Reliability studies of multireservoir system using stochastic approach

Jamaldeen M. Esuf Lebbe

Civil Engineering

October 1991

Abstract

This study has been conducted as an initial attempt to find the maximum releases from a multi-reservoir system and to come up with an operating policy. In this case study, streamflow records at a multi-reservoir system (5 reservoirs) in Sri Lanka was considered. Thirty six years of flow data at the reservoir sites were analyzed statistically and 700 traces for each reservoir were generated stochastically, and maximum releases for each month were determined knowing reservoir capacities. Fitting an extreme value distribution to these releases, a reliability curve was obtained. These releases have been used to compute the hydroelectric power that can be generated from the reservoir system. This has been compared with the total power requirement of Sri Lanka considering the benefit of the hydroelectric power generation only. It was found that 52 percent and 55 percent of the total power requirement of Sri Lanka can be met if the releases considered to be at the probability levels of 99 percent and 42.92 percent (mean) respectively.

Reliability Studies of Multi-Reservoir System Using Stochastic Approach

by

Jamaldeen M. Esuf Lebbe

A Thesis Presented to the

FACULTY OF THE COLLEGE OF GRADUATE STUDIES

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

DHAHRAN, SAUDI ARABIA

In Partial Fulfillment of the
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This thesis, written by **JAMALDEEN M. ESUF LEBBE** under the direction of his thesis committee, and approved by all the members, has been presented to and accepted by the Dean, College of graduate Studies, in partial fulfilment of the requirement for the degree of

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This thesis is

dedicated to

my son Anan

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ABSTRACT

This study has been conducted as an initial attempt to find the maximum releases from a multi-reservoir system and to come up with an operating policy. In this case study, streamflow records at a multi-reservoir system (5 reservoirs) in Sri Lanka was considered. Thirty six years of flow data at the reservoir sites were analyzed statistically and 700 traces for each reservoir were generated stochastically, and maximum releases for each month were determined knowing reservoir capacities. Fitting an extreme value distribution to these releases, a reliability curve was obtained. These releases have been used to compute the hydroelectric power that can be generated from the reservoir system. This has been compared with the total power requirement of Sri Lanka considering the benefit of the hydroelectric power generation only. It was found that 52 percent and 55 percent of the total power requirement of Sri Lanka can be met if the releases considered to be at the probability levels of 99 percent and 42.92 percent (mean) respectively.

خلاصة

لقد اجريت هذه الدراسة كمحاولة ابتدائية لايجاد التسرب الأولى الأعظمي من مجموعة خزانات واستخلاص سياسة تشغيلية . في هذا البحث تم دراسة نظام خزانات (خمسة خزانات) في سريلانكا .

لقد تمت دراسة احصائية لمعلومات مدتها ٣٦ سنة وتم عمل ٧٠٠ تتابع ودراستها بالطريقة الستوكاستيكية . وتم حساب التسرب الأعظمي لكل شهر وذلك بعد معرفة سعة الخزانات ، ولقد تم الحصـــول على منحنيات وثوق وذلك باستعمال القيم العظمي . ثم استعملت هذه القيم لحساب الطاقة الكهرومائية التي ممكن استخراجها من الخزانات وقد تم مقارنة هذا باحتياجات دولة سريلانكا من الطاقة . وبالأخذ بعين الاعتبار فائدة الطاقة فقد وجد أن ٥٢٪ و ٥٥٪ من احتياجات سريلانكا من الطاقة ممكن توفيرها إذا كان التسرب قد حسب على احتمالي ٩٩٪ و ٤٢,٩٢٪ (معدلاً) وذلك على التتابع .

CHAPTER 1

INTRODUCTION AND SCOPE OF RESEARCH

1.1 Introduction

Stochastic science is defined as the art of estimating the probability of things so that in our judgement and actions, we may choose to follow the best, the safest, the surest, or the most soul-searching way. Unfortunately, hydrology is unable to provide either the exact probability distribution of flows or long records of past flows. Existing streamflow records are usually not sufficiently extensive enough to provide estimates of future behavior of streamflows. Strict use of historical record alone in operational study involves several potentially serious problems. One answer to this problem is to generate possible (but not observed) long historical records that may be used to determine several quantities of interest within defined statistical errors. Such streamflows can be generated or synthesized using stochastic streamflow models.

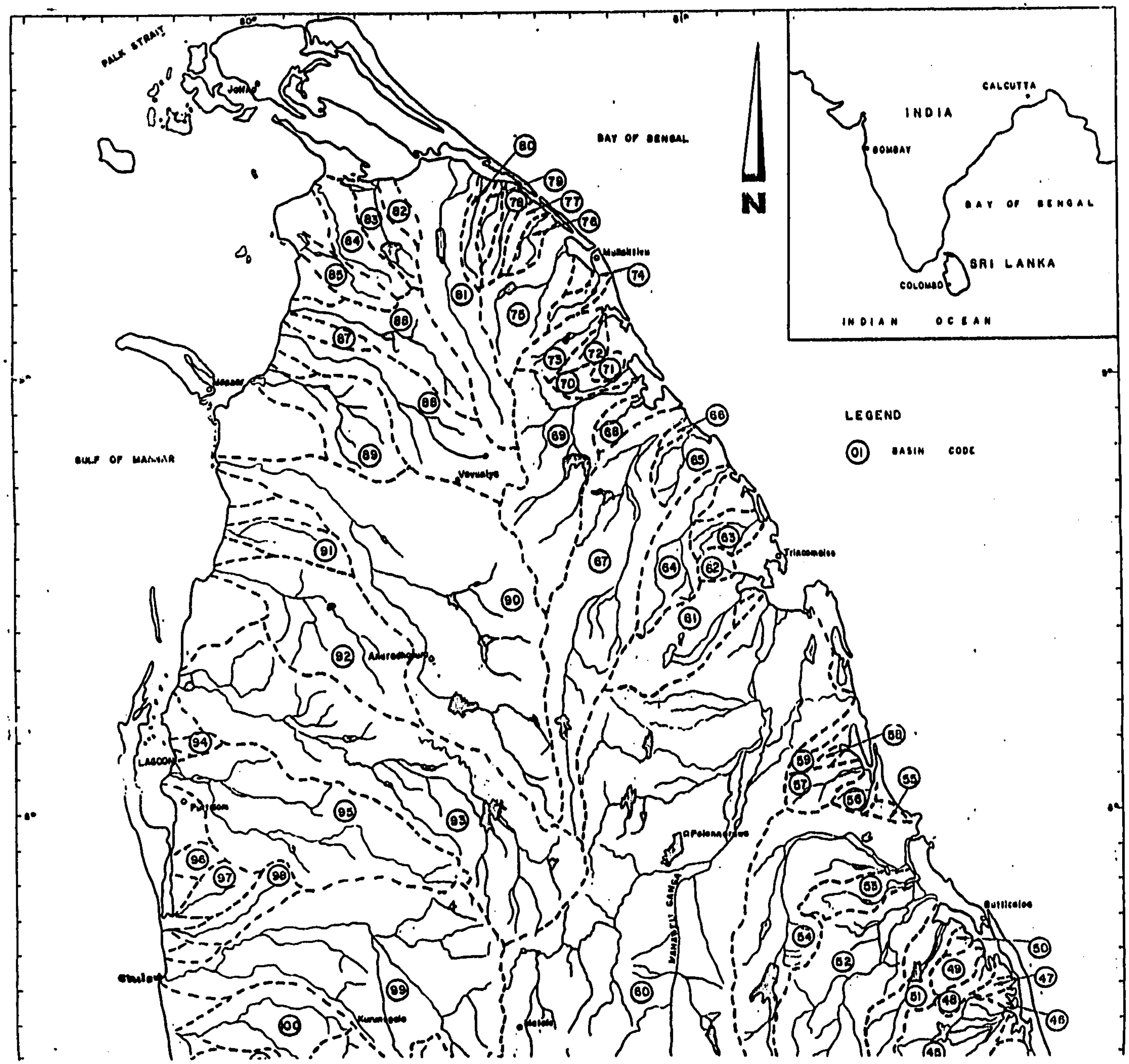
Stochastic hydrology is meaningful only in a design or operational decision making sense. Stochastic methods were first introduced into

hydrology to cope with the problem of reservoir design. But no studies have been conducted to maximize the release from an existing reservoir where operational policy have been changed because of the increase in demands. This is precisely the problem facing the operators of a recently constructed reservoir system (Mahaweli) in Sri Lanka. This reservoir problem in Sri Lanka seems to be an ideal candidate for the analysis mentioned earlier. The historical data required for such an analysis was available in Sri Lanka.

Sri Lanka is a tropical island with a land mass of 25,332 square miles (6 1/2 million hectares), situated in the Indian Ocean, latitude between 6 degree and 10 degree north and longitude between 80 degree and 81 degree east. The island is subjected to two monsoons; the South-West monsoon prevailing from about April to September and the North-East monsoon from October to March. On the basis of distribution of rainfall, the island is divided into two distinct areas; the wet and dry zones. The wet zone comprises of the South-West area, covering about a quarter of the island, extending southwards from Chilaw and terminating with Kandy and Nuwara-Eliya in the east. The area of the wet zone is about 4 million acres. The wet zone, with its two rainy seasons and an annual average rainfall of 95 inches, is well developed with economic crops such as tea, rubber, coconut etc.. The present economy of the country largely depends on the development of the wet zone. The rest of the island consists of its dry zone. Dry zone comprising of over 12 million acres, has only one rainy season, from about October to March, and the average annual precipitation is about 57 inches. The dry zone area is arid and dry, and well suited for irrigated agriculture.

The only source of water in Sri Lanka is direct rainfall. The amount of rainfall varies from place to place. The island is served with a network of rain gauge stations, some of which have been in operation for over a hundred years. The most important stations are equipped with automatic recorders. Today there are over 600 rain gauge stations established all over the island. Runoff from the rivers of Sri Lanka, varies very widely from stream to stream due to variation in rainfall, type of soil, its slope and other factors[1].

For the purpose of assessing the yield from river basins, stream gauging stations have been established to measure the flow of most of the important rivers of Sri Lanka. The territory of Sri Lanka has been divided into 103 natural river basins. The river basin map of Sri Lanka is given in Figure (1.1). Among these river basins, Mahaweli basin is the largest, and covers nearly one sixth of the area of the island. Its length is 207 miles. It has its sources in the central highlands and drops nearly 8000 ft to flow into sea at south of Trincomalee in the eastern province. At present, the Mahaweli scheme contains five major reservoirs and six hydroelectric power stations. Figure (1.2) shows their location map and the schematic diagram in detail. Since this is the largest irrigation scheme in the island and major source of hydroelectric power, reliability studies of these reservoirs be all important in arriving at proper operational rules of these reservoirs.


PALK STRAIT
Jaffna
BAY OF BENGAL
Mullaitivu
Vavuniya
GULF OF MANNAR
Mannar
Trincomalee
Anuradhapura
LAGOON
Puttalam
Polonnaruwa
MAHAWELI GANGA
Batticaloa
Chilaw
Kurunegala
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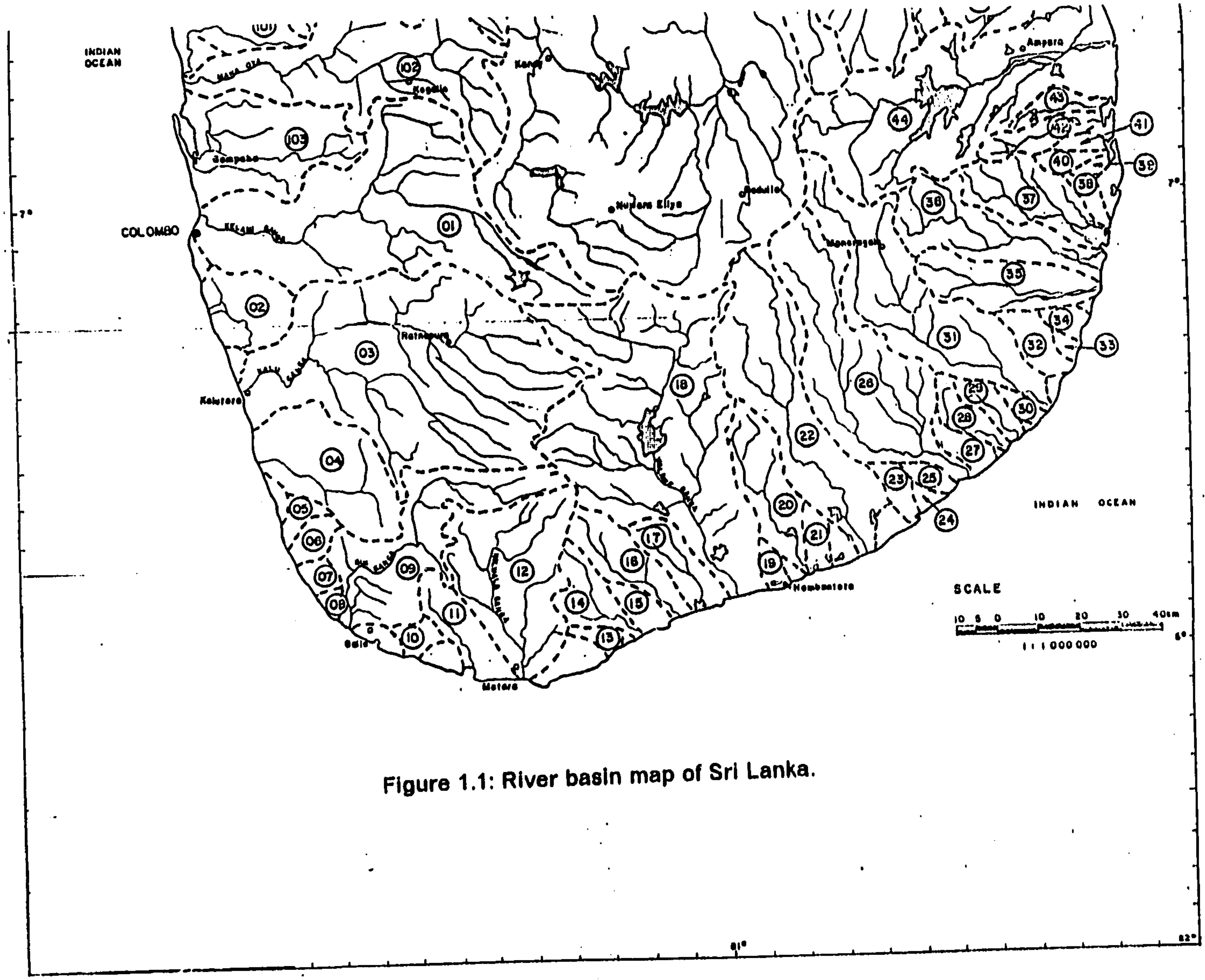
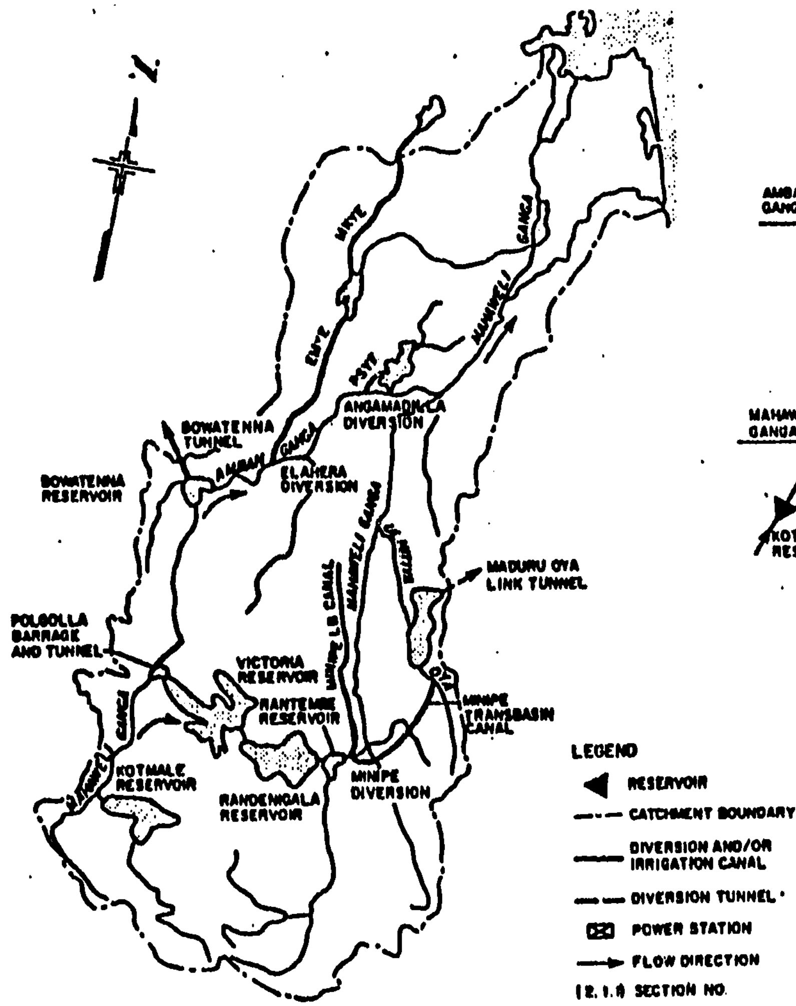
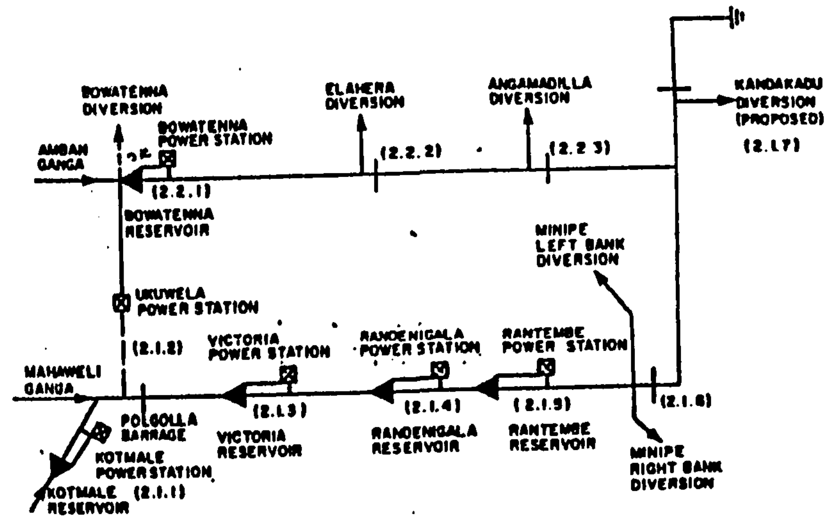


Figure 1.1: River basin map of Sri Lanka.



LOCATION MAP



SCHEMATIC DIAGRAM

Figure 1.2: Reservoir location map and Schematic diagram.

1.2 Scope of Research

This study is an attempt to find the maximum monthly releases with given reliability from an existing reservoir system where the hydroelectric power generation and irrigation supply are maximized. Finding the monthly constant releases from a reservoir will be of great help for the water management personnel to plan entire activities in advance. Recent studies show that using historical records of flow alone to find releases from a reservoir gives erroneous results. To over come this problem, stochastic technique is used to generate thousands of synthetic traces. Lognormal Markov's monthly flow model [2] is employed for this purpose. The generated traces, from this model, are used in Sequent Peak Algorithm to find the releases. Reliability studies are conducted for these releases from each trace in order to make sure the certainty of the release.

Chapter 2 reviews the literature in the field of stochastic hydrology and other relative topics which includes stochastic streamflow models, and reliability studies.

Chapter 3 describes the theoretical consideration of this study, while Chapter 4 considers data analysis in which data acquisition and data distribution are considered.

Chapter 5 examines the results of this study and Chapter 6 gives the conclusions and recommendations.

CHAPTER 2

LITERATURE SURVEY

2.1 Introduction

Importance of reservoir reliability studies has been realized long time before. Introduction of probability theory to this field opened the way to determine the reliability of a reservoir to meet a certain demand or to determine the reliability of releases (demands) that can be met from a fixed finite storage capacity. Information on the reliability of the release from a storage reservoir is of crucial importance where operating policy is not known. This chapter summarizes the investigations curried out in the field of reservoir reliability studies.

Prior to the introduction of stochastic streamflow models (SSM) for this analysis mass curve technique (introduced by Ripple 1883) or sequent-peak algorithm (by Thomas and Burden 1963) flow were used. Thus, until the advent of the field of stochastic hydrology, determination of the reservoir design capacity of the release from a storage reservoir seemed simple: one just determined the minimum storage that would have been required over the

N-year historical period to provide the target yield or vice versa with absolutely no water storage. Fiering [6] documents the following three principal shortcomings of the strict use of historical records.

1. The analysis is based on solely on the historical records, and it is unlikely that the same flow sequence will recur during the active life of the complete structure.

2. The mass diagram (based solely upon the historical flow sequence) do not help the designer to establish or complete the risk to be taken with regard to water shortage during periods of low flow.

3. The length of the historical record is likely to differ from the economic life of the proposed structure.

Stochastic streamflow models provide the answers that can be used to circumvent shortcomings of the strict use of the historical record alone. It also can provide estimates of reliability in the face of the rising demands for water [7]. It can be used to provide estimates of expectation and variance of project net benefits, which is an important information for an economic or decision theoretical analysis of storage-water-yield problems. There is almost no case study literature available in the field of demand calculation from a known reservoir capacity using stochastic technique. This proposed study clarifies the possibility of demand calculation from a known reservoir

capacity. This survey will cover stochastic streamflow models, reliability studies of release from a storage reservoir and sequent-peak algorithm.

