692	14.408
534	75.500	83.590	-8.090
535	83.900	74.739	9.161
536	76.700	89.104	-12.404
537	71.500	75.651	-4.151
538	78.800	57.606	21.194
539	91.200	72.182	19.018
540	92.000	107.995	-15.995
541	93.900	107.376	-13.476
542	85.600	98.393	-12.793
543	83.400	78.521	4.879
544	99.400	91.669	7.731
545	106.100	111.085	-4.985
546	111.500	110.032	1.468
547	102.800	112.065	-9.265
548	105.100	114.302	-9.202
549	97.400	105.192	-7.792
550	77.300	63.463	13.837
551	77.300	82.299	-4.999
552	79.100	49.809	29.291
553	83.500	103.227	-19.727
554	92.300	69.347	22.953
555	90.000	92.254	-2.254
556	80.300	102.798	-22.498
557	98.400	58.837	39.563
558	136.600	101.468	35.132
559	111.800	111.657	.143
560	98.000	110.987	-12.987
561	91.200	94.128	-2.928
562	80.800	116.351	-35.551
563	79.500	94.944	-15.444
564	77.700	58.234	19.466
565	71.000	83.221	-12.221
566	74.600	95.214	-20.614
567	95.000	74.587	20.413
568	111.400	78.412	32.988
569	114.300	98.944	15.356
570	116.300	114.438	1.862
571	107.500	120.086	-12.586
572	97.500	108.770	-11.270
573	100.300	105.153	-4.853
574	93.100	110.799	-17.699
575	84.400	81.545	2.855
576	77.800	111.701	-33.901

I	OBSERVED	GENERATED	RESIDUE
577	81.200	73.385	7.815
578	81.900	70.991	10.909
579	74.300	87.239	-12.939
580	74.100	71.073	3.027
581	75.200	76.510	-1.310
582	79.800	93.407	-13.607
583	77.800	95.740	-17.940
584	76.000	88.867	-12.867
585	77.600	84.672	-7.072
586	84.900	94.398	-9.498
587	74.600	96.807	-22.207
588	77.700	80.984	-3.284
589	74.600	64.870	9.730
590	73.800	94.803	-21.003
591	84.700	60.008	24.692
592	86.900	95.376	-8.476
593	91.400	60.076	31.324
594	79.500	100.614	-21.114
595	79.500	94.307	-14.807
596	80.300	79.096	1.204
597	77.100	88.503	-11.403
598	70.500	73.669	-3.169
599	74.600	97.791	-23.191
600	76.500	50.589	25.911
601	68.200	91.763	-23.563
602	69.000	72.729	-3.729
603	71.700	69.635	2.065
604	75.200	80.866	-5.666
605	81.600	90.780	-9.180
606	82.800	86.370	-3.570
607	95.600	77.039	18.561
608	100.400	92.537	7.863
609	99.800	95.105	4.695
610	94.400	80.384	14.016
611	82.000	86.742	-4.742
612	78.800	108.631	-29.831
613	73.800	89.402	-15.602
614	75.900	86.001	-10.101
615	76.300	57.274	19.026
616	71.200	108.101	-36.901
617	86.100	70.034	16.066
618	88.200	95.784	-7.584
619	88.100	88.131	-.031
620	86.800	79.939	6.861
621	86.500	106.304	-19.804
622	88.900	129.321	-40.421
623	89.300	114.824	-25.524
624	88.700	79.167	9.533

I	OBSERVED	GENERATED	RESIDUE
625	97.900	97.453	.447
626	113.700	83.587	30.113
627	83.000	107.715	-24.715
628	142.900	86.849	56.051
629	122.500	156.699	-34.199
630	112.400	121.142	-8.742
631	109.700	121.979	-12.279
632	144.500	107.972	36.528
633	102.500	142.617	-40.117
634	95.500	135.575	-40.075
635	90.000	91.080	-1.080
636	87.300	77.995	9.305
637	84.700	84.102	.598
638	81.200	100.292	-19.092
639	79.900	95.402	-15.502
640	81.600	95.400	-13.800
641	77.600	108.959	-31.359
642	75.900	88.771	-12.871
643	58.700	78.217	-19.517
644	45.900	57.919	12.019
645	52.200	62.274	-10.074
646	56.600	67.873	-11.273
647	55.000	77.547	-22.547
648	59.100	61.101	-2.001
649	56.600	49.365	7.235
650	60.000	70.500	-10.500
651	69.500	62.624	6.876
652	72.900	80.600	-7.700
653	70.200	88.321	-18.121
654	71.200	95.465	-24.265
655	68.900	57.836	11.064
656	79.100	71.701	7.398
657	86.100	98.571	-12.471
658	85.900	86.598	-.698
659	87.500	82.746	4.754
660	84.600	81.815	2.785
661	84.000	69.808	14.192
662	82.500	78.030	4.470
663	80.800	89.396	-8.596
664	70.500	68.066	2.434
665	85.400	97.230	-11.830
666	92.000	84.245	7.755
667	108.300	115.722	-7.422
668	97.500	119.849	-22.349
669	94.500	77.405	17.095
670	88.600	103.998	-15.398
671	60.000	108.148	-48.148
672	40.200	47.715	-7.515