2.2 Stochastic Streamflow Models

Stochastic monthly streamflow models are often used in simulation studies to evaluate the likely future performance of water resource systems. Stochastic hydrology took several steps before reaching presently available sophisticated models.

The work of Fiering [5] was a useful starting point for techniques applying autoregression studies to the problem of storage. This approach was considered to be best for economic studies of reservoirs.

Lloyd [13] gave a relatively complete summary of the state of art of stochastic reservoir theory. It was unfortunately long and often the principles involved were not obvious. All the work described depended on Markovion storage relationship and relatively simple releases. Then the basic Markov model was extended to the case of seasonal inputs after Lloyd [14]. He next summarized correlated inflows and as a logical extension summarized correlated seasons. Time dependent results and the effects of initial storage conditions were examined in Lloyd's summary. White [23] surveyed the stochastic aspects of reservoir storage. He advocated use of Markovion methods and pointed to the erroneous results involved in reservoir capacity

determination. He, however, showed that the method described by Hazen (1914) gave reasonably acceptable results, when compared with Markovian studies, provided the probability of emptying is low. But he did not define reservoir failure and the reservoir problem involved.

Klemes [9] developed a technique for computing certainty distribution for specified reservoir life for random input and uniform or random reservoir draft. Later Klemes [10], he extended his study to examine variability of a storage reservoir having seasonal input.

Burges [2] did a critical analysis on the use of stochastic hydrology to determine storage requirements for reservoirs. In this study, normally distributed Markov model was used to generate monthly and annual flows. It has been shown most storage cases satisfied the basic extreme value (Type I) distribution when mathematically correlated input parameters were used. But for the case when the generator coefficient of variation and the demand are small, eye fitting gave a better fit.

Hoshi and Burges [8] used annual streamflow volumes. modeled by Autoregressive(AR(1)) and Autoregressive Moving Average (ARMA (1,1)) process to study the impact of seasonal flow characteristics and demand patterns for one required reservoir storage. They pointed out that incorporation of the long term persistence into an annually generated flows by using ARMA(1,1) model with Hurst coefficient 0.7 did not significantly

influence storage requirements. They concluded that AR(1) is quite suitable for practical application. Procedures for its use for the multi-site case are given in Hoshi and Burges [8].

Hirsch [7] used six synthetic models in the study of water supply reliability and pointed out that a new type of auto-regressive-moving-average model was operationally superior to an autoregressive model.

Stedinger and Taylor [16,17] studied the performance of a wide range of monthly streamflow models and compared using data for the Upper Delaware River basin in New York state. It was shown that Thomas-Fierring monthly autoregressive Markov model and the AR(1) annual flow model with disaggregation to obtain monthly flow showed better behavior than other models. Furthermore, among these two models Thomas-Fierring Markov monthly models showed better behavior than AR(1) model.

Stedinger, Cohn and Pei [18] developed a condensed version of Valencia-Schaake disaggregation model which describes the distribution of monthly streamflow sequences using a set of coupled univariate regression models rather than a multivariate time series formulation. They concluded that condensed disaggregation model is attractive because it has fewer parameters but can still reproduce the mean, variance and period-to-period correlations of the individual flows while approximately preserving the relationship among the monthly and annual flow values. But they failed to

state that how accurate the reproduction of the mean, variance and correlations.

Vogel and Stadinger [20] have illustrated the study of the value of stochastic streamflow models in overyear reservoir design applications that fitting an AR(1) lognormal model leads to more precise estimate of annual storage requirements than if only the historical flows are employed, even in situation when the flows were not generated with an AR(1) lognormal model.

CHAPTER 3

THEORETICAL CONSIDERATIONS

3.1 Introduction

An important tool in water resource system planning is synthetic streamflows, which allows the planner to evaluate proposed system designs more thoroughly and in a more statistically sophisticated manner than was possible with previously available methods. Synthetic streamflows and operational hydrology together open the way to add to the planning process, the capacity for increased scope and sensitivity of evaluations.

In fact past civil engineers knew that the flow pattern varies considerably from stream to stream and historical record provides a very valuable clue to the future behavior of the stream. They used Ripple mass curve analysis to investigate the storage capacity using historical records. Similarly a historical record for a stream had been used to examine the aspects of following patterns and design appropriateness. Such use of the historical record alone however, involves the following serious problems.

1. Any historical record of flows for any given stream is quite short because exact pattern of flows during the historical period is extremely

unlikely to recur during that period in which the proposed system would be operative. Furthermore, characteristics of the recorded flows are not at all likely to be maintained during the economic life of the system. In all cases planners would certainly agree that the worst flood (or drought) on record is not the worst possible flood (or drought). Also, the historical record may not be long enough to provide the planner with as much data as he needs.

2. An important fact is that in eventually proposed designs this use of the historical record alone gives no idea of the risks involved[6].

In order to overcome these problems engineers use operational hydrology to estimate expected frequency and severity of failures. But hydrology is unable to provide either the exact probability distribution of flows or long records of past flows to engineers to conduct operational studies. Therefore, hydrologists had to devise some models that should be sufficiently realistic while at the same time improve the planning significantly. Early attempts were made to come up with manually generated flows in hydrological studies, but the tremendous amount of calculation consumed much of their valuable time. After the invention of the modern electronic computers large scale analysis of data in hydrology became possible and helped to improve new statistical techniques which improved the synthetic streamflow models. Several sophisticated synthetic streamflow models are now in use. Some recommended models for simulation studies are:

1) Thomas- Fiering monthly autoregressive Markov model.

2) The best autoregressive moving average (ARMA) model of the deseasonalized monthly flows.

3) A fractional Gaussian noise (FGN) model of the deseasionalized monthly flows.

4) The best ARMA model of annual flows using dissagregation to obtain monthly values, and

5) A fractional Gaussian noise (FGN) model of annual flows using dissagregation to obtain monthly flows.

3.2 Steps to choose a model

Choosing a model for the use of operational requires several steps. First step is statistical evaluation of the historical data to select the family of distributions for the use in the flow generation. Second step is analysis of time series and random numbers. Third step is selecting a generating scheme for the synthetic flow.

3.2.1. Evaluation of the Statistics

Evaluation of the statistics of the historical record are usually carried out in the following manner. The historical record is examined to see whether they are regulated (any man made changes in the flow) or unregulated. If unregulated then flows can be synthesized as described here. If the historical flow is regulated in the past, then the unregulated portion of

historical record is taken for synthesis.

The mean of the historical flow is calculated for whatever time intervals are considered to be important (i.e. months and year). In this study monthly mean is used.The mean is defined by

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i \tag{1}$$

The standard deviation of the historical flows is calculated using

$$s^2 = \frac{1}{n-1}\sum_{i=1}^{n} x_i^2 - \frac{n}{n-1}\bar{x}^2. \tag{2}$$

The serial correlation coefficient is calculated by

$$\rho = \frac{\sum_{i=1}^{n-1} x_{i,j}x_{i,j-1} - n\bar{x}_j\bar{x}_{j-1}}{(n-1)s_{x_j}s_{x_{j-1}}} \tag{3}$$

Where

i = Sequence index

j = Monthly index

Next, logarithms of historical flows are calculated and the mean, standard deviation, and correlation coefficient are calculated for logarithmic values. Then normal probability paper is used to fit the historical flows. If the best fitting curve is straight line then the historical flows are said to be following a normal distribution. If the flows are not following normal distribution, then lognormal probability paper is used to fit the logarithmic values of historical flows. If the best fitting curve is straight line the flow said to be following lognormal distribution. If the flow data are not following normal or lognormal

distribution then other alternatives are possible such as gamma distribution ect. will have to be tested for.

3.2.2 Time series and Random Numbers

Whenever a sequence of values of synthetic flows for a given stream are generated, we should consider the flows to be the results of a random process. The history of the stream provides valuable information about probable future flows. Models for generations should use such information and must include random, competent to reflect our inability to predict future flow sequences exactly. A set of historical or synthetic flows for a stream is a sequence of numbers or values produced by a random process in a succession of time intervals: such a sequence is called time series. In general, the i^{th} number of a time series, which we write as x_i ,is the sum of two parts:

$$x_i = d_i + e_i \tag{4}$$

Where

d_i = deterministic part

e_i = random number with certain probability distribution or pattern.

Let us consider random part of our time series. The programmer who is considering a simulation problem must have a source of random numbers.

There are several random number distributions, but in this study normally distributed random numbers with zero mean and unit standard deviation, are used. The reason why normally distributed random numbers were selected, will be explained later in this chapter.

Let us consider the second part of the time series, which is the deterministic part. This deterministic part should be devised so that the generated flows show the same characteristics as the historical flow record does. In other words, the generated flow should have the same statistical characteristics such as mean, standard deviation and serial correlations coefficient.

3.2.3. Choosing a Model

After the sample parameters of the flows are identified and the distribution is selected, the modeler must next select a generating scheme for the synthetic flows. As we saw in the previous section the form of such scheme is

$$q_i = d_i + e_i \tag{5}$$

With d_i the deterministic part and e_i the random part of the synthetic flow. After several modifications with some reasonable assumptions [2] lognormal Markov monthly synthetic flow generating scheme has taken the form of

$$q_{i,j} = \mu_j + \rho_j \frac{\sigma_j}{\sigma_{j-1}}(q_{i-1,j-1} - \mu_{j-1}) + n_i \sigma_j \sqrt{1-\rho_j^2} \tag{6}$$

where

i = the sequence index

j = the monthly index

q = flow (log values of depth over the catchment area)

ρ_j = correlation coefficient between months j and j-1

n = unit normal deviate

To preserve the historical statistics of the flows rather than of their logarithms, mathematically corrected approach is used. In this approach the monthly parameters μ_j , σ_j , ρ_j (they are not population parameters) are defined as

$$\overline{X}_j = \exp(\mu_j + \frac{\sigma_j^2}{2}) \tag{7}$$

$$\sigma_{xj}^2 = \exp(2\sigma_j^2 + 2\mu_j) - \exp(\sigma_j^2 + 2\mu_j) \tag{8}$$

$$R_{0j} = \frac{\exp(\sigma_{j-1}\sigma_j\rho_j) - 1}{[\exp(\sigma_{j-1}^2 - 1]^{1/2}[\exp(\sigma_j^{2)} - 1]^{1/2}} \tag{9}$$

Where $\overline{X}_j$, σ_{xj}^2 , R_{oj} are the observed means, variance, and serial correlation for month j (R_{oj} is the correlation of month j with j-1)

Lognormal Markovian monthly model is selected in this study because of the following reasons.

1. Monthly flow generating scheme was needed.
2. This model can be adopted to lognormally distributed flows.
3. Latest studies show that this model leads to more precise estimates of

monthly flows by producing severe droughts than other available models [16].

3.3 Operation Study.

Operation study is nothing but means to determine required capacity for a river reservoir. In the past, operation study was used to analyze only for a selected critical period of very low flows. But now, availability of modern computers favor the use of long synthetic records. The past practice can only define the capacity required during the selected drought. In the case of synthetic data, it is possible to estimate even the reliability of reservoirs of various capacities. The most commonly used methods for this purpose are sequent-peak-algorithm and Ripple mass curve.

3.3.1 Sequent Peak Algorithm (SPA).

In the case of calculating reservoir capacity using SPA, values of the cumulative sum of inflow minus withdrawals (including average evaporation and seepage) are calculated (Figure (3.1)). The first peak (local maximum of cumulative net inflow) and the sequent peak (next following peak which is greater than the first peak) are identified. The required storage for the interval is the difference between the initial peak and the lowest trough in the interval. The procedure is repeated for all cases in the period under study

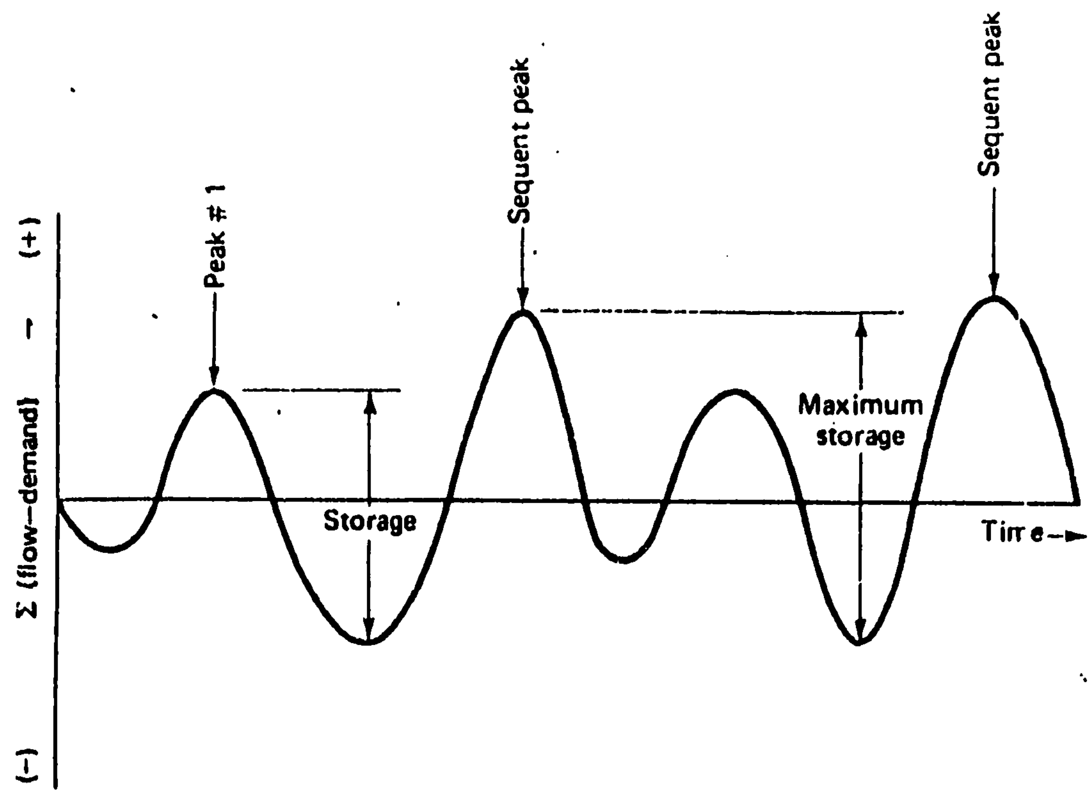


Figure 3.1: Illustration of the sequent-peak algorithm (From Water Resources Engineering Ray K.Linsey and Joseph B. Franzini).

and the largest value of required storage is determined. In the case of demand determination, with assumed initial demands the largest value of required storage is determined as mentioned above. Then, the calculated reservoir capacity and known reservoir capacity will be compared. This procedure will be repeated with iteratively changed demand until calculated reservoir and the known reservoir capacity are found to be the same. Since both capacities are the same, it can be said that the demands that satisfy the condition can be met by the reservoir under study. This procedure will be repeated for all traces and the demands obtained will be used for the reliability studies which is explained later in this chapter.

3.3.2 Ripple Mass Curve Analysis

Ripple mass curve is a cumulative plotting of net reservoir inflow. A sample plot is given in Figure (3.2). The slope of the mass curve at any time is a measure of inflow at that time. Demand curves representing uniform rate of demand are straight lines. Demand lines drawn tangent to the high points of the mass curve, (A,B) represent rates of withdrawal from the reservoir. Assuming the reservoir to be full wherever a demand line intersects the mass curve, the maximum departure between demand line and the mass curve represent the reservoir capacity required to satisfy the demand. Mass curve may also may be used to determine yield which may be expected with the given reservoir capacity Figure (3.3). In this case tangents are drawn to the high points of the mass curve (A,B) in such a manner that their maximum

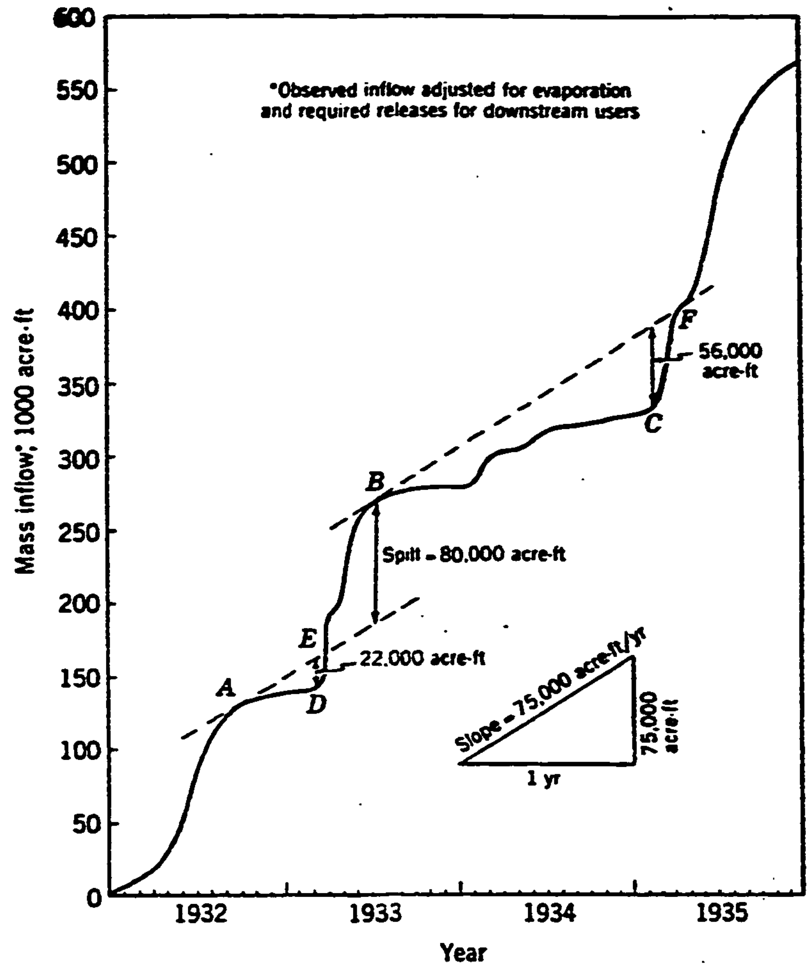


Figure 3.2: Use of mass curve to determine the reservoir capacity to meet a given demand (From Water Resources Engineering Ray K.Linsey and Joseph B. Franzini).

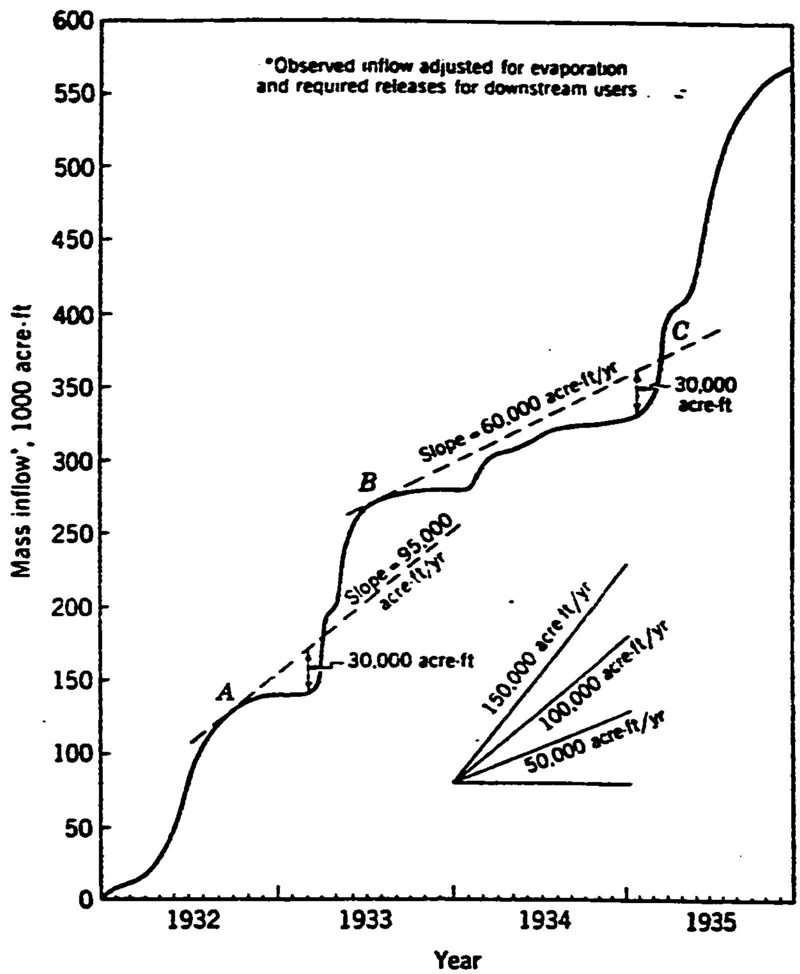


Figure 3.3: Use of mass curve to determine the possible demand from a reservoir of specified capacity (From Water Resources Engineering Ray K. Linsley and Joseph B. Franzin).

departure from the mass curve does not exceed the specified reservoir capacity. The minimum slope of the resulting lines indicate the yields that can be met from the specified storage capacity. A demand line must intersect the mass curve when extended forward. If it is not, then the reservoir will not refill.

In this study, sequent-peak algorithm method has been chosen for operational study. This method was selected because of the Fiering's [5] clear explanation of the algorithm and its use. He has stated:

> "sequent- peak algorithm differs from mass curve analysis in that the formalism of locating the correct starting storage is avoided; moreover, it precludes the ambiguous results frequently observed when mass curve analysis is applied to reservoir design. It specifies a sequence of calculations that elucidates the concept of mass analysis and is equivalent to a linear programming solution for the optimal waste pattern ...."

3.3.3 Flow generation

Once the synthetic generating scheme is chosen, then, flows can be generated. Stochastic analysis should be used to generate a number of synthetic flow traces usually between 500 and 1000 of length equal to the expected useful life usually between 50 and 100 years of the project under study. The restriction on the number of traces is the outcome of a research project done by Burges [2] . In his research, groups of 50, 100, 250, 500, and 1000 data point were plotted on extreme value paper. It can be seen from

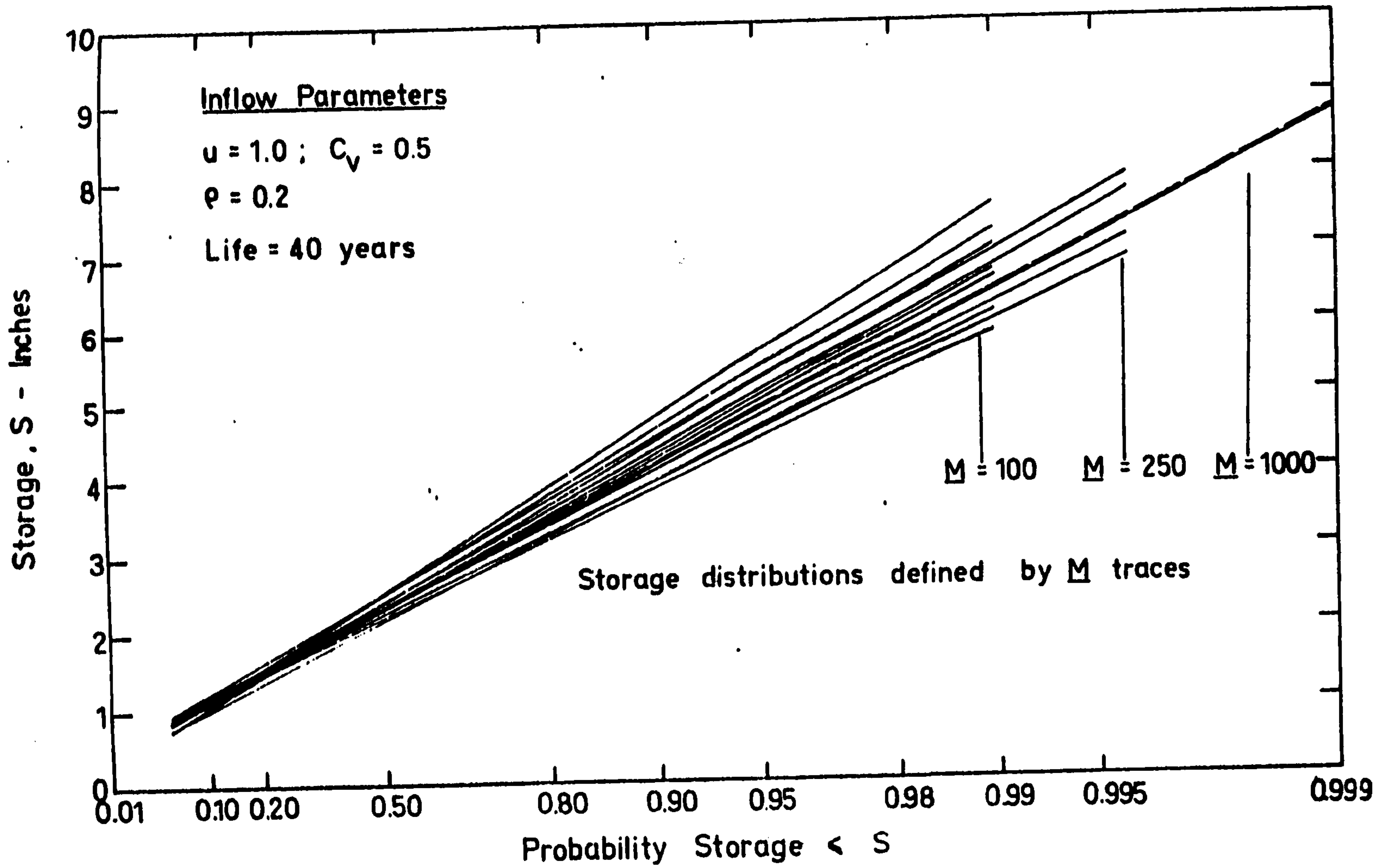


Figure 3.4a Influance of the number of traces used to define the distribution of storage (From Use of Stochastic Hydrology to Determine Storage requirements for Reservoirs Stephen J. Burges)

Figure 3.4a that increase in number of traces brings the distribution line closer to the true line. Furthermore, it shows that the line defined by two separate groups of 1000 values are virtually identical. From the results of this study he concluded that the exact distribution (Gumbel Extreme-value Distribution) is well defined by 1000 storage values (traces) and for most purposes 500 values (traces) would probably suffice. In the latter case the largest 4 or 5 values should be deleted because of the influence of these values (if they are assigned probabilities that are significantly in error) on the parameters of the extreme value distribution. The restriction on the expected life of the project is also explained and concluded in the same way as restriction on number of traces. In this study, 700 synthetic traces have been generated for each reservoir and the life of the reservoir is taken as 50 years. In each trace 612 flows were generated and the first 12 flows were discarded to eliminate the starting bias. The remaining 600 flows from each trace are now ready for the operational studies.

3.4 Reliability Studies

Information on the reliability of a reservoir is of crucial importance in the operational study in water resource engineering. The reliability of a reservoir is defined as the probability that it will deliver the expected demand throughout its life time without incurring a deficiency. In this sense, life time is taken as the economic life, which is usually between 50 and 100 years. We may estimate the reliability by generating statistically 500 to 1000 traces.

each trace equal in length to the adopted project life. Each trace then may be said to represent one possible example of what might occur during the project life time, and all traces are equally likely representatives of this future period. If the storage required to deliver a specified demand is calculated for each trace, the resulting values of storage can be ranked in order of magnitude and plotted as a frequency curve, or theoretical curve can be calculated from the data. There are several distributions available for this purpose but there is no real proof of their validity. Since the primary objective of this study is to find the maximum demand (extreme value) Gumbel extreme-value distribution appears to be the most appropriate distribution than others [12]. The result is a reliability curve which indicates the probability that the demands during the project life can be met as a function of reservoir capacity.

Alternatively, the same techniques can be adopted for determining the demand that can be met by a given capacity of a reservoir. As explained earlier in this chapter, demands will be calculated, using sequent-peak algorithm, from each trace. The resulting demands then can be described by an appropriate distribution. In this study, Gumbel extreme-value distribution is used. An illustration of reliability curve, using Gumbel extreme-value distribution, is given in Figure (3.4). Theoretical aspects of Gumbel extreme value distribution is discussed below.

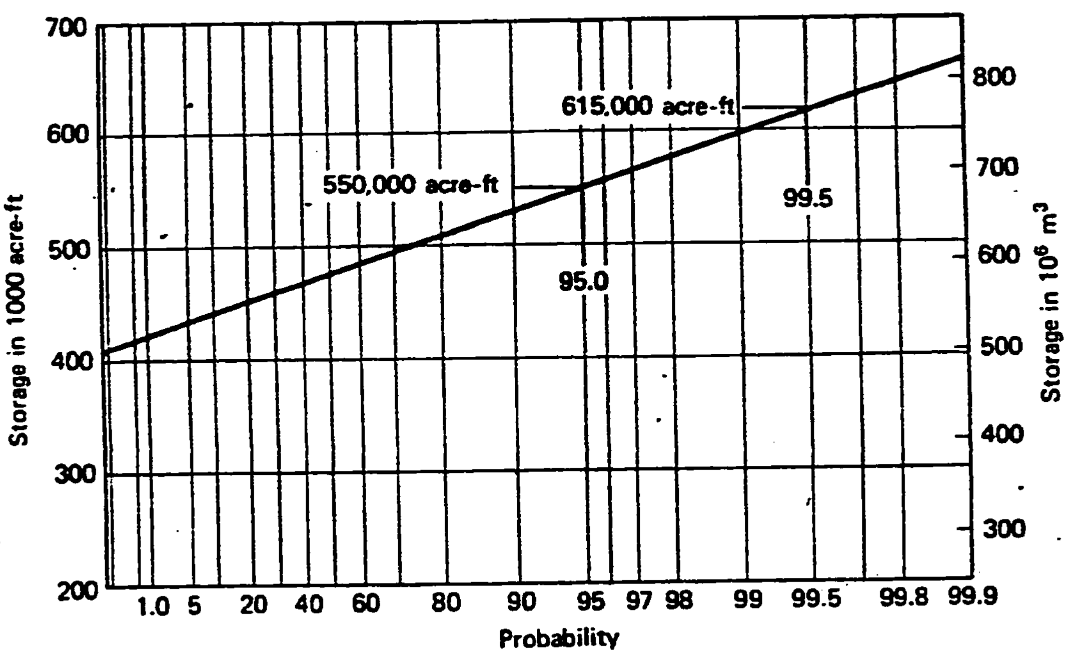


Figure 3.4: Illustration of Reliability curve (From Water Resources Engineering Ray K. Linsley and Joseph B. Franzini).

3.5 Gumbel Extreme-Value Distribution

Several distribution have been suggested as appropriate for streamflow out there is no real proof of their validity. Fischer and Tippet (1928) showed that if one selected the largest event from each of many large samples, the distribution of these extreme values was independent of the original distribution and conformed to a limiting function. Gumbel suggested that this distribution of extreme values was appropriate for flood analysis since the annual flood could be assumed to be the largest sample of 365 possible values each year. Based on the argument that the distribution of the floods is limited , i.e. that there is no physical limit to the maximum flood, he proposed that the probability P of the occurrence of a value equal to or greater than any value X be expressed as

$$P = 1 - e^{-e^{-y}} \qquad (10)$$

Where y is the reduced variate given by

$$y = \frac{1}{.7797\sigma}(x - \bar{x} + 0.45\sigma) \qquad (11)$$

Where

x = flood magnitude with the probability P

$\bar{x}$ = arithmetic mean

$$\sigma = [\frac{\sum(x-\bar{x})^2}{n\text{-}1}]^{1/2}$$

Where

n = The number of items in the series.

If t_p is the true recurrence interval, then the probability P that will be equal to or exceed X in any one year is:

$$P = \frac{1}{t_p} \tag{12}$$

The probability of an event can be obtained by the use of a plotting position. For example, when annual maximum values are being analyzed the recurrent interval t_p is defined as the mean time in years with N future trials, for the m^{th} largest values among the annual maxima to be exceeded once on the average. There are several plotting position formulas available. These formulas do not account for the sample size, that is the length of the record, except the general formula given by Gringorten (1963) which has the form

$$t_p = \frac{N+1-2a}{m-a} \tag{13}$$

where

N = The number of years of record

m = The rank

a = $0 < a < 1$

The parameter "a" depends on the distribution and the number of years

of record. If the distribution is normal, Gumbel, or lognormal "a" is equal to 0.375, 0.44, or 0.40 respectively. The length of the record and the corresponding values of parameter "a" is given below.

N	10	20	30	40	50	60	70	80	90	100
a	.448	.443	.442	.441	.440	.440	.440	.440	.439	.439

When the number of years of record is very large then the effect of parameter "a" in the general formula will be very small. Therefore, for larger values of N, the general formula boils down to the form of Weibull plotting position which is the most common plotting position used in hydrology [22]. Hence, for larger values of N the recurrence interval t_p can be written as

$$t_p = \frac{N+1}{m}$$

It can be seen from the Equation (11) that when t_p is equal to 2.33 years x is equal to $\bar{x}$ This implies that in the Gumbel extreme-value distribution, at the return period of 2.33 years, or at the probability level of 42.97 percent, the flood magnitude will be equal to the arithmetic mean of the series.

Once the mean release (demand) and the releases at the probability level of 99 percent are calculated from the very first reservoir, statistics of the next reservoir should be updated according to the calculated mean. This can be done by using the following methods.

1. Mean inflow to the next reservoir can be calculated using

regression coefficients found from the historical data.

2. Standard deviation can be calculated by using the formula

$$\sigma = \sqrt{\frac{MSE}{N}} \tag{14}$$

where

MSE = Mean Standard Error in each month

N = Number of historical data in each month

3. Correlation coefficient can be calculated by using

$$\rho = \sqrt{R^2} \tag{15}$$

where

$$R^2 = \frac{SS_R}{S_{yy}}$$

where

R = Coefficient Determination.

$$SS_R = \sum(\hat{y}_i - \bar{y})^2$$

$$S_{yy} = \sum\{y_i - \bar{y}\}^2$$

Where

$\hat{y}_i$ = Regression estimate of Y.

$\bar{y}$ = Mean value of observations.

y_i = observation

CHAPTER 4

DATA ANALYSIS AND METHODOLOGY

4.1 Data Acquisition

Application of stochastic hydrology to a scheme of river reservoirs needs long historical record of streamflow data, downstream requirements when reservoir capacity is not known, or reservoir capacity when the operational policy is not known, and other related data such as catchment area, precipitation record, evaporation data, key maps of river basins etc.. In the case of Sri Lanka where operational policy is not known because of the change in demand, and the availability of all required data makes it an ideal place for this case study. As a result, it was decided to acquire all necessary data from Sri Lanka. Details of the data and the place where they were acquired are discussed below.

4.1.1 Historical Monthly Flow Data

Historical monthly flow data, given in Appendix (1), were obtained from Mahaweli Authority of Sri Lanka, 500 T. B. Jaya Mawatha, Colombo 10, Sri Lanka. Historical flow data were acquired for five reservoirs and a barrage namely Kotmale, Victoria, Randenigale, Rantembe, Bowatenne, and Polgolla respectively. Each data set, for each reservoir, consists of 36 years of

monthly flow data starting from 1949 up to 1985. These are incremental inflow into the reservoirs. All flow data are given in Million Cubic Meters (MCM). Precipitation data was also acquired from the same place. Also the location of the gauging station and drainage area are given. All rainfall data are given in millimeters (mm).

4.1.2 Key Maps of River Basins

Key maps of river basins were acquired from Ceylon Electricity Board prepared by Lahmeyer International - DECON Consulting Engineers, Frankfurt (M), F.R. Germany under the project: Master Plan for Electricity Supply of Sri Lanka. The key maps consist of catchment boundaries of rivers, location of stream gauges and precipitation stations.

4.1.3 Reservoir Configuration and Power Flow Data

Reservoir configuration and power flow data were acquired from Mahaweli Water Resource Management, 500 T. B. Jaya Mawatha, Colombo 10, Sri Lanka This was prepared and submitted to Mahaweli Water Resource Management by Canadian International Development Agency. Reservoir characteristics, area capacity tables, power station characteristics, and turbine efficiency tables are given in this report for each reservoir in the river basin.

4.2 Model Development

Stochastic monthly streamflow models are often used in simulation

studies to evaluate the likely future performance of water resource system. In general, the development and use of a stochastic streamflow model may involve the following steps [20]:

1. Obtain streamflow records and other information.

2. Select models to describe the marginal probability distribution of flows in different seasons and estimate the model's parameters.

3. Select an appropriate model of the special and temporal dependence of the streamflows.

4. Verify the computer implementation of the model performance as specified.

5. Validate the model for water resource system simulation.

6. Usage of the model.

With these steps in mind, a program has been developed. In this program, markov monthly streamflow model was used as a stochastic generator. The flow chart of the program is given in Figure (4.1). Input to this program is the mathematically corrected statistics of historical streamflow data and the output is a set of release (demands).

First phase of the program reads and writes the input. Second phase of the program calculates the deterministic component, which is denoted by DCOMP(K), of Markov's model. DCOMP(K) is calculated by the equation given below.

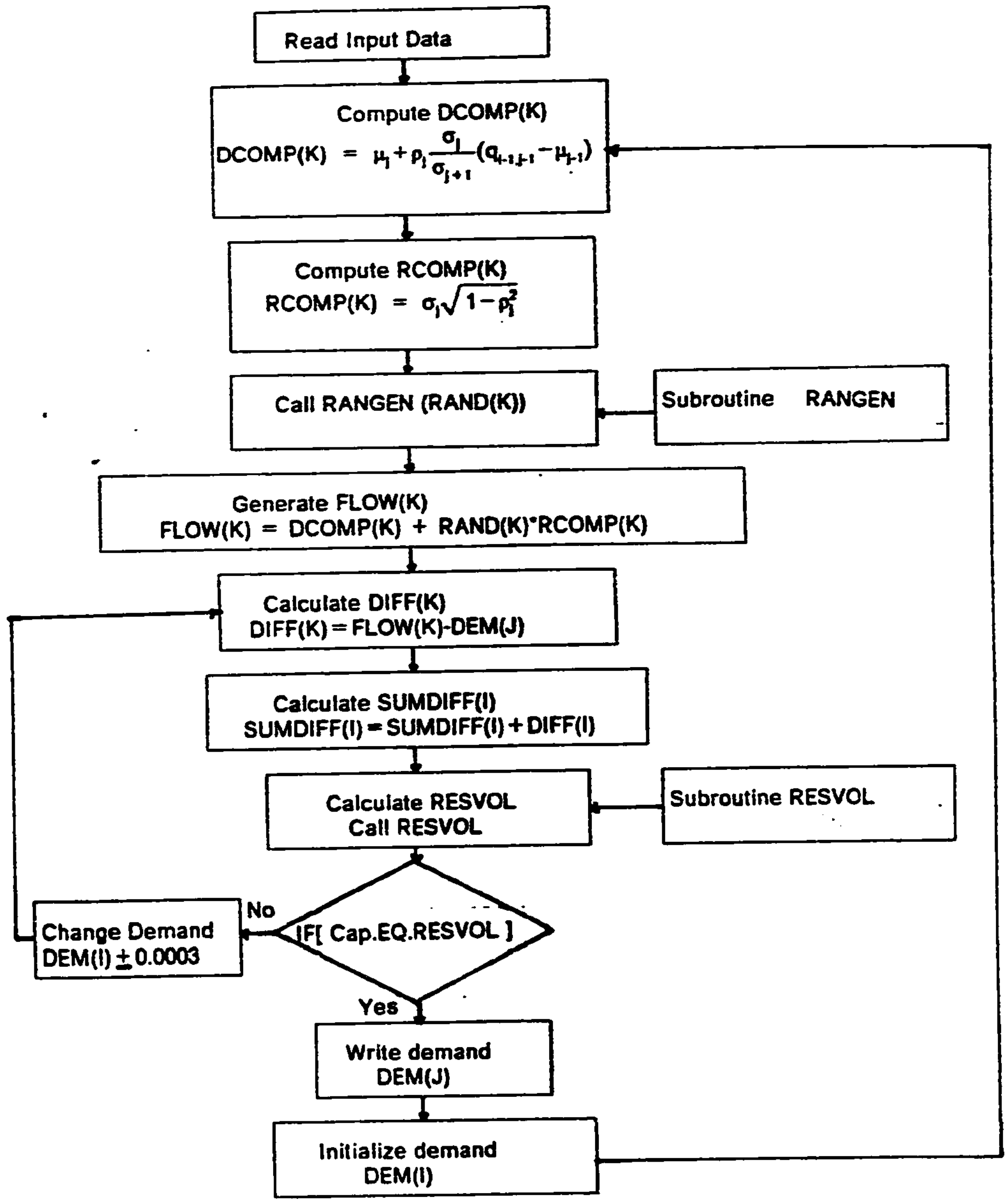


Figure 4.1: Flow chart of the program developed for the study.

Reservoir location	Reservoir capacity(MCM)	Catchment area(sq.Km)	Power flow(m/s)	Power (MWH)
Kotmale	172.9	544.0	38.0	67.0
Victoria	721.2	629.0	46.7	70.0
Randenigale	864.4	444.4	90.0	63.0
Randembe	22.0	747.1	90.0	24.5
Bowatenne	52.0	505.7	94.9	40.0

Table 4.1 : Required data for power calculation

$$DCOMP(K) = \mu_j + \rho_j \frac{\sigma_j}{\sigma_{j-1}} (q_{i-1,j-1} - \mu_{j-1})$$

In the next phase random component, which is denoted by RCOMP(K), of the Markov's model is calculated using the equation given below.

$$RCOMP(K) = \sigma_j \sqrt{1 - \rho_j^2}$$

Random number denoted by RAND(K) is produced by a subroutine with zero mean and unit standard deviation. This subroutine, written by D.Knuth [11], is available in the IBM scientific subroutine package. Random numbers from this subroutine is directly used without taking the logarithmic value of them, because the model requires random numbers with zero mean and unit standard deviation. With these three components (DCOMP(K), RCOMP(K), and RAND(K)) synthetic streamflow , denoted by FLOW(K), are generated using the equation of:

FLOW (K) = DCOMP(K) + RAND(K) X RCOMP(K)

In this study 600 (50X12) streamflows were generated for each trace and this procedure was repeated for 700 traces.