I	OBSERVED	GENERATED	RESIDUE
673	115.900	31.136	84.764
674	109.400	122.523	-13.123
675	82.300	103.868	-21.568
676	103.200	98.336	4.864
677	99.700	144.461	-44.761
678	86.000	110.861	-24.861
679	79.400	91.491	-12.091
680	60.400	95.654	-35.254
681	59.700	44.723	14.977
682	57.400	53.008	4.392
683	57.500	59.679	-2.179
684	53.000	70.143	-17.143
685	44.800	41.454	3.346
686	41.100	55.848	-14.748
687	43.300	54.866	-11.566
688	63.800	70.172	-6.372
689	66.000	81.004	-15.004
690	86.900	59.870	27.030
691	93.300	74.394	18.906
692	93.100	80.615	12.485
693	106.800	105.207	1.593
694	109.100	109.590	-.490
695	102.100	117.755	-15.655
696	103.600	87.193	16.407
697	97.000	101.571	-4.571
698	88.000	58.927	29.073
699	94.500	104.803	-10.303
700	97.500	103.510	-6.010
701	101.700	109.232	-7.532
702	95.700	125.105	-29.405
703	104.000	106.524	-2.524
704	104.600	87.666	16.934
705	102.900	103.803	-.903
706	102.600	112.060	-9.460
707	89.600	109.107	-19.507
708	83.000	70.372	12.628
709	82.000	102.142	-20.142
710	84.400	48.535	35.865
711	89.500	82.030	7.470
712	91.100	75.998	15.102
713	107.600	103.648	3.952
714	100.300	134.813	-34.513
715	91.500	105.529	-14.029
716	93.200	86.982	6.218
717	97.000	86.644	10.356
718	101.300	108.266	-6.966
719	105.500	94.864	10.636
720	106.900	71.836	35.064

I	OBSERVED	GENERATED	RESIDUE
721	112.100	86.827	25.273
722	104.100	125.422	-21.322
723	98.900	102.179	-3.279
724	80.800	102.450	-21.650
725	64.100	102.035	-37.935
726	68.200	78.174	-9.974
727	94.400	65.297	29.103
728	109.100	84.767	24.333
729	104.600	102.856	1.744
730	103.600	116.720	-13.120
731	105.600	103.251	2.349
732	101.400	104.159	-2.759
733	109.400	99.118	10.282
734	101.700	88.678	13.022
735	99.800	101.809	-2.009
736	135.200	128.357	6.843
737	137.800	157.023	-19.223
738	117.700	134.039	-16.339
739	125.200	110.858	14.342
740	126.000	116.606	9.394
741	112.200	125.004	-12.804
742	108.300	110.195	-1.895
743	105.000	89.321	15.679
744	101.600	102.037	-.437
745	106.000	88.784	17.216
746	104.300	83.199	21.101
747	100.900	108.353	-7.453
748	100.000	85.219	14.781
749	101.300	98.621	2.679
750	104.600	112.073	-7.473
751	110.600	111.529	-.929
752	107.800	118.559	-10.759
753	84.700	113.341	-28.641
754	74.000	81.752	-7.752
755	75.100	49.870	25.230
756	67.900	83.500	-15.600
757	63.300	73.739	-10.439
758	60.300	45.059	15.241
759	56.300	52.753	3.547
760	68.600	77.013	-8.413
761	74.300	92.442	-18.142
762	108.100	87.409	20.691
763	71.100	116.611	-45.511
764	65.400	66.265	-.865
765	54.700	77.895	-23.195
766	57.500	51.507	5.993
767	51.100	36.688	14.412
768	56.800	50.861	5.939

I	OBSERVED	GENERATED	RESIDUE
769	57.500	68.205	-10.705
770	60.100	50.595	9.505
771	57.000	60.380	-3.380
772	47.500	58.700	-11.200
773	79.100	73.141	5.959
774	107.300	92.896	14.404
775	93.000	108.240	-15.240
776	151.100	103.421	47.679
777	129.900	144.502	-14.602
778	104.100	146.117	-42.017
779	98.300	106.814	-8.514
780	97.500	98.127	-.627
781	86.800	100.257	-13.457
782	82.300	89.962	-7.662
783	81.600	96.657	-15.057
784	110.000	105.080	4.920
785	119.000	125.522	-6.522
786	113.900	104.951	8.949
787	107.200	85.979	21.221
788	97.400	103.211	-5.811
789	109.000	84.662	24.338
790	160.900	103.101	57.799
791	134.500	156.821	-22.321
792	119.000	131.621	-12.621
793	108.600	119.278	-10.678
794	113.400	112.711	.689
795	114.100	114.584	-.484
796	155.400	120.080	35.320
797	159.600	140.747	18.853
798	158.300	154.195	4.105
799	142.400	140.580	1.820
800	135.900	136.556	-.656
801	128.300	126.466	1.834
802	116.200	149.931	-33.731
803	113.700	99.689	14.011
804	101.400	93.535	7.865
805	99.100	101.704	-2.604
806	88.600	125.110	-36.510
807	102.800	95.900	6.900
808	119.800	99.805	19.995
809	134.900	132.602	2.298
810	136.700	135.181	1.519
811	119.800	140.303	-20.503
812	95.900	97.582	-1.682
813	80.700	113.591	-32.891
814	91.200	81.417	9.783
815	87.900	80.368	7.532
816	85.900	69.349	16.551

I	OBSERVED	GENERATED	RESIDUE
817	85.000	89.173	-4.173
818	81.300	73.934	7.366
819	80.100	93.851	-13.751
820	87.600	81.120	6.480
821	101.900	82.641	19.259
822	116.800	114.945	1.855
823	106.000	92.159	13.841
824	103.200	90.883	12.317
825	99.800	94.023	5.777
826	100.900	109.630	-8.730
827	96.900	98.163	-1.263
828	95.400	111.169	-15.769
829	94.900	101.362	-6.462
830	92.100	79.184	12.916
831	87.800	103.213	-15.413
832	85.600	118.660	-33.060
833	94.600	74.008	20.592
834	163.400	83.029	80.371
835	134.300	141.032	-6.732
836	122.000	128.286	-6.286
837	116.400	138.046	-21.646
838	132.300	101.227	31.073
839	142.500	147.182	-4.682
840	128.300	134.254	-5.954

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