The next phase of program deals with reservoir volume calculation using subroutine RESVOL. This subroutine follows Sequent Peak Algorithm method to calculate reservoir volume. Assuming the mean of the historical data as the initial demand the difference between the flow and the demand (DIFF(K)) for each month is calculated. The cumulative values of DIFF(K) known as SUMDIFF(K) is the primary input to the subroutine RESVOL. The reservoir

added or subtracted to the demand computed previously. Then, the new capacity required to meet this demand is obtained using the sequent-peak algorithm. This procedure is continued until the computed capacity is very nearly equal to the capacity of the reservoir in question and the corresponding demand is now chosen as the release from the reservoir. The same procedure is carried out for the other traces as well and the corresponding releases are obtained for each of the traces.

4.3 Data Analysis

Historical monthly flows and yearly flows were plotted against time to determine any possible trend. No visible trends were found in these plots and the data was considered to be random. After a careful check for the disturbance of the data, several tests were made to determine the probability distribution so that the most suitable synthetic scheme may be selected. To perform this exercise the STATGRAF package was used. Chi square values indicate at the significant level of 0.002 all historical flow at all locations follow lognormal distribution. These are shown in Figures(4.2-4.6) and Tables (4.2-4.6).

In view of this result the lognormal Markov monthly flow model was selected for generating synthetic flows. Input parameters to this model were

Lower Limit	Upper Limit	Observed Frequency	Expected Frequency	Chisquare
at or bellow	18.52	35	25	4.10559
18.52	37.04	78	84	.40521
37.04	55.56	75	83	.83389
55.56	74.07	46	64	5.22795
74.07	92.59	49	47	.12647
92.59	111.11	45	33	4.14760
111.11	129.63	24	24	.00125
129.63	148.15	28	17	6.71825
148.15	166.67	16	13	.90565
166.67	185.19	10	9	.04494
185.19	203.70	4	7	1.29476
203.70	222.22	9	5	2.54587
222.22	259.26	7	7	.00771
259.26	314.81	4	6	.64374

Chisquare = 30.774 With 12 d.f. Sig. Level = 2.12244E-3

Table 4.2 : Chisquare test for the historical data of Kotmale rservoir

Lower Limit	Upper Limit	Observed Frequency	Expected Frequency	Chisquare
at or bellow	18.52	59	64	.4051
18.52	37.04	92	110	.2.9484
37.04	55.56	94	80	2.5604
55.56	74.07	55	53	.0955
74.07	92.59	45	35	2.8180
92.59	111.11	28	24	.7376
111.11	129.63	14	17	.3959
129.63	148.15	21	12	7.2114
148.15	166.67	9	9	.0231
166.67	185.19	5	6	.2783
185.19	222.22	5	8	1.3647
222.22	277.78	2	7	3.3174
277.78		3	8	3.3203

Chisquare = 25.4762 With 10 d.f. Sig. Level = 4.51231E-3

Table 4.3 : Chisquare test for the historical data of Victoria rservoir

Lower Limit	Upper Limit	Observed Frequency	Expected Frequency	Chisquare
at or bellow	18.52	133	136	0.0705
18.52	37.04	124	116	0.5174
37.04	55.56	52	66	2.1900
55.56	74.07	42	37	0.6562
74.07	92.59	25	23	0.1865
92.59	111.11	17	15	0.2852
111.11	129.63	7	10	0.9712
129.63	148.15	9	7	0.4993
148.15	166.67	6	5	0.1461
166.67	203.70	7	7	0.0187
203.70	259.26	6	5	0.1124
259.26		4	7	1.0441

Chisquare = 6.69764 With 9 d.f. Sig. Level = 0.668566

Table 4.4: Chisquare test for the historical data of Randenigale rservoir

Lower Limit	Upper Limit	Observed Frequency	Expected Frequency	Chisquare
at or bellow	22.22	33	44	2.80972
22.22	44.44	191	175	1.42736
44.44	66.67	117	118	0.00473
66.67	88.89	57	54	0.20388
88.89	111.11	14	23	3.45490
111.11	133.33	8	10	0.35490
133.33		12	8	1.46445

Chisquare = 9.71844 With 4 d.f. Sig. Level = 0.0454473

Table 4.5 : Chisquare test for the historical data of Rantambe rservoir

Lower Limit	Upper Limit	Observed Frequency	Expected Frequency	Chisquare
at or bellow	14.81	120	112	0.6118
14.81	29.63	124	133	0.5461
29.63	44.44	65	75	1.3144
44.44	59.26	45	42	0.2392
59.26	74.07	27	24	0.2727
74.07	88.89	19	15	1.1132
88.89	103.70	8	9	0.2359
103.70	118.52	7	6	0.0888
118.52	148.15	12	7	3.2113
148.15		5	9	1.5820

Chisquare = 9.21522 With 12 d.f. Sig. Level = 0.237571

Table 4.6: Chisquare test for the historical data of Bowatenne rservoir

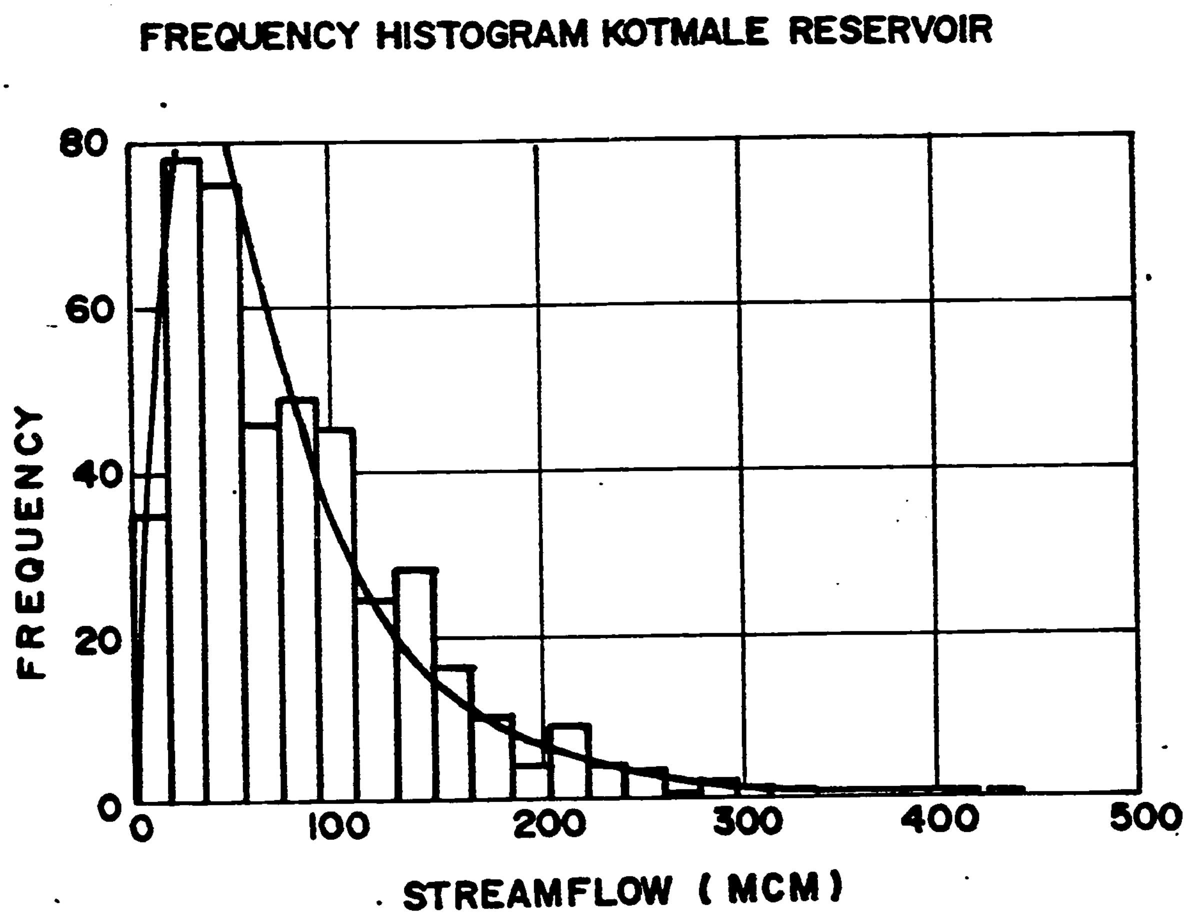


Figure 4.2: Lognormally fitted frequency histogram for Kotmale reservoir.

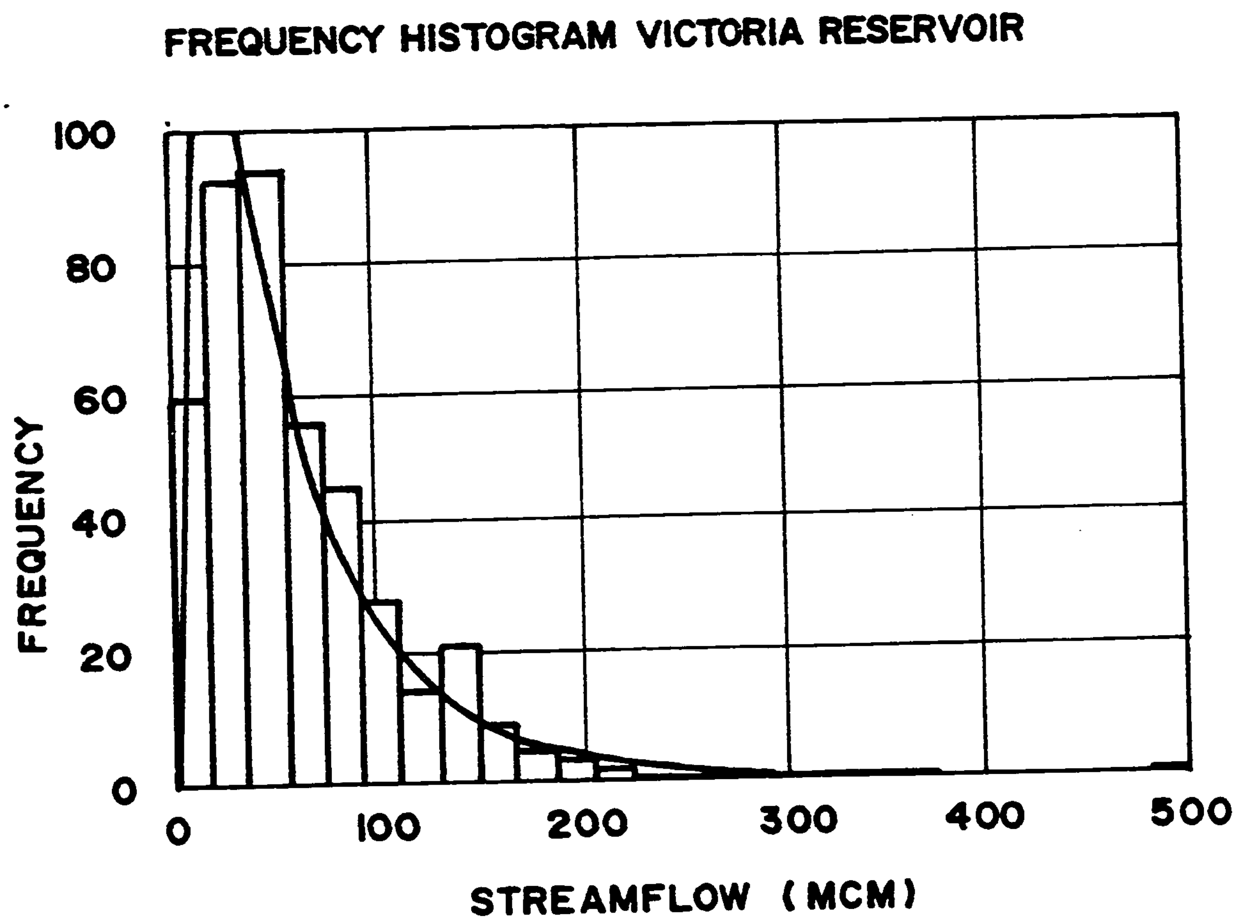


Figure 4.3: Lognormally fitted frequency histogram for Victoria reservoir.

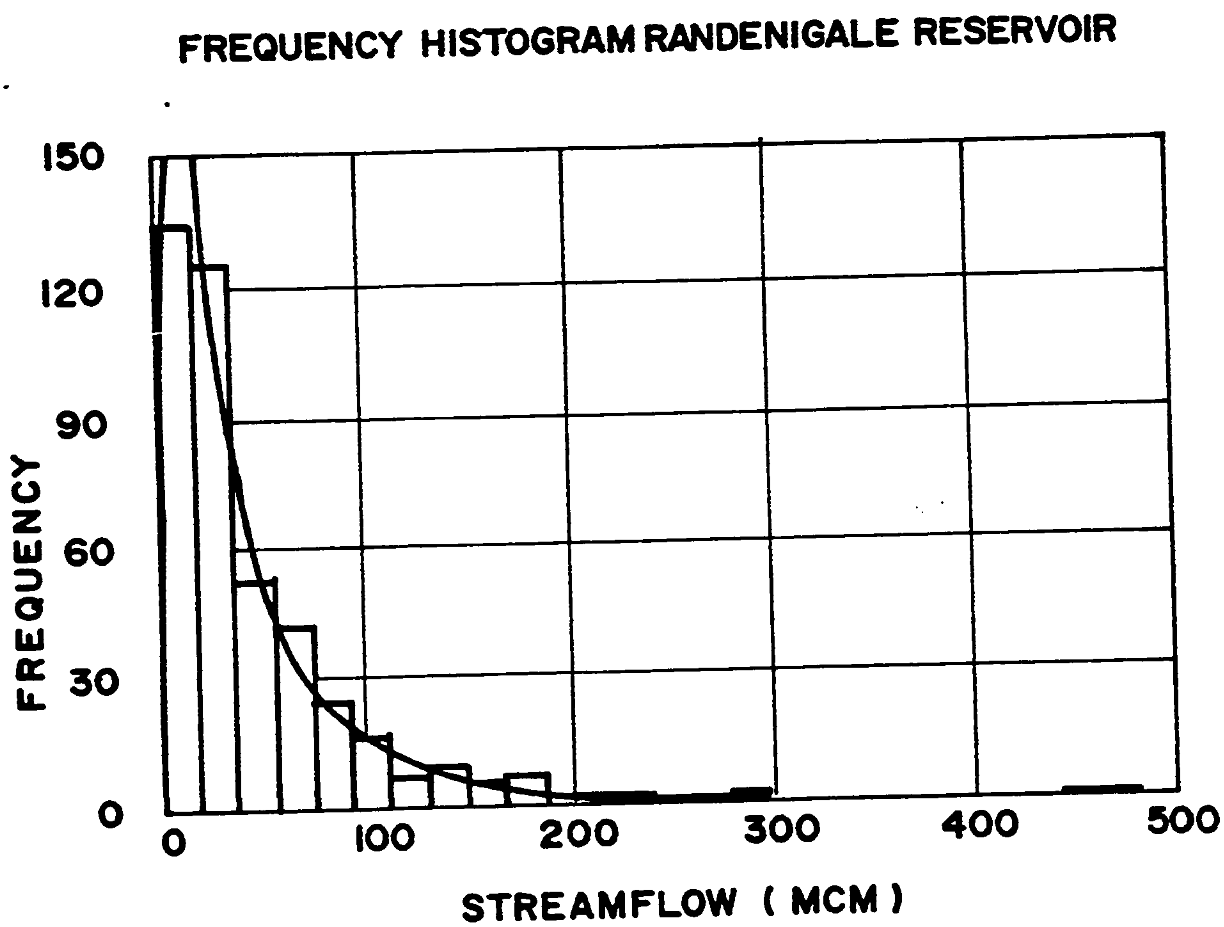


Figure 4.4: Lognormally fitted frequency histogram for Randenigale reservoir

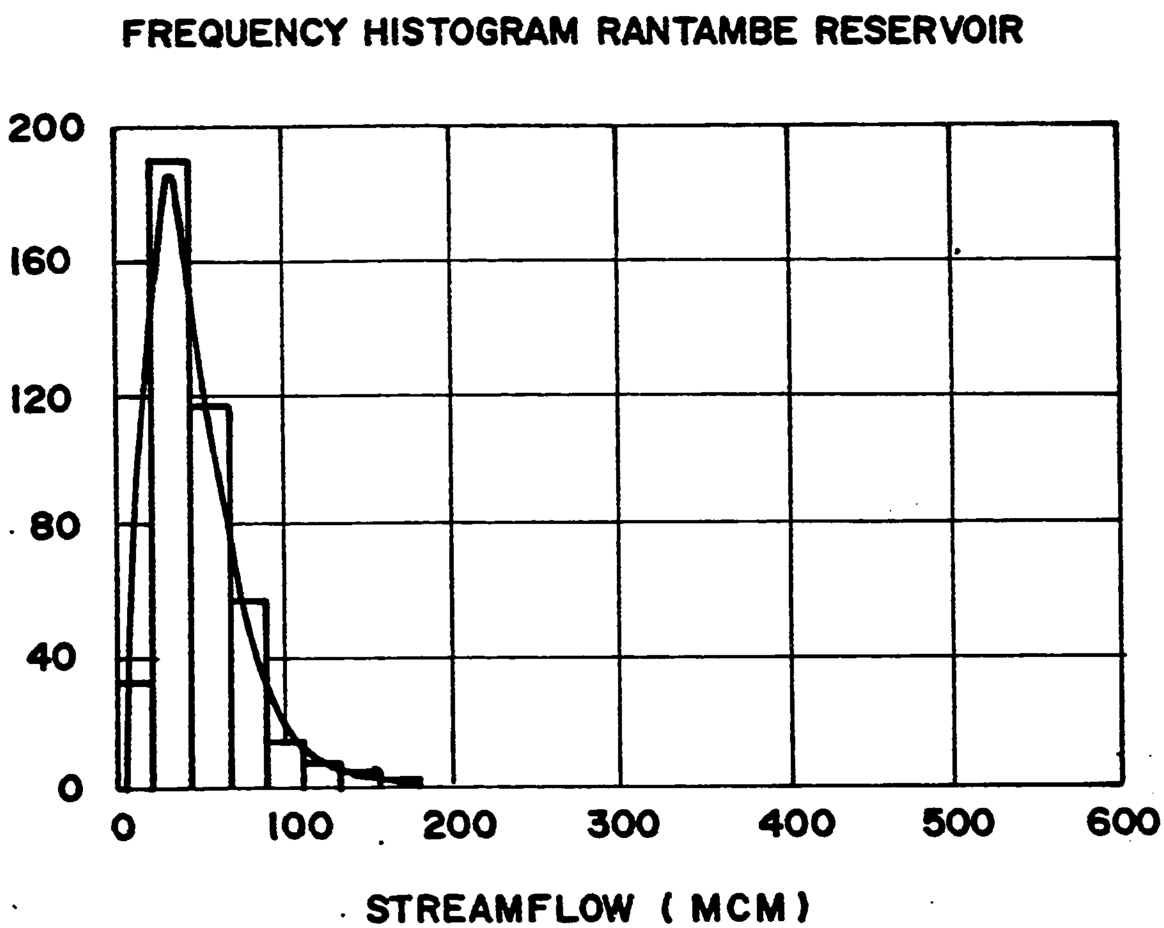


Figure 4.5: Lognormally fitted frequency histogram for Rantembe reservoir.

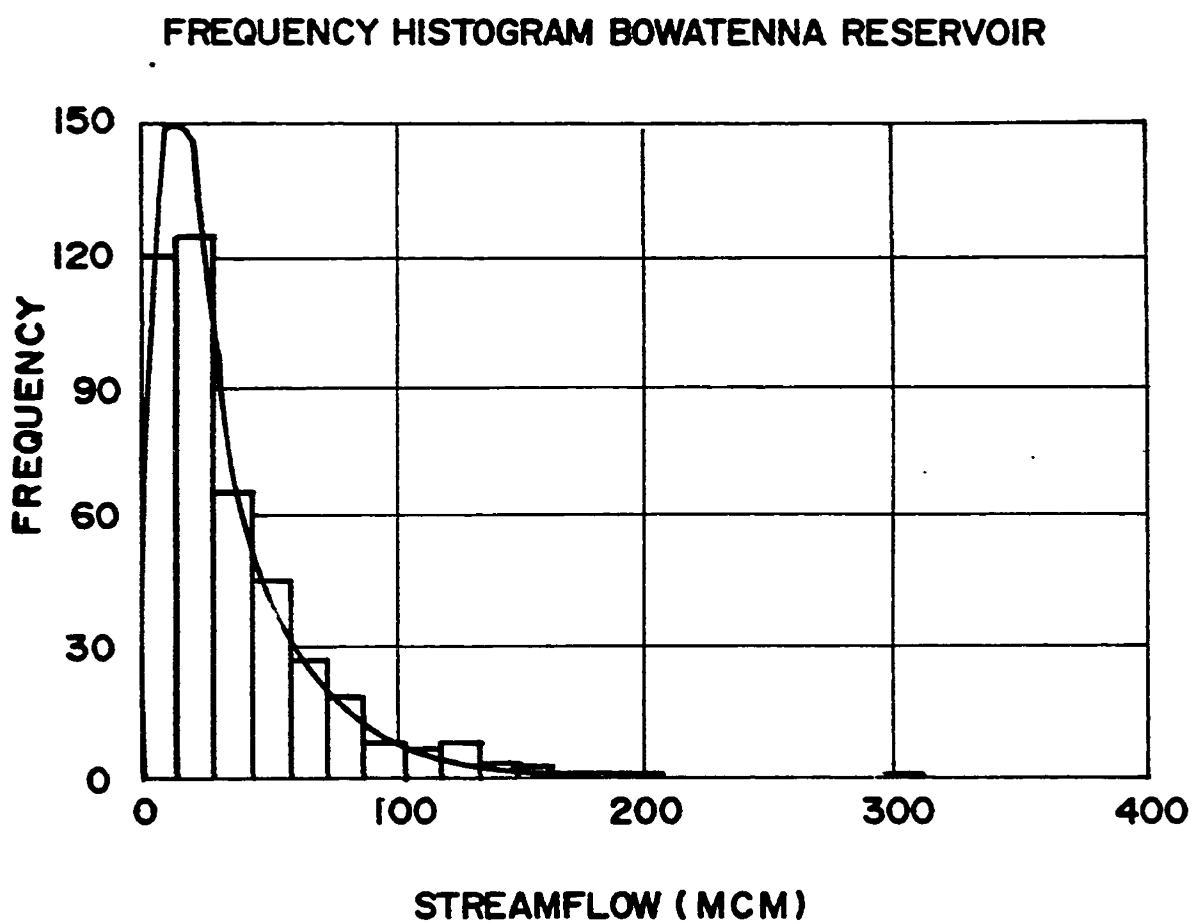


Figure 4.6: Lognormally fitted frequency histogram for Bowatenne reservir.

the mean, the standard deviation, and the serial correlation coefficient of historical data. The statistics were found using SAS regression packages. These statistics were used in equations (7,8,9) to calculate mathematically corrected input to the Markov model explained in Chapter 3. Mathematically corrected input data are given in tables (4.7-4.11).

As one can see in the use of the Markov model necessitates the generation of random numbers with zero mean and unit standard deviation. After making sure of the zero mean and standard deviation using goodness of fit, IBM's Random number generator package was selected and used in the model to generate the synthetic streamflow. With the random number generator package and statistics of historical data, synthetic data were generated. Next, statistics of synthetic data and the statistics of historical data were compared in order to make sure that the statistics of the historical data were preserved. These comparisons are shown in Tables (4.7-4.11). It was concluded, from the results given in Tables (4.7-4.11), that the model generates flows which have the same statistics as the historical flows. Having ascertained that the synthetic flows preserved the statistics of the historical flows, the next stage of operation was the application of the model to flows at Kotmale, the first reservoir in the scheme. Output from the model is a set of releases (demands) which can be met from this reservoir capacity. As explained earlier, Gumbel extreme value distribution was employed to study the reliability of these releases. As explained earlier in Chapter 3, values corresponding to the probability level of 42.97 percent as mean releases and the releases at the probability level of 99 percent were chosen

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
HISTORICAL MEAN	3.037	2.835	2.525	2.077	1.494	1.393	1.797	2.234	2.839	3.104	3.001	2.861
SYNTHETIC MEAN	3.036	2.833	2.525	2.078	1.495	1.394	1.797	2.238	2.842	3.104	3.002	2.861
HISTORICAL STAND.DIVIATION	0.116	0.204	0.202	0.163	0.188	0.146	0.170	0.483	0.454	0.170	0.212	0.222
SYNTHETIC STAND.DIVIATION	0.116	0.203	0.201	0.162	0.186	0.145	0.168	0.477	0.450	0.169	0.211	0.221
HISTORICAL CORR.COEFFICIENT	0.000	0.479	0.225	0.430	0.765	0.678	0.389	0.218	0.203	0.334	0.460	0.280
SYNTHETIC CORR.COEFFICIENT	0.005	0.468	0.227	0.426	0.759	0.674	0.378	0.220	0.197	0.328	0.458	0.274

Table 4.7 : Statistics of historical and synthetic flow data of Kotmale reservoir.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
HISTORICAL MEAN	3.098	2.325	1.810	1.504	0.877	0.388	1.595	2.129	2.955	3.295	3.015	2.904
SYNTHETIC MEAN	3.098	2.325	1.810	1.504	0.876	0.388	1.595	2.130	2.955	3.294	3.016	2.904
HISTORICAL STAD.DIVIATION	0.004	0.019	0.029	0.005	0.013	0.034	0.016	0.022	0.016	0.004	0.003	0.006
SYNTHETIC STAD.DIVIATION	0.003	0.019	0.028	0.004	0.014	0.034	0.015	0.021	0.014	0.004	0.003	0.006
HISTORICAL CORR.COEFFICIENT	0.254	0.586	0.849	0.737	0.745	0.821	0.560	0.694	0.417	0.538	0.638	0.696
SYNTHETIC CORR.COEFFICIENT	0.254	0.589	0.846	0.734	0.744	0.819	0.564	0.699	0.419	0.541	0.640	0.697

Table 4.8 : Statistics of historical and syntheticc flow data of Victoria reservoir.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
HISTORICAL MEAN	3.553	3.008	2.419	2.456	2.489	2.503	3.006	3.172	3.954	4.243	3.903	3.790
SYNTHETIC MEAN	3.553	3.008	2.419	2.456	2.489	2.503	3.006	3.172	3.954	4.243	3.903	3.790
HISTORICAL STAND.DIVIATION	0.015	0.045	0.044	0.103	0.033	0.023	0.010	0.025	0.007	0.007	0.014	0.011
SYNTHETIC STAND.DIVIATION	0.014	0.044	0.043	0.101	0.033	0.023	0.009	0.024	0.004	0.004	0.013	0.009
HISTORICAL CORR.COEFFICIENT	0.909	0.809	0.989	0.849	0.980	0.920	0.969	0.903	0.954	0.879	0.853	0.942
SYNTHETIC CORR.COEFFICIENT	0.909	0.814	0.987	0.849	0.977	0.918	1.022	0.911	0.957	0.912	0.849	0.950

Table 4.9 : Statistics of historical and synthetic flow data of Randenigale reservoir.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
HISTORICAL MEAN	2.580	2.413	2.793	2.785	2.263	1.773	1.476	1.641	0.784	3.088	3.772	2.931
SYNTHETIC MEAN	2.580	2.412	2.793	2.785	2.263	1.773	1.476	1.642	0.785	3.088	3.772	2.931
HISTORICAL STAND.DIVIATION	0.034	0.069	0.097	0.096	0.118	0.083	0.077	0.087	0.135	0.011	0.005	0.017
SYNTHETIC STAND.DIVIATION	0.034	0.069	0.097	0.095	0.117	0.082	0.076	0.086	0.134	0.010	0.003	0.017
HISTORICAL CORR.COEFFICIENT	0.280	0.241	0.469	0.625	0.362	0.352	0.294	0.227	0.001	0.334	0.611	0.253
SYNTHETIC CORR.COEFFICIENT	0.278	0.231	0.470	0.622	0.352	0.351	0.283	0.230	-.001	0.366	0.609	0.257

Table 4.10: Statistics of historical and synthetic flow data of Rantembe reservoir.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
HISTORICAL MEAN	3.950	3.627	2.761	2.247	2.407	2.575	2.981	3.639	4.466	4.593	4.230	4.423
SYNTHETIC MEAN	3.950	3.626	2.760	2.247	2.407	2.575	2.981	3.639	4.466	4.593	4.230	4.423
HISTORICAL STAND.DIVIATION	0.033	0.055	0.104	0.046	0.028	0.036	0.040	0.040	0.033	0.023	0.024	0.025
SYNTHETIC STAND. DIVIATION	0.033	0.055	0.104	0.046	0.028	0.038	0.039	0.039	0.032	0.022	0.023	0.024
HISTORICAL CORR.COEFFICIENT	0.409	0.365	0.754	0.637	0.811	0.639	0.579	0.713	0.509	0.434	0.320	0.597
SYNTHETIC CORR.COEFFICIENT	0.387	0.341	0.752	0.635	0.811	0.638	0.568	0.707	0.492	0.405	0.284	0.570

Table 4.11: Statistics of historical and synthetic flow data of Bowatenne reservoir.

from this distribution and recorded. Having obtained this releases, statistics of the next reservoir were updated according to these releases. This has been done as explained in Chapter 3. Then, the new statistics were used as input to the model for the next reservoir. This procedure was continued until all reservoirs are taken into consideration. Finally, mean releases and the releases at the probability level of 99 percent from each reservoir were recorded and an operating policy for the system was prepared.

CHAPTER 5

ANALYSIS OF RESULTS

Since this study deals with a multi reservoir system, a proper way to analyse the results is to consider a single reservoir in the system initially and then to consider the other cases wherever necessary. Some of the results are already shown in chapter 4. A more detailed analysis of the results of the operation and reliability studies are presented here.

As discussed in chapter 4 , historical data was tested for possible trends and appeared to be random. Next, several test were made to determine the probability distribution of the historical flow to select the most suitable synthetic scheme. All historical flows at all reservoir sites best fitted the lognormal distribution. Thus, the lognormal Markov monthly flow model was selected as the synthetic flow generator. A key requirement in the synthetic flow generation is that "the statistics of the historical data" must be preserved. Therefore, statistics of the historical flow and the statistics of the synthetic flow were compared to make sure that the statistics of the historical flow data were preserved. From the results given in tables (4.7-4.11) it may be concluded that the model preserves the statistics of the historical flow

data. After having drawn this conclusion, the model was applied to the first (Kotmale) reservoir in the system.

5.1 Results of Operation Study

The outcome of the application of the model to the Kotmale reservoir is a set of maximum possible releases (demands) that can be met from the known reservoir capacity. These demands (releases) for each month represent the largest event (release) for that month that is possible using the given capacity of the reservoir. Thus, each trace provides 12 values of releases for the life of the reservoir. 700 such traces will provide a matrix of 700 X 12 entries, which is in fact 700 maximum possible values for each of the 12 months.

As one can see from this theoretical plot given in Appendix 2, for certain months, the releases appear to remain constant. This is because of the following constraints being placed in the iterative process.

1. To economize the power generation the turbine must be run as efficiently as possible. There is a given minimum supply required to do this. Wherever the release from the reservoir falls this minimum it is set at the minimum requirement level.

2. To prevent negative releases during the iterative process.

In operation studies the primary objective is to determine either the capacity of the reservoir that can meet a given demand or to determine the demand (release) that can be met by the reservoir of a given capacity The

study undertaken in this research pertains to the later case. Having predetermined releases (demands) for certain months does not interfere in the synthetic flow generation.

In view of the demand being fixed for the months of dry season, reliability curves obtained by the process explained earlier should be a straight line, as shown in Figure (5.1).

5.2 Results of Reliability Studies

As shown earlier there are 700 maximum possible releases for each month for a given reservoir. All these releases have the same likelihood of occurrence. Thus, these values may be ranked in the order of magnitude and plotted as a frequency curve. As pointed by Burges (1975), and Linsley(1979), the Gumbel extreme value distribution appears to be the appropriate one for this purpose. The result, therefore, should be the reliability curve for each month of the year for the reservoir. In this study, Weibull plotting position formula with the Gumbel probability paper were used to obtain the reliability curve. In order to have this plot, selected probability levels and the corresponding releases (demands) were taken and plotted on Gumbel extreme value distribution paper. The results of this plot is a set of straight lines. Each line represents the reliability distribution of that particular month. This plot can be used as to select releases (demands) with certain reliability according to the necessity of the requirement. For example, from the Figure 5.1, it will be 91 (MCM) if one needed the demand for the month of july with the reliability of 95 percent. It means that 91 (MCM) can be met as demand

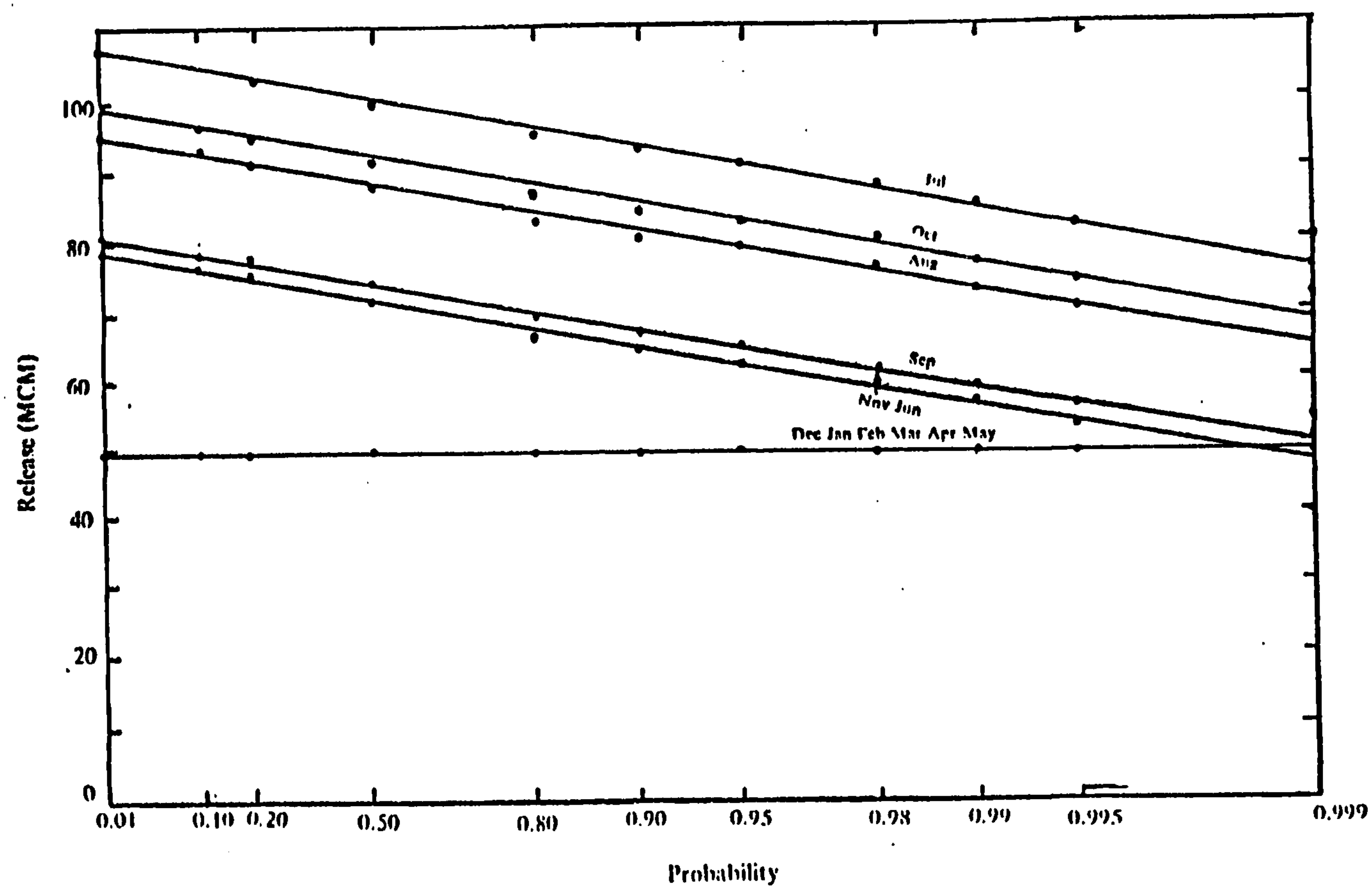


Figure 5.1: Reliability Curve of Kotmale reservoir

from the reservoir with the reliability of 95 percent. In this study, the mean releases were chosen as the required demands at the probability level of 42.97 percent. This is because of the reason that usually engineers consider the mean values for their studies in power generation schemes or in irrigation projects. If the reservoir is used for water supply then, it is better to choose higher level of probability.

The release obtained from the reliability curve is the release that is going to be maintained for the rest of the life of that reservoir. As explained in chapter 3 next reservoir inflow statistics were updated corresponding to the above release. This procedure was continued for all cases in the study and the releases were tabulated. These are shown in Tables(5.1,5.2). From this information and the information given in Table (4.1), total power that can be generated from the watershed for each month was calculated using the equation given below,

$$P = \eta \frac{\gamma H Q}{102}$$

Where

P = Power (KWH)

η = efficiency of the turbine

γ = Specific gravity of water (Kg/ m^3)

H = Design head (m)

Q = Discharge (m^3 /sec)

These are given in tables (5.3,5.4). The total average monthly power requirement in SriLanka and the power that can be generated from Mahaweli

Reservoir	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Kotmale	92.5	71.9	49.3	49.3	49.3	49.3	49.3	49.3	72.2	100.4	88.5	74.3
Victoria	104.8	60.5	60.5	60.5	60.5	60.5	60.5	60.5	86.3	135.1	93.7	80.4
Randenigale	131.8	89.5	89.5	89.5	89.5	89.5	89.5	89.5	208.3	285.9	197.0	173.3
Rnantembe	98.6	83.4	122.0	121.0	71.8	44.0	32.7	38.5	16.4	163.8	324.7	140.0
Bowatenne	224.6	161.0	64.3	41.7	43.4	52.4	81.5	163.0	380.3	432.7	299.1	365.9

Table 5.1: Final releases at the probability level of 42.92 percent (mean) from all reservoirs after simulation (values are in MCM).

Reservoir	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Kotmale	77.6	57.0	49.3	49.3	49.3	49.3	49.3	49.3	57.3	85.4	73.6	59.4
Victoria	127.8	57.6	45.3	45.3	45.3	45.3	45.3	45.3	114.5	168.6	118.4	112.6
Randenigale	129.0	89.5	89.5	89.5	89.5	89.5	89.5	89.5	205.4	283.0	194.0	170.0
Rnantembe	99.1	57.9	44.1	81.9	81.2	32.1	29.1	29.1	29.1	123.0	280.9	98.4
Bowatenne	217.3	153.6	57.0	41.7	41.7	45.0	74.2	155.6	373.0	425.3	291.7	358.5

Table 5.2: Final releases at the probability level of 99 percent from all reservoirs after simulation (values are in MCM).

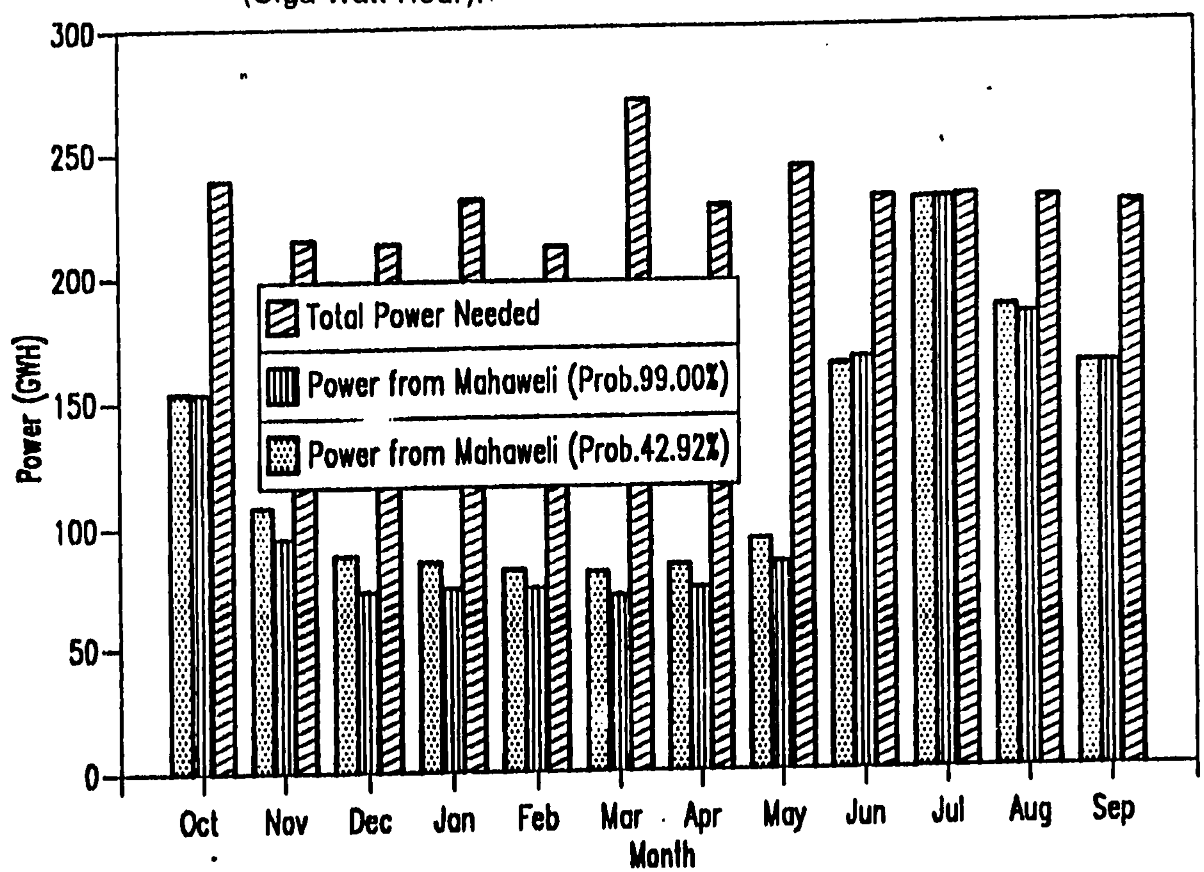
Reservoir	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Kotmale	45.3	35.2	24.1	24.1	24.1	24.1	24.1	24.1	35.4	49.2	43.3	36.4
Victoria	26.3	18.9	7.5	4.9	5.1	6.1	9.5	19.1	44.5	50.7	35.0	42.8
Randenigale	25.6	17.4	17.4	17.4	17.4	17.4	17.4	17.4	40.5	55.6	38.3	33.7
Rantembe	43.6	25.2	25.2	25.2	25.2	25.2	25.2	25.2	35.9	56.3	39.0	33.5
Bowatenne	7.5	6.3	9.2	9.1	5.4	3.3	2.5	2.9	1.2	12.4	24.6	10.6
Polgolla	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
Total	153.1	107.8	88.2	85.5	82.0	80.9	83.5	93.5	162.3	229.0	185.0	161.8

Table 5.3: Total power that can be generated form all hydropower stations in Mahaweli scheme at the probability level of 42.92 percent (GWH).

Reservoir	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Kotmale	38.0	27.9	24.1	24.1	24.1	24.1	24.1	24.1	28.1	41.8	36.1	29.1
Victoria	53.2	24.0	18.8	18.8	18.8	18.8	18.8	18.8	47.7	70.1	49.3	46.8
Randenigale	25.1	17.4	17.4	17.4	17.4	17.4	17.4	17.4	39.9	55.0	37.7	33.1
Rantembe	7.5	4.4	3.3	6.2	6.2	2.4	2.2	2.2	2.2	9.3	21.2	7.4
Bowatenne	25.4	18.0	6.7	4.9	4.9	5.3	8.7	18.2	43.7	49.8	34.1	42.0
Polgolla	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Total	152.6	95.1	73.7	74.8	74.8	71.4	74.6	84.1	165.0	229.4	181.8	161.8

Table 5.4: Total power that can be generated form all hydropower stations in Mahaweli scheme at the probability level of 99 percent (GWH).

Figure 5.2: Comparision of total power requirement and the power can be generated from Mahaweli scheme for each month at the probability level of 42.92 percent and 99 percent (Giga Watt Hour).



scheme are compared in figure 5.2. From the figure, it is clear that nearly 55 percent at the probability level of 42.92 percent and 52 percent at the probability level of 99 percent respectively, of the total power requirement can be met from Mahaweli scheme alone.

CHAPTER 6

CONCLUSION

Subject to the constraints concerning the usage of the Markov model and the Sequent-peak analysis the following broad based conclusions may be drawn.

1. Monthly streamflows at all reservoir locations of Mahaweli scheme of Sri Lanka fit the lognormal distribution.

2. Stochastic approach is not only useful in determining reservoir capacities but also in determining probable releases given the reservoir capacities.

3. Lag-one lognormal monthly Markov model appears to be suitable model for performing operation studies in multi-reservoir system.

4. Reliability studies of reservoirs can be successfully performed using stochastic techniques combined with either the Ripple mass curve or the sequent-peak algorithm and the Fischer-Tippet Type 1 (Gumbel) extreme value distribution

5. At 99 percent reliability, nearly 52 percent of the total power requirements of Sri Lanka may be met from Mahaweli watershed alone, if the suggested operating policy in this study is maintained, however, at reliability level of 42.92 percent (mean monthly flow) this requirement may be reached to approximately 55 percent.

RECOMMENDATION

This study has come up with operating regulation pertaining to maximizing power generation only. However, the reservoir system investigated in Sri Lanka has yet an another important purpose of providing water for irrigation requirements in the developed lands in the system. Thus, it is recommended that further studies be conducted to come up with a set of operating regulations where benefits from power generation and irrigation are maximized. A possible approach for optimizing the benefits from irrigation and power generation is to use Chance-Constrained programming (Duffaa,1991) reach to an overall operating policy. The study in this thesis can be extended for the purpose of forecasting future releases from the reservoirs and time series analysis is recommended for such study.

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Appendix 1

Year	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1949/1950	98.6	30.1	79.3	42.1	24.0	25.9	18.7	39.8	85.8	139.3	17.6	207.5
1950/1951	62.4	42.2	28.0	75.6	44.1	28.7	37.1	44.4	429.7	176.3	2.2	86.8
1951/1952	135.5	135.4	57.7	72.3	32.9	22.3	61.7	226.4	178.0	138.8	17.8	112.5
1952/1953	156.9	53.1	36.1	33.8	15.0	35.6	75.7	33.7	76.8	128.0	14.6	91.3
1953/1954	102.3	101.5	73.5	83.7	48.0	33.9	48.3	48.6	55.7	100.9	12.9	85.5
1954/1955	180.6	51.6	79.5	71.2	41.2	17.6	46.6	107.5	352.4	136.2	1.6	87.0
1955/1956	87.5	81.3	33.3	13.0	11.1	14.3	13.3	37.7	129.7	127.1	13.7	113.9
1956/1957	144.2	106.4	76.2	40.1	28.8	25.1	19.8	39.4	140.5	151.1	1.8	93.0
1957/1958	79.0	110.0	218.3	89.6	38.8	53.8	49.3	17.5	106.1	108.5	13.2	50.2
1958/1959	155.1	118.8	55.4	29.1	17.1	11.6	39.8	42.0	211.1	239.0	6.6	80.3
1959/1960	107.7	93.6	54.1	39.2	57.1	36.7	49.1	64.7	103.9	131.9	17.4	217.8
1960/1961	164.4	162.0	58.2	34.2	28.8	23.4	28.3	112.6	88.9	91.3	19.9	79.4
1961/1962	61.0	79.7	61.5	40.9	22.3	19.2	28.5	114.4	69.7	136.6	4.3	154.5
1962/1963	128.7	78.5	49.7	51.4	29.8	19.6	41.8	35.3	61.8	97.4	3.5	71.2
1963/1964	131.1	103.0	109.8	73.2	44.7	33.0	18.0	23.1	34.8	112.3	12.9	139.9
1964/1965	61.8	136.4	46.4	18.8	15.5	13.4	49.5	204.0	114.3	48.4	8.7	109.3
1965/1966	102.7	93.0	82.0	50.0	20.2	27.0	41.9	24.0	33.4	54.7	2.0	105.2
1966/1967	139.1	104.6	49.3	34.4	25.5	24.4	17.5	18.9	47.6	82.3	0.1	43.1
1967/1968	162.7	117.9	142.1	36.2	15.2	21.1	18.0	47.5	80.7	260.1	20.2	166.3
1968/1969	144.6	96.3	57.3	33.2	15.9	13.3	45.3	92.1	155.5	84.8	7.4	104.1
1969/1970	98.0	62.4	71.4	72.2	44.2	27.1	43.1	41.7	77.1	92.4	16.5	59.9
1970/1971	111.3	94.9	119.0	65.8	27.1	23.6	56.8	57.9	101.9	149.9	14.9	239.9
1971/1972	132.7	70.4	103.8	31.2	14.6	9.3	27.5	109.2	33.5	180.0	12.9	77.0
1972/1973	172.4	141.0	95.8	44.6	23.6	17.8	22.7	16.4	36.9	67.7	17.0	62.0
1973/1974	53.0	79.5	88.8	53.6	24.7	26.5	49.2	71.0	147.3	250.1	31.0	140.4
1974/1975	129.8	62.3	47.1	56.2	31.0	32.6	46.3	57.2	188.1	100.5	12.4	154.7
1975/1976	214.5	256.1	80.2	54.8	22.0	17.6	44.5	19.8	15.1	59.4	6.6	44.9
1976/1977	81.7	83.4	53.4	23.0	17.0	17.2	28.5	85.2	113.8	54.3	3.6	47.8
1977/1978	176.4	96.8	57.5	29.2	21.0	24.5	18.2	179.5	95.5	219.1	25.2	107.5
1978/1979	142.2	245.1	87.5	33.2	21.1	16.3	32.9	62.6	102.1	185.2	15.7	144.2
1979/1980	186.1	190.2	114.4	37.9	18.0	16.7	32.4	40.2	47.5	104.3	14.2	57.9
1980/1981	112.0	78.8	60.7	44.2	19.5	19.2	25.1	23.0	140.1	86.9	8.7	216.8
1981/1982	66.7	100.3	50.4	16.3	11.6	19.3	24.4	62.1	141.5	112.8	4.9	45.6
1982/1983	74.5	81.9	79.0	47.9	18.4	15.0	10.6	24.1	25.4	49.0	5.6	52.9
1983/1984	52.2	89.4	96.7	78.5	51.4	44.2	53.7	49.3	100.3	228.5	4.5	102.6
1984/1985	116.5	63.0	53.0	45.3	16.9	21.6	22.0	54.9	278.6	164.2	16.5	73.1

Historical flow data for KOTMALE reservoir (Million Cubic Meters)

Year	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1949/1950	78.9	70.6	78.1	33.6	24.1	36.2	19.4	71.2	132.9	154.7	19.5	207.7
1950/1951	92.2	108.1	9.9	79.6	18.3	3.8	86.7	34.4	181.9	95.2	4.5	60.3
1951/1952	114.5	190.9	48.6	49.8	12.5	12.4	34.3	188.5	168.5	118.2	18.3	40.4
1952/1953	259.1	81.3	30.4	13.3	8.6	5.1	8.5	8.9	69.8	93.3	9.4	45.2
1953/1954	90.9	60.5	56.3	13.7	3.0	42.9	88.3	127.0	102.2	76.8	11.5	83.7
1954/1955	194.9	85.5	131.3	48.1	39.2	62.4	43.8	277.5	434.8	192.4	17.7	137.7
1955/1956	171.9	135.2	50.0	24.1	4.0	13.4	10.3	35.7	280.0	73.4	16.6	126.3
1956/1957	186.5	301.3	73.2	28.6	41.2	20.9	34.6	89.1	260.4	281.7	0.5	35.9
1957/1958	64.3	212.4	478.2	55.2	20.8	39.3	68.1	114.8	86.1	186.4	10.8	64.1
1958/1959	227.3	133.3	74.2	25.7	16.3	6.9	52.9	74.0	231.8	254.7	12.6	115.0
1959/1960	156.1	126.3	70.3	59.3	75.5	45.2	103.5	99.6	134.9	157.7	12.7	144.9
1960/1961	176.2	227.8	80.0	35.8	21.1	16.4	33.5	132.5	112.0	107.1	22.9	97.7
1961/1962	102.6	112.9	70.4	53.3	30.8	30.6	54.4	142.9	89.6	142.3	19.3	163.5
1962/1963	179.4	114.0	62.2	48.6	28.0	28.7	53.8	59.4	93.0	135.8	17.0	110.5
1963/1964	189.5	121.0	150.8	50.1	36.3	44.6	45.7	82.5	93.9	156.6	18.7	156.4
1964/1965	123.9	231.9	60.6	15.9	15.6	7.2	73.0	225.4	185.1	56.7	18.9	65.8
1965/1966	178.9	116.0	94.7	33.0	18.8	22.8	61.6	36.1	35.8	63.1	4.8	219.6
1966/1967	198.2	156.5	73.9	34.7	32.0	33.6	26.8	26.3	103.3	109.4	7.1	42.4
1967/1968	222.5	128.7	142.7	19.3	3.7	19.1	40.7	100.7	134.4	252.2	14.1	145.1
1968/1969	124.2	114.4	63.2	25.1	17.0	12.3	65.0	136.2	182.0	72.6	7.4	107.2
1969/1970	120.3	82.3	75.1	57.9	44.0	28.3	71.5	69.0	115.0	118.2	11.2	88.9
1970/1971	149.6	150.1	140.3	67.5	28.1	30.5	88.3	124.1	170.2	193.8	12.4	373.8
1971/1972	189.3	86.2	108.6	21.0	4.5	2.0	38.2	209.2	40.7	165.1	13.4	77.7
1972/1973	245.8	188.5	136.7	10.4	6.6	10.7	8.0	12.8	35.9	42.2	7.0	26.1
1973/1974	21.7	67.6	71.6	34.9	22.8	24.0	101.0	155.3	233.6	311.4	29.3	288.4
1974/1975	208.7	77.2	94.0	33.8	14.6	13.8	31.2	65.0	264.5	80.2	26.6	174.4
1975/1976	191.5	302.6	120.5	46.6	16.2	3.0	38.5	20.4	11.3	77.7	2.6	57.1
1976/1977	125.3	141.3	85.8	23.3	9.4	12.1	36.1	146.4	157.1	102.0	5.5	51.7
1977/1978	171.2	143.3	64.1	22.1	13.4	16.7	10.7	162.7	85.9	151.3	18.0	107.4
1978/1979	148.9	317.8	119.9	44.2	27.9	21.5	18.3	51.2	79.5	97.9	5.7	136.4
1979/1980	153.2	162.2	126.0	38.7	16.4	11.2	44.9	34.4	40.9	100.4	6.0	64.4
1980/1981	95.7	101.2	70.9	37.4	11.7	8.3	22.5	21.4	153.7	115.0	0.8	246.4
1981/1982	107.9	152.7	61.3	29.2	16.1	7.2	35.3	75.8	323.7	183.2	10.0	41.5
1982/1983	90.5	137.4	121.3	47.4	19.1	8.8	13.5	23.8	37.8	60.3	18.1	86.8
1983/1984	60.5	180.7	190.7	74.7	62.4	86.0	115.9	85.4	150.3	289.0	5.4	91.2
1984/1985	165.5	90.5	41.0	41.5	5.1	4.3	27.5	61.1	391.4	329.4	17.9	78.3

Historical flow data for POLGOLLE reservoir (Million Cubic Meters)

Year	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1949/1950	69.3	88.0	144.3	67.8	72.3	44.8	29.8	34.4	63.6	27.6	9.3	82.0
1950/1951	55.4	64.5	22.7	282.5	55.5	24.7	47.8	24.8	44.0	72.7	0.1	59.3
1951/1952	45.5	115.0	79.6	133.2	57.6	16.2	51.6	118.0	126.9	74.0	13.4	26.3
1952/1953	98.0	73.7	45.0	46.3	19.8	24.6	45.4	15.3	33.1	49.7	8.3	6.0
1953/1954	59.0	45.4	42.4	45.8	38.8	58.3	35.0	52.9	36.6	29.5	0.7	47.8
1954/1955	95.4	71.6	181.8	181.2	100.0	47.9	81.4	52.7	41.7	44.7	4.2	57.3
1955/1956	50.3	52.0	45.0	46.2	15.1	29.1	30.9	40.5	163.8	47.4	5.0	4.0
1956/1957	51.3	104.5	82.2	97.3	81.4	37.6	25.5	26.9	102.2	119.3	3.9	22.8
1957/1958	39.3	191.3	492.0	170.1	40.4	33.2	92.0	117.2	108.0	52.2	15.0	22.3
1958/1959	30.1	90.3	68.3	43.6	17.2	11.6	47.3	35.3	43.5	84.1	6.2	30.0
1959/1960	134.6	140.4	105.6	134.0	230.7	61.8	54.3	57.5	69.6	100.9	3.4	150.0
1960/1961	71.9	144.2	45.8	55.2	37.1	26.6	28.9	93.1	47.4	58.4	7.1	38.9
1961/1962	45.5	127.5	116.3	106.4	62.7	24.5	61.3	157.1	78.9	68.0	9.5	140.6
1962/1963	135.6	91.7	111.0	141.3	83.1	37.5	54.8	34.0	55.9	67.4	6.1	49.5
1963/1964	83.1	111.1	169.8	196.6	139.6	73.0	34.6	49.2	26.3	82.3	2.5	58.1
1964/1965	46.3	113.2	78.4	49.8	127.3	31.1	83.3	130.2	39.5	10.8	1.1	24.9
1965/1966	66.4	116.9	124.4	80.1	35.7	41.3	50.4	20.3	25.0	39.3	4.1	98.8
1966/1967	67.5	106.3	58.9	79.3	104.1	52.5	37.5	21.5	50.3	71.0	2.5	34.2
1967/1968	89.4	165.5	217.2	62.6	25.1	36.3	40.7	52.5	21.6	123.7	0.0	68.3
1968/1969	108.4	154.5	146.0	61.9	22.3	19.1	87.3	80.2	94.7	39.7	8.1	69.3
1969/1970	129.7	87.9	140.0	102.6	163.0	31.0	60.4	39.4	57.8	53.8	9.3	39.1
1970/1971	123.2	108.7	195.2	141.3	29.4	29.5	49.0	56.4	60.3	51.8	10.9	149.2
1971/1972	66.8	13.7	244.0	63.2	20.4	8.7	28.3	73.3	13.6	80.4	6.9	15.4
1972/1973	86.3	157.6	302.9	24.9	11.8	3.7	17.9	4.0	17.3	48.4	4.9	21.0
1973/1974	27.6	75.8	122.2	26.3	11.2	10.5	22.3	26.6	25.1	49.7	13.0	75.6
1974/1975	31.9	98.0	70.9	44.9	13.0	24.0	20.8	55.1	92.9	16.0	4.4	64.5
1975/1976	43.9	141.0	88.3	83.5	21.6	8.5	20.5	3.7	4.7	15.3	4.6	24.6
1976/1977	72.2	92.0	59.8	12.2	9.4	12.9	24.6	82.7	55.2	35.9	6.7	7.3
1977/1978	141.2	91.7	76.0	34.4	27.3	36.8	15.9	96.4	21.9	69.5	9.7	14.6
1978/1979	83.6	205.3	98.5	35.0	5.3	16.6	14.4	17.3	13.5	12.4	1.9	23.0
1979/1980	39.7	166.8	83.1	24.1	1.5	0.8	15.2	23.0	16.7	35.6	7.3	19.0
1980/1981	54.6	96.5	50.5	40.5	24.9	13.0	21.3	20.4	53.9	35.0	0.9	52.3
1981/1982	35.4	64.3	28.9	18.7	3.4	7.2	14.8	37.8	39.1	9.1	2.5	7.3
1982/1983	50.6	83.7	155.9	29.7	4.3	11.8	11.1	16.9	5.2	8.8	2.0	9.6
1983/1984	52.0	105.0	141.2	136.3	77.7	78.2	81.6	80.4	51.3	78.5	6.4	47.4
1984/1985	70.2	69.2	52.5	62.9	30.0	18.2	22.0	41.3	63.9	64.3	0.4	34.0

Historical flow data for VICTORIA reservoir (Million Cubic Meters)

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1949/1950	40.9	74.2	143.2	80.5	67.1	44.9	17.3	18.7	16.5	8.9	0.2	27.1
1950/1951	28.4	33.7	23.0	282.5	37.4	19.6	34.5	23.0	17.8	27.4	7.1	28.0
1951/1952	23.6	82.6	93.7	174.7	52.0	12.8	33.0	58.4	37.5	34.1	9.7	22.2
1952/1953	43.0	63.5	58.9	72.6	24.0	21.1	31.9	4.3	13.8	22.2	8.9	3.0
1953/1954	34.4	40.1	62.5	64.7	40.2	44.2	22.9	14.6	6.6	9.4	9.4	18.5
1954/1955	65.1	66.0	175.1	240.2	121.5	37.4	52.6	17.3	11.2	13.1	8.7	28.7
1955/1956	27.1	32.1	67.4	73.2	26.4	20.8	13.2	11.4	67.6	13.2	4.4	1.1
1956/1957	28.3	23.2	107.3	97.4	78.5	41.0	14.5	14.0	28.7	43.3	9.7	15.4
1957/1958	25.0	151.8	447.0	470.8	65.8	65.4	59.1	65.7	42.1	17.5	3.8	21.6
1958/1959	46.2	62.2	82.3	57.3	22.3	9.6	27.7	20.4	19.0	25.6	0.2	16.3
1959/1960	92.6	121.7	123.0	142.7	243.0	71.2	26.8	23.5	17.0	54.9	9.7	49.8
1960/1961	50.0	88.6	54.0	67.7	42.4	27.9	19.9	33.3	15.5	19.1	9.0	17.6
1961/1962	31.2	132.7	130.2	167.3	89.0	30.6	40.7	74.2	25.4	25.4	7.9	51.1
1962/1963	73.9	92.3	123.0	140.3	106.9	27.3	40.0	33.3	18.8	28.5	1.3	32.8
1963/1964	50.8	95.6	160.5	229.2	175.6	76.6	23.9	26.4	7.6	41.8	4.9	22.5
1964/1965	25.8	63.8	82.3	63.3	141.6	20.6	55.1	96.3	10.7	6.0	2.5	9.5
1965/1966	47.4	99.1	129.0	110.4	46.9	35.0	42.7	31.3	10.9	12.3	5.5	44.3
1966/1967	50.4	87.2	57.6	87.6	105.4	42.4	26.1	11.9	18.2	17.5	4.8	20.5
1967/1968	57.4	153.7	167.4	81.9	17.4	30.6	19.5	28.9	6.7	32.9	7.6	25.5
1968/1969	73.3	104.3	144.7	79.0	35.3	19.1	64.8	33.9	26.6	20.0	9.7	35.2
1969/1970	84.5	70.4	140.2	166.9	155.3	25.8	36.4	26.6	15.1	15.4	7.3	17.4
1970/1971	58.3	78.1	206.3	209.1	26.1	23.5	29.6	35.8	22.0	21.2	8.9	63.1
1971/1972	44.3	14.5	230.7	81.8	46.1	7.1	16.7	39.2	4.5	28.0	1.8	12.5
1972/1973	72.6	145.9	295.2	49.5	16.4	3.3	11.0	2.3	7.2	17.6	1.4	15.7
1973/1974	24.3	68.2	116.2	40.5	10.6	8.8	12.4	12.6	7.7	18.4	7.5	28.6
1974/1975	18.2	28.7	85.3	67.9	12.4	16.5	13.6	31.9	34.2	7.3	7.2	29.7
1975/1976	15.7	65.8	98.3	109.7	31.2	8.2	13.5	6.8	1.6	5.3	9.9	8.8
1976/1977	36.5	63.5	50.6	18.9	10.9	10.3	13.2	38.2	13.8	18.8	8.3	7.1
1977/1978	92.0	59.9	95.1	65.0	27.1	29.2	11.8	44.6	4.4	27.1	7.0	4.1
1978/1979	56.8	108.5	113.3	46.7	5.3	10.6	8.8	7.4	5.3	5.5	3.7	11.2
1979/1980	31.0	109.4	81.9	53.2	7.5	1.1	10.9	14.7	4.3	9.3	5.5	8.2
1980/1981	40.3	79.5	50.5	48.4	34.8	10.9	16.5	17.0	14.1	17.2	7.6	23.0
1981/1982	20.9	42.3	32.9	30.5	5.6	5.8	9.3	17.4	11.7	4.6	1.2	3.1
1982/1983	31.9	60.1	164.2	53.3	11.5	7.2	7.0	3.8	1.8	4.6	1.0	4.7
1983/1984	32.4	74.4	160.3	170.1	87.7	106.1	45.9	43.4	14.8	27.6	4.7	24.6
1984/1985	43.4	55.2	60.3	79.8	34.1	15.8	13.5	20.4	19.7	22.5	6.3	18.1

Historical flow data for RANDENIGALE reservoir (Million Cubic Meter)

Year	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1949/1950	45.6	67.6	54.1	59.5	33.8	26.5	46.4	45.5	29.3	30.3	2.8	28.7
1950/1951	54.1	100.7	174.4	122.7	73.2	58.0	64.1	69.7	43.3	27.6	6.0	19.3
1951/1952	67.5	127.0	161.2	122.1	166.5	80.2	82.9	66.2	35.9	47.3	1.0	26.2
1952/1953	50.4	59.6	28.1	81.0	54.9	35.1	66.9	72.2	41.5	35.6	5.1	28.6
1953/1954	43.8	73.2	77.4	82.3	60.6	47.9	45.6	52.6	23.4	26.8	4.7	29.4
1954/1955	31.6	133.1	524.7	275.5	149.3	125.2	84.6	69.8	42.7	37.1	1.6	22.4
1955/1956	39.5	40.4	20.8	20.4	15.4	6.8	10.5	20.0	21.9	40.5	8.0	39.5
1956/1957	40.9	65.1	52.3	52.6	47.9	35.0	39.0	43.4	31.0	27.0	8.8	23.5
1957/1958	67.2	149.7	333.6	166.4	70.6	66.4	76.8	70.8	33.6	31.2	1.7	19.9
1958/1959	47.2	64.5	63.8	47.7	28.4	15.7	50.8	51.1	42.3	35.0	9.5	22.3
1959/1960	57.1	60.2	60.1	86.7	145.5	72.8	80.0	55.3	28.9	47.3	6.3	35.7
1960/1961	53.4	53.5	34.5	75.4	60.0	49.4	59.9	77.1	37.7	29.5	8.8	28.9
1961/1962	31.0	65.6	32.7	40.3	47.6	37.4	43.2	58.7	27.0	25.5	4.3	28.7
1962/1963	49.3	42.6	54.0	83.7	59.9	40.5	53.1	45.3	29.9	24.9	9.4	22.4
1963/1964	56.1	84.3	107.1	110.3	61.2	68.2	37.6	35.4	26.4	26.8	3.9	24.6
1964/1965	45.3	69.7	55.1	79.1	53.6	35.5	58.7	50.7	31.1	28.7	2.6	25.5
1965/1966	49.3	83.1	92.0	64.1	53.4	35.6	46.1	35.3	21.5	30.4	2.7	29.5
1966/1967	41.3	52.9	37.8	64.6	53.6	38.4	38.0	40.3	24.5	32.0	1.4	29.3
1967/1968	47.5	72.7	73.7	43.0	31.5	18.8	32.7	40.5	27.6	34.7	3.3	25.4
1968/1969	50.1	72.2	104.7	85.3	68.0	44.7	45.5	43.7	26.3	30.8	9.6	28.8
1969/1970	52.9	89.1	135.8	110.4	68.4	49.3	64.9	67.7	31.8	29.4	6.4	24.6
1970/1971	73.2	94.7	151.8	108.6	106.7	62.2	126.7	72.5	45.0	47.0	9.8	35.2
1971/1972	41.5	53.9	52.8	52.5	45.7	25.6	42.1	58.2	25.2	27.0	1.3	23.0
1972/1973	51.9	73.2	61.7	94.0	116.6	63.1	74.7	79.6	48.1	36.3	9.3	24.4
1973/1974	39.8	65.9	131.6	100.4	60.4	30.6	104.2	74.8	47.8	45.6	1.3	27.1
1974/1975	49.5	54.9	44.7	95.7	66.0	51.9	67.0	53.2	39.3	34.3	6.6	28.8
1975/1976	40.0	40.2	33.4	62.9	27.2	23.7	43.1	45.1	22.1	17.1	8.0	19.3
1976/1977	46.0	62.6	45.8	64.7	39.7	34.5	40.8	43.5	25.1	28.3	9.4	24.7
1977/1978	58.9	79.7	32.0	80.5	70.8	50.0	65.9	74.3	36.6	36.6	0.1	28.9
1978/1979	48.0	70.4	84.4	85.5	48.6	38.3	30.7	32.4	23.4	28.1	1.3	26.9
1979/1980	39.1	50.1	39.1	73.1	76.4	45.7	61.9	46.4	34.1	28.1	0.3	23.4
1980/1981	43.4	68.3	53.1	39.9	24.4	14.6	19.9	27.9	18.6	35.2	9.6	38.5
1981/1982	40.7	64.3	42.6	45.8	37.0	25.7	32.9	39.1	27.7	28.7	0.6	25.9
1982/1983	48.2	73.1	80.6	74.5	56.1	33.2	29.8	37.8	24.1	25.4	9.0	25.7
1983/1984	43.4	62.5	60.8	81.4	61.4	51.4	66.4	58.9	32.7	35.6	6.2	26.4
1984/1985	44.2	63.3	35.5	50.4	39.4	28.1	37.1	37.5	26.7	28.1	9.8	25.7

Historical flow data for RANTEMBE reservoir (Million Cubic Meters)

Year	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1949/1950	18.0	48.0	129.9	76.7	33.0	54.3	16.5	15.2	13.2	16.4	5.0	23.8
1950/1951	24.2	25.2	30.4	204.7	41.3	21.1	33.5	18.1	28.6	19.3	8.9	26.5
1951/1952	44.5	74.9	86.5	127.5	49.4	26.2	30.2	39.3	44.5	33.3	9.4	19.3
1952/1953	84.4	76.8	53.3	43.7	35.2	35.2	47.3	3.3	6.5	22.1	7.1	11.8
1953/1954	50.4	54.9	75.2	112.3	63.3	57.9	60.9	30.9	22.9	22.2	9.8	11.7
1954/1955	52.0	52.3	141.2	151.4	85.3	48.2	61.9	60.6	47.1	33.6	0.3	37.5
1955/1956	36.8	37.9	49.0	35.6	9.7	11.3	10.9	7.7	24.3	10.7	7.1	7.0
1956/1957	21.6	87.4	75.9	64.2	62.0	43.5	22.3	31.6	45.3	29.2	1.0	8.1
1957/1958	48.1	115.3	308.2	118.7	26.7	64.7	58.2	46.3	14.6	11.6	0.3	6.8
1958/1959	31.7	35.0	62.8	36.2	14.5	6.8	20.6	26.7	18.3	29.2	0.2	12.6
1959/1960	38.8	55.3	76.9	70.5	145.0	48.3	39.9	23.8	16.9	33.0	8.9	11.1
1960/1961	32.5	97.4	54.3	86.7	40.9	23.9	22.8	29.9	17.0	16.5	2.5	8.6
1961/1962	12.7	64.0	84.4	87.7	44.2	19.5	34.8	54.3	16.2	15.6	5.6	17.7
1962/1963	60.9	49.5	85.6	131.0	77.0	22.7	34.3	17.6	11.0	10.7	9.8	7.4
1963/1964	13.7	57.9	135.1	142.9	92.1	49.4	24.5	21.2	12.5	17.7	3.1	12.2
1964/1965	13.7	41.1	75.5	40.6	58.5	19.1	41.2	53.0	17.6	8.1	7.0	6.3
1965/1966	33.7	63.9	101.4	60.9	33.2	36.4	27.2	11.7	8.8	6.2	3.5	14.9
1966/1967	36.7	93.1	56.8	59.3	71.7	23.7	17.2	12.5	9.4	6.9	8.5	4.1
1967/1968	38.6	105.6	156.3	63.9	18.3	37.4	20.3	11.2	7.7	18.7	9.7	6.3
1968/1969	28.8	65.8	112.0	79.3	46.1	25.1	36.1	21.8	16.5	8.3	6.2	13.3
1969/1970	55.1	41.8	105.2	92.0	119.3	26.4	41.1	25.0	11.9	8.7	5.9	9.4
1970/1971	22.7	38.8	81.6	97.8	33.8	23.9	37.4	30.3	19.9	11.7	4.9	42.5
1971/1972	32.1	28.7	188.8	39.5	19.4	4.7	14.9	44.1	11.4	14.3	7.3	5.8
1972/1973	53.1	57.3	123.4	21.1	20.7	10.5	12.6	9.3	7.1	6.0	5.2	4.4
1973/1974	7.3	23.4	101.2	47.3	8.8	7.2	20.6	10.6	9.8	14.5	8.7	27.4
1974/1975	17.6	13.0	55.8	45.8	21.7	25.4	12.3	13.1	15.9	12.7	6.7	15.7
1975/1976	23.5	58.2	64.3	28.4	7.8	34.1	20.6	16.7	10.2	25.4	7.2	9.2
1976/1977	30.9	68.5	65.1	15.7	18.1	14.0	23.9	10.9	10.6	11.6	4.6	5.0
1977/1978	30.4	64.5	90.9	26.5	44.6	22.7	29.3	5.6	11.3	3.9	3.6	5.7
1978/1979	38.3	61.9	44.1	39.6	74.2	23.4	29.0	31.0	15.6	15.8	2.1	32.7
1979/1980	42.5	40.0	24.1	25.9	39.8	24.2	29.2	9.7	14.3	6.1	5.5	6.6
1980/1981	31.4	49.9	104.4	62.7	38.3	25.5	12.5	10.6	2.7	7.1	9.1	15.0
1981/1982	26.3	29.2	53.3	17.8	17.4	14.7	14.5	10.1	11.9	22.7	1.2	11.0
1982/1983	30.2	62.3	132.7	16.5	15.0	17.5	13.9	11.3	10.4	6.5	7.3	3.7
1983/1984	16.8	26.3	74.8	123.4	113.3	58.9	61.3	21.0	14.5	15.3	3.1	28.7
1984/1985	50.6	55.3	63.9	55.2	42.9	50.7	24.8	12.6	13.3	27.3	4.3	7.3

Historical flow data for BOWATENNE reservoir (Million Cubic Meters)

Appendix 2

FILE: FKOT1 OUT67 A1 KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS, DHAHRAN

PROBABILITY AND CACULATED DEMANDS FOR KOTMALE RESERVOIR

PROB	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
0.14	101.999	81.299	56.642	49.286	49.286	49.286	49.286	49.286	81.668	109.856	97.990	83.723
0.29	100.564	79.873	55.216	49.286	49.286	49.286	49.286	49.286	80.242	108.421	96.555	82.298
0.43	100.279	79.590	54.933	49.286	49.286	49.286	49.286	49.286	79.959	108.136	96.270	82.015
0.57	100.181	79.493	54.835	49.286	49.286	49.286	49.286	49.286	79.861	108.038	96.171	81.917
0.71	100.148	79.460	54.802	49.286	49.286	49.286	49.286	49.286	79.829	108.005	96.139	81.884
0.86	100.038	79.351	54.693	49.286	49.286	49.286	49.286	49.286	79.720	107.895	96.029	81.775
1.00	99.775	79.090	54.432	49.286	49.286	49.286	49.286	49.286	79.459	107.632	95.766	81.514
1.14	99.709	79.024	54.367	49.286	49.286	49.286	49.286	49.286	79.393	107.566	95.700	81.449
1.28	99.655	78.970	54.312	49.286	49.286	49.286	49.286	49.286	79.339	107.512	95.645	81.394
1.43	99.315	78.633	53.975	49.286	49.286	49.286	49.286	49.286	79.001	107.172	95.306	81.057
1.57	99.304	78.622	53.964	49.286	49.286	49.286	49.286	49.286	78.991	107.161	95.295	81.046
1.71	98.964	78.284	53.627	49.286	49.286	49.286	49.286	49.286	78.653	106.821	94.955	80.709
1.85	98.844	78.165	53.507	49.286	49.286	49.286	49.286	49.286	78.533	106.701	94.835	80.589
2.00	98.778	78.099	53.442	49.286	49.286	49.286	49.286	49.286	78.468	106.635	94.769	80.524
2.14	98.745	78.067	53.409	49.286	49.286	49.286	49.286	49.286	78.436	106.602	94.736	80.491
2.28	98.701	78.023	53.365	49.286	49.286	49.286	49.286	49.286	78.392	106.558	94.692	80.447
2.43	98.658	77.980	53.322	49.286	49.286	49.286	49.286	49.286	78.348	106.515	94.648	80.404
2.57	98.647	77.969	53.311	49.286	49.286	49.286	49.286	49.286	78.338	106.504	94.637	80.393
2.71	98.636	77.958	53.300	49.286	49.286	49.286	49.286	49.286	78.327	106.493	94.626	80.382
2.85	98.636	77.958	53.300	49.286	49.286	49.286	49.286	49.286	78.327	106.493	94.626	80.382
3.00	98.581	77.903	53.246	49.286	49.286	49.286	49.286	49.286	78.272	106.438	94.572	80.328
3.14	98.340	77.664	53.006	49.286	49.286	49.286	49.286	49.286	78.033	106.197	94.331	80.088
3.28	98.318	77.642	52.984	49.286	49.286	49.286	49.286	49.286	78.011	106.175	94.309	80.066
3.42	98.186	77.512	52.854	49.286	49.286	49.286	49.286	49.286	77.880	106.043	94.177	79.936
3.57	98.175	77.501	52.843	49.286	49.286	49.286	49.286	49.286	77.870	106.033	94.166	79.925
3.71	98.165	77.490	52.832	49.286	49.286	49.286	49.286	49.286	77.859	106.022	94.155	79.914
3.85	98.132	77.457	52.799	49.286	49.286	49.286	49.286	49.286	77.826	105.989	94.122	79.881
3.99	98.033	77.359	52.701	49.286	49.286	49.286	49.286	49.286	77.728	105.890	94.024	79.783
4.14	97.989	77.316	52.658	49.286	49.286	49.286	49.286	49.286	77.684	105.846	93.980	79.740
4.28	97.945	77.272	52.614	49.286	49.286	49.286	49.286	49.286	77.641	105.802	93.936	79.696
4.42	97.923	77.250	52.593	49.286	49.286	49.286	49.286	49.286	77.619	105.780	93.914	79.675
4.56	97.923	77.250	52.593	49.286	49.286	49.286	49.286	49.286	77.619	105.780	93.914	79.675
4.71	97.913	77.239	52.582	49.286	49.286	49.286	49.286	49.286	77.608	105.770	93.903	79.664
4.85	97.891	77.218	52.560	49.286	49.286	49.286	49.286	49.286	77.587	105.748	93.881	79.642
4.99	97.891	77.218	52.560	49.286	49.286	49.286	49.286	49.286	77.587	105.748	93.881	79.642
5.14	97.880	77.207	52.549	49.286	49.286	49.286	49.286	49.286	77.576	105.737	93.870	79.631
5.28	97.803	77.131	52.473	49.286	49.286	49.286	49.286	49.286	77.499	105.660	93.794	79.555
5.42	97.770	77.098	52.440	49.286	49.286	49.286	49.286	49.286	77.467	105.627	93.761	79.522
5.56	97.759	77.087	52.429	49.286	49.286	49.286	49.286	49.286	77.456	105.616	93.750	79.511
5.71	97.759	77.087	52.429	49.286	49.286	49.286	49.286	49.286	77.456	105.616	93.750	79.511
5.85	97.639	76.967	52.310	49.286	49.286	49.286	49.286	49.286	77.336	105.496	93.629	79.392
5.99	97.628	76.956	52.299	49.286	49.286	49.286	49.286	49.286	77.325	105.485	93.618	79.381
6.13	97.617	76.946	52.288	49.286	49.286	49.286	49.286	49.286	77.314	105.474	93.607	79.370
6.28	97.606	76.935	52.277	49.286	49.286	49.286	49.286	49.286	77.304	105.463	93.597	79.359
6.42	97.595	76.924	52.266	49.286	49.286	49.286	49.286	49.286	77.293	105.452	93.586	79.348
6.56	97.518	76.848	52.190	49.286	49.286	49.286	49.286	49.286	77.216	105.375	93.509	79.272
6.70	97.485	76.815	52.157	49.286	49.286	49.286	49.286	49.286	77.184	105.342	93.476	79.239
6.85	97.463	76.793	52.135	49.286	49.286	49.286	49.286	49.286	77.162	105.320	93.454	79.217
6.99	97.463	76.793	52.135	49.286	49.286	49.286	49.286	49.286	77.162	105.320	93.454	79.217

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7.13	97.430	76.761	52.103	49.286	49.286	49.286	49.286	49.286	77.129	105.287	93.421	79.185
7.28	97.376	76.706	52.048	49.286	49.286	49.286	49.286	49.286	77.075	105.233	93.366	79.130
7.42	97.332	76.663	52.005	49.286	49.286	49.286	49.286	49.286	77.031	105.189	93.323	79.087
7.56	97.332	76.663	52.005	49.286	49.286	49.286	49.286	49.286	77.031	105.189	93.323	79.087
7.70	97.299	76.630	51.972	49.286	49.286	49.286	49.286	49.286	76.999	105.156	93.290	79.054
7.85	97.277	76.608	51.950	49.286	49.286	49.286	49.286	49.286	76.977	105.134	93.268	79.032
7.99	97.233	76.565	51.907	49.286	49.286	49.286	49.286	49.286	76.933	105.090	93.224	78.989
8.13	97.233	76.565	51.907	49.286	49.286	49.286	49.286	49.286	76.933	105.090	93.224	78.989
8.27	97.178	76.510	51.852	49.286	49.286	49.286	49.286	49.286	76.879	105.035	93.169	78.934
8.42	97.167	76.499	51.842	49.286	49.286	49.286	49.286	49.286	76.868	105.024	93.158	78.924
8.56	97.156	76.488	51.831	49.286	49.286	49.286	49.286	49.286	76.857	105.014	93.147	78.913
8.70	97.135	76.467	51.809	49.286	49.286	49.286	49.286	49.286	76.835	104.992	93.125	78.891
8.84	97.113	76.445	51.787	49.286	49.286	49.286	49.286	49.286	76.814	104.970	93.103	78.869
8.99	97.091	76.423	51.765	49.286	49.286	49.286	49.286	49.286	76.792	104.948	93.082	78.847
9.13	97.025	76.358	51.700	49.286	49.286	49.286	49.286	49.286	76.727	104.882	93.016	78.782
9.27	97.025	76.358	51.700	49.286	49.286	49.286	49.286	49.286	76.727	104.882	93.016	78.782
9.42	97.003	76.336	51.678	49.286	49.286	49.286	49.286	49.286	76.705	104.860	92.994	78.760
9.56	96.992	76.325	51.667	49.286	49.286	49.286	49.286	49.286	76.694	104.849	92.983	78.749
9.70	96.981	76.314	51.656	49.286	49.286	49.286	49.286	49.286	76.683	104.838	92.972	78.739
9.84	96.948	76.282	51.624	49.286	49.286	49.286	49.286	49.286	76.650	104.805	92.939	78.706
9.99	96.937	76.271	51.613	49.286	49.286	49.286	49.286	49.286	76.640	104.794	92.928	78.695
10.13	96.926	76.260	51.602	49.286	49.286	49.286	49.286	49.286	76.629	104.783	92.917	78.684
10.27	96.915	76.249	51.591	49.286	49.286	49.286	49.286	49.286	76.618	104.772	92.906	78.673
10.41	96.904	76.238	51.580	49.286	49.286	49.286	49.286	49.286	76.607	104.761	92.895	78.662
10.56	96.872	76.205	51.548	49.286	49.286	49.286	49.286	49.286	76.574	104.729	92.862	78.630
10.70	96.861	76.195	51.537	49.286	49.286	49.286	49.286	49.286	76.563	104.718	92.851	78.619
10.84	96.850	76.184	51.526	49.286	49.286	49.286	49.286	49.286	76.552	104.707	92.840	78.608
10.98	96.850	76.184	51.526	49.286	49.286	49.286	49.286	49.286	76.552	104.707	92.840	78.608
11.13	96.839	76.173	51.515	49.286	49.286	49.286	49.286	49.286	76.542	104.696	92.830	78.597
11.27	96.839	76.173	51.515	49.286	49.286	49.286	49.286	49.286	76.542	104.696	92.830	78.597
11.41	96.762	76.097	51.439	49.286	49.286	49.286	49.286	49.286	76.465	104.619	92.753	78.521
11.55	96.751	76.086	51.428	49.286	49.286	49.286	49.286	49.286	76.455	104.608	92.742	78.510
11.70	96.718	76.053	51.395	49.286	49.286	49.286	49.286	49.286	76.422	104.575	92.709	78.477
11.84	96.641	75.977	51.319	49.286	49.286	49.286	49.286	49.286	76.346	104.499	92.632	78.401
11.98	96.631	75.966	51.308	49.286	49.286	49.286	49.286	49.286	76.335	104.488	92.621	78.390
12.13	96.576	75.912	51.254	49.286	49.286	49.286	49.286	49.286	76.280	104.433	92.567	78.336
12.27	96.565	75.901	51.243	49.286	49.286	49.286	49.286	49.286	76.269	104.422	92.556	78.325
12.41	96.554	75.890	51.232	49.286	49.286	49.286	49.286	49.286	76.259	104.411	92.545	78.314
12.55	96.532	75.868	51.210	49.286	49.286	49.286	49.286	49.286	76.237	104.389	92.523	78.292
12.70	96.521	75.857	51.199	49.286	49.286	49.286	49.286	49.286	76.226	104.378	92.512	78.281
12.84	96.499	75.835	51.178	49.286	49.286	49.286	49.286	49.286	76.204	104.356	92.490	78.260
12.98	96.477	75.814	51.156	49.286	49.286	49.286	49.286	49.286	76.182	104.334	92.468	78.238
13.12	96.455	75.792	51.134	49.286	49.286	49.286	49.286	49.286	76.161	104.312	92.446	78.216
13.27	96.455	75.792	51.134	49.286	49.286	49.286	49.286	49.286	76.161	104.312	92.446	78.216
13.41	96.433	75.770	51.112	49.286	49.286	49.286	49.286	49.286	76.139	104.290	92.424	78.194
13.55	96.411	75.748	51.090	49.286	49.286	49.286	49.286	49.286	76.117	104.268	92.402	78.173
13.69	96.302	75.639	50.982	49.286	49.286	49.286	49.286	49.286	76.008	104.159	92.293	78.064
13.84	96.302	75.639	50.982	49.286	49.286	49.286	49.286	49.286	76.008	104.159	92.293	78.064
13.98	96.258	75.596	50.938	49.286	49.286	49.286	49.286	49.286	75.965	104.115	92.249	78.020
14.12	96.225	75.563	50.905	49.286	49.286	49.286	49.286	49.286	75.932	104.082	92.216	77.987
14.27	96.214	75.552	50.895	49.286	49.286	49.286	49.286	49.286	75.921	104.071	92.205	77.977
14.41	96.214	75.552	50.895	49.286	49.286	49.286	49.286	49.286	75.921	104.071	92.205	77.977
14.55	96.203	75.541	50.884	49.286	49.286	49.286	49.286	49.286	75.910	104.060	92.194	77.966
14.69	96.170	75.509	50.851	49.286	49.286	49.286	49.286	49.286	75.878	104.027	92.161	77.933
14.84	96.159	75.498	50.840	49.286	49.286	49.286	49.286	49.286	75.867	104.016	92.150	77.922

14.98	96.159	75.498	50.840	49.286	49.286	49.286	49.286	49.286	75.867	104.016	92.150	77.922
15.12	96.137	75.476	50.818	49.286	49.286	49.286	49.286	49.286	75.845	103.994	92.128	77.900
15.26	96.116	75.454	50.797	49.286	49.286	49.286	49.286	49.286	75.823	103.973	92.106	77.879
15.41	96.105	75.444	50.786	49.286	49.286	49.286	49.286	49.286	75.812	103.962	92.095	77.868
15.55	95.951	75.291	50.633	49.286	49.286	49.286	49.286	49.286	75.660	103.808	91.942	77.715
15.69	95.951	75.291	50.633	49.286	49.286	49.286	49.286	49.286	75.660	103.808	91.942	77.715
15.83	95.929	75.269	50.612	49.286	49.286	49.286	49.286	49.286	75.638	103.786	91.920	77.694
15.98	95.907	75.248	50.590	49.286	49.286	49.286	49.286	49.286	75.616	103.764	91.898	77.672
16.12	95.896	75.237	50.579	49.286	49.286	49.286	49.286	49.286	75.606	103.753	91.887	77.661
16.26	95.885	75.226	50.568	49.286	49.286	49.286	49.286	49.286	75.595	103.742	91.876	77.650
16.41	95.885	75.226	50.568	49.286	49.286	49.286	49.286	49.286	75.595	103.742	91.876	77.650
16.55	95.831	75.171	50.514	49.286	49.286	49.286	49.286	49.286	75.540	103.688	91.821	77.596
16.69	95.831	75.171	50.514	49.286	49.286	49.286	49.286	49.286	75.540	103.688	91.821	77.596
16.83	95.798	75.139	50.481	49.286	49.286	49.286	49.286	49.286	75.508	103.655	91.789	77.563
16.98	95.743	75.084	50.427	49.286	49.286	49.286	49.286	49.286	75.453	103.600	91.734	77.509
17.12	95.644	74.986	50.329	49.286	49.286	49.286	49.286	49.286	75.355	103.501	91.635	77.411
17.26	95.644	74.986	50.329	49.286	49.286	49.286	49.286	49.286	75.355	103.501	91.635	77.411
17.40	95.590	74.932	50.274	49.286	49.286	49.286	49.286	49.286	75.301	103.447	91.580	77.356
17.55	95.590	74.932	50.274	49.286	49.286	49.286	49.286	49.286	75.301	103.447	91.580	77.356
17.69	95.546	74.888	50.231	49.286	49.286	49.286	49.286	49.286	75.257	103.403	91.537	77.313
17.83	95.491	74.834	50.176	49.286	49.286	49.286	49.286	49.286	75.203	103.348	91.482	77.258
17.97	95.458	74.801	50.144	49.286	49.286	49.286	49.286	49.286	75.170	103.315	91.449	77.226
18.12	95.458	74.801	50.144	49.286	49.286	49.286	49.286	49.286	75.170	103.315	91.449	77.226
18.26	95.458	74.801	50.144	49.286	49.286	49.286	49.286	49.286	75.170	103.315	91.449	77.226
18.40	95.447	74.790	50.133	49.286	49.286	49.286	49.286	49.286	75.159	103.304	91.438	77.215
18.54	95.425	74.769	50.111	49.286	49.286	49.286	49.286	49.286	75.138	103.282	91.416	77.193
18.69	95.349	74.693	50.035	49.286	49.286	49.286	49.286	49.286	75.061	103.206	91.339	77.117
18.83	95.305	74.649	49.991	49.286	49.286	49.286	49.286	49.286	75.018	103.162	91.296	77.073
18.97	95.239	74.584	49.926	49.286	49.286	49.286	49.286	49.286	74.952	103.096	91.230	77.008
19.12	95.228	74.573	49.915	49.286	49.286	49.286	49.286	49.286	74.942	103.085	91.219	76.997
19.26	95.228	74.573	49.915	49.286	49.286	49.286	49.286	49.286	74.942	103.085	91.219	76.997
19.40	95.217	74.562	49.904	49.286	49.286	49.286	49.286	49.286	74.931	103.074	91.208	76.986
19.54	95.206	74.551	49.893	49.286	49.286	49.286	49.286	49.286	74.920	103.063	91.197	76.975
19.69	95.206	74.551	49.893	49.286	49.286	49.286	49.286	49.286	74.920	103.063	91.197	76.975
19.83	95.195	74.540	49.882	49.286	49.286	49.286	49.286	49.286	74.909	103.052	91.186	76.964
19.97	95.173	74.518	49.861	49.286	49.286	49.286	49.286	49.286	74.887	103.030	91.164	76.943
20.11	95.162	74.507	49.850	49.286	49.286	49.286	49.286	49.286	74.876	103.019	91.153	76.932
20.26	95.140	74.486	49.828	49.286	49.286	49.286	49.286	49.286	74.855	102.997	91.131	76.910
20.40	95.140	74.486	49.828	49.286	49.286	49.286	49.286	49.286	74.855	102.997	91.131	76.910
20.54	95.129	74.475	49.817	49.286	49.286	49.286	49.286	49.286	74.844	102.986	91.120	76.899
20.68	95.108	74.453	49.795	49.286	49.286	49.286	49.286	49.286	74.822	102.965	91.098	76.877
20.83	95.086	74.431	49.773	49.286	49.286	49.286	49.286	49.286	74.800	102.943	91.076	76.856
20.97	95.075	74.420	49.763	49.286	49.286	49.286	49.286	49.286	74.789	102.932	91.065	76.845
21.11	95.064	74.410	49.752	49.286	49.286	49.286	49.286	49.286	74.778	102.921	91.054	76.834
21.26	95.064	74.410	49.752	49.286	49.286	49.286	49.286	49.286	74.778	102.921	91.054	76.834
21.40	95.042	74.388	49.730	49.286	49.286	49.286	49.286	49.286	74.757	102.899	91.033	76.812
21.54	95.042	74.388	49.730	49.286	49.286	49.286	49.286	49.286	74.757	102.899	91.033	76.812
21.68	95.020	74.366	49.708	49.286	49.286	49.286	49.286	49.286	74.735	102.877	91.011	76.790
21.83	94.965	74.312	49.654	49.286	49.286	49.286	49.286	49.286	74.680	102.822	90.956	76.736
21.97	94.965	74.312	49.654	49.286	49.286	49.286	49.286	49.286	74.680	102.822	90.956	76.736
22.11	94.943	74.290	49.632	49.286	49.286	49.286	49.286	49.286	74.659	102.800	90.934	76.714
22.25	94.943	74.290	49.632	49.286	49.286	49.286	49.286	49.286	74.659	102.800	90.934	76.714
22.40	94.932	74.279	49.621	49.286	49.286	49.286	49.286	49.286	74.648	102.789	90.923	76.703
22.54	94.899	74.246	49.588	49.286	49.286	49.286	49.286	49.286	74.615	102.756	90.890	76.670
22.68	94.877	74.224	49.567	49.286	49.286	49.286	49.286	49.286	74.593	102.734	90.868	76.649

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22.82	94.866	74.214	49.556	49.286	49.286	49.286	49.286	49.286	74.582	102.723	90.857	76.638
22.97	94.866	74.214	49.556	49.286	49.286	49.286	49.286	49.286	74.582	102.723	90.857	76.638
23.11	94.845	74.192	49.534	49.286	49.286	49.286	49.286	49.286	74.561	102.702	90.835	76.616
23.25	94.845	74.192	49.534	49.286	49.286	49.286	49.286	49.286	74.561	102.702	90.835	76.616
23.40	94.823	74.170	49.512	49.286	49.286	49.286	49.286	49.286	74.539	102.680	90.813	76.594
23.54	94.823	74.170	49.512	49.286	49.286	49.286	49.286	49.286	74.539	102.680	90.813	76.594
23.68	94.812	74.159	49.501	49.286	49.286	49.286	49.286	49.286	74.528	102.669	90.802	76.583
23.82	94.812	74.159	49.501	49.286	49.286	49.286	49.286	49.286	74.528	102.669	90.802	76.583
23.97	94.801	74.148	49.490	49.286	49.286	49.286	49.286	49.286	74.517	102.658	90.792	76.573
24.11	94.790	74.137	49.480	49.286	49.286	49.286	49.286	49.286	74.506	102.647	90.781	76.562
24.25	94.790	74.137	49.480	49.286	49.286	49.286	49.286	49.286	74.506	102.647	90.781	76.562
24.39	94.724	74.072	49.414	49.286	49.286	49.286	49.286	49.286	74.441	102.581	90.715	76.496
24.54	94.724	74.072	49.414	49.286	49.286	49.286	49.286	49.286	74.441	102.581	90.715	76.496
24.68	94.713	74.061	49.403	49.286	49.286	49.286	49.286	49.286	74.430	102.570	90.704	76.485
24.82	94.713	74.061	49.403	49.286	49.286	49.286	49.286	49.286	74.430	102.570	90.704	76.485
24.96	94.702	74.050	49.393	49.286	49.286	49.286	49.286	49.286	74.419	102.559	90.693	76.475
25.11	94.702	74.050	49.393	49.286	49.286	49.286	49.286	49.286	74.419	102.559	90.693	76.475
25.25	94.702	74.050	49.393	49.286	49.286	49.286	49.286	49.286	74.419	102.559	90.693	76.475
25.39	94.691	74.039	49.382	49.286	49.286	49.286	49.286	49.286	74.408	102.548	90.682	76.464
25.53	94.658	74.007	49.349	49.286	49.286	49.286	49.286	49.286	74.376	102.515	90.649	76.431
25.68	94.647	73.996	49.338	49.286	49.286	49.286	49.286	49.286	74.365	102.504	90.638	76.420
25.82	94.603	73.952	49.295	49.286	49.286	49.286	49.286	49.286	74.321	102.461	90.594	76.377
25.96	94.560	73.909	49.286	49.286	49.286	49.286	49.286	49.286	74.278	102.417	90.550	76.333
26.11	94.549	73.898	49.286	49.286	49.286	49.286	49.286	49.286	74.267	102.406	90.540	76.322
26.25	94.516	73.865	49.286	49.286	49.286	49.286	49.286	49.286	74.234	102.373	90.507	76.290
26.39	94.516	73.865	49.286	49.286	49.286	49.286	49.286	49.286	74.234	102.373	90.507	76.290
26.53	94.505	73.854	49.286	49.286	49.286	49.286	49.286	49.286	74.223	102.362	90.496	76.279
26.68	94.505	73.854	49.286	49.286	49.286	49.286	49.286	49.286	74.223	102.362	90.496	76.279
26.82	94.494	73.844	49.286	49.286	49.286	49.286	49.286	49.286	74.212	102.351	90.485	76.268
26.96	94.483	73.833	49.286	49.286	49.286	49.286	49.286	49.286	74.201	102.340	90.474	76.257
27.10	94.461	73.811	49.286	49.286	49.286	49.286	49.286	49.286	74.180	102.318	90.452	76.235
27.25	94.450	73.800	49.286	49.286	49.286	49.286	49.286	49.286	74.169	102.307	90.441	76.224
27.39	94.439	73.789	49.286	49.286	49.286	49.286	49.286	49.286	74.158	102.296	90.430	76.213
27.53	94.417	73.767	49.286	49.286	49.286	49.286	49.286	49.286	74.136	102.274	90.408	76.192
27.67	94.362	73.713	49.286	49.286	49.286	49.286	49.286	49.286	74.082	102.219	90.353	76.137
27.82	94.351	73.702	49.286	49.286	49.286	49.286	49.286	49.286	74.071	102.208	90.342	76.126
27.96	94.341	73.691	49.286	49.286	49.286	49.286	49.286	49.286	74.060	102.198	90.331	76.115
28.10	94.341	73.691	49.286	49.286	49.286	49.286	49.286	49.286	74.060	102.198	90.331	76.115
28.25	94.330	73.680	49.286	49.286	49.286	49.286	49.286	49.286	74.049	102.187	90.320	76.104
28.39	94.319	73.669	49.286	49.286	49.286	49.286	49.286	49.286	74.038	102.176	90.309	76.094
28.53	94.297	73.648	49.286	49.286	49.286	49.286	49.286	49.286	74.016	102.154	90.288	76.072
28.67	94.286	73.637	49.286	49.286	49.286	49.286	49.286	49.286	74.006	102.143	90.277	76.061
28.82	94.286	73.637	49.286	49.286	49.286	49.286	49.286	49.286	74.006	102.143	90.277	76.061
28.96	94.242	73.593	49.286	49.286	49.286	49.286	49.286	49.286	73.962	102.099	90.233	76.017
29.10	94.231	73.582	49.286	49.286	49.286	49.286	49.286	49.286	73.951	102.088	90.222	76.007
29.24	94.231	73.582	49.286	49.286	49.286	49.286	49.286	49.286	73.951	102.088	90.222	76.007
29.39	94.209	73.561	49.286	49.286	49.286	49.286	49.286	49.286	73.929	102.066	90.200	75.985
29.53	94.187	73.539	49.286	49.286	49.286	49.286	49.286	49.286	73.908	102.044	90.178	75.963
29.67	94.154	73.506	49.286	49.286	49.286	49.286	49.286	49.286	73.875	102.011	90.145	75.930
29.81	94.143	73.495	49.286	49.286	49.286	49.286	49.286	49.286	73.864	102.000	90.134	75.919
29.96	94.089	73.441	49.286	49.286	49.286	49.286	49.286	49.286	73.810	101.946	90.079	75.865
30.10	94.067	73.419	49.286	49.286	49.286	49.286	49.286	49.286	73.788	101.924	90.057	75.843
30.24	94.023	73.375	49.286	49.286	49.286	49.286	49.286	49.286	73.744	101.880	90.014	75.800
30.39	93.990	73.343	49.286	49.286	49.286	49.286	49.286	49.286	73.712	101.847	89.981	75.767
30.53	93.957	73.310	49.286	49.286	49.286	49.286	49.286	49.286	73.679	101.814	89.948	75.734

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30.67	93.891	73.245	49.286	49.286	49.286	49.286	49.286	49.286	73.614	101.748	89.882	75.669
30.81	93.891	73.245	49.286	49.286	49.286	49.286	49.286	49.286	73.614	101.748	89.882	75.669
30.96	93.826	73.180	49.286	49.286	49.286	49.286	49.286	49.286	73.548	101.683	89.816	75.604
31.10	93.826	73.180	49.286	49.286	49.286	49.286	49.286	49.286	73.548	101.683	89.816	75.604
31.24	93.793	73.147	49.286	49.286	49.286	49.286	49.286	49.286	73.516	101.650	89.783	75.571
31.38	93.782	73.136	49.286	49.286	49.286	49.286	49.286	49.286	73.505	101.639	89.773	75.560
31.53	93.782	73.136	49.286	49.286	49.286	49.286	49.286	49.286	73.505	101.639	89.773	75.560
31.67	93.749	73.103	49.286	49.286	49.286	49.286	49.286	49.286	73.472	101.606	89.740	75.528
31.81	93.749	73.103	49.286	49.286	49.286	49.286	49.286	49.286	73.472	101.606	89.740	75.528
31.95	93.727	73.082	49.286	49.286	49.286	49.286	49.286	49.286	73.450	101.584	89.718	75.506
32.10	93.716	73.071	49.286	49.286	49.286	49.286	49.286	49.286	73.440	101.573	89.707	75.495
32.24	93.694	73.049	49.286	49.286	49.286	49.286	49.286	49.286	73.418	101.551	89.685	75.473
32.38	93.683	73.038	49.286	49.286	49.286	49.286	49.286	49.286	73.407	101.540	89.674	75.462
32.52	93.672	73.027	49.286	49.286	49.286	49.286	49.286	49.286	73.396	101.529	89.663	75.451
32.67	93.661	73.016	49.286	49.286	49.286	49.286	49.286	49.286	73.385	101.518	89.652	75.441
32.81	93.661	73.016	49.286	49.286	49.286	49.286	49.286	49.286	73.385	101.518	89.652	75.441
32.95	93.628	72.984	49.286	49.286	49.286	49.286	49.286	49.286	73.352	101.485	89.619	75.408
33.10	93.617	72.973	49.286	49.286	49.286	49.286	49.286	49.286	73.342	101.474	89.608	75.397
33.24	93.606	72.962	49.286	49.286	49.286	49.286	49.286	49.286	73.331	101.463	89.597	75.386
33.38	93.606	72.962	49.286	49.286	49.286	49.286	49.286	49.286	73.331	101.463	89.597	75.386
33.52	93.595	72.951	49.286	49.286	49.286	49.286	49.286	49.286	73.320	101.452	89.586	75.375
33.67	93.595	72.951	49.286	49.286	49.286	49.286	49.286	49.286	73.320	101.452	89.586	75.375
33.81	93.563	72.918	49.286	49.286	49.286	49.286	49.286	49.286	73.287	101.420	89.553	75.343
33.95	93.541	72.897	49.286	49.286	49.286	49.286	49.286	49.286	73.265	101.398	89.531	75.321
34.09	93.519	72.875	49.286	49.286	49.286	49.286	49.286	49.286	73.244	101.376	89.510	75.299
34.24	93.508	72.864	49.286	49.286	49.286	49.286	49.286	49.286	73.233	101.365	89.499	75.288
34.38	93.486	72.842	49.286	49.286	49.286	49.286	49.286	49.286	73.211	101.343	89.477	75.266
34.52	93.464	72.820	49.286	49.286	49.286	49.286	49.286	49.286	73.189	101.321	89.455	75.245
34.66	93.464	72.820	49.286	49.286	49.286	49.286	49.286	49.286	73.189	101.321	89.455	75.245
34.81	93.464	72.820	49.286	49.286	49.286	49.286	49.286	49.286	73.189	101.321	89.455	75.245
34.95	93.431	72.788	49.286	49.286	49.286	49.286	49.286	49.286	73.157	101.288	89.422	75.212
35.09	93.409	72.766	49.286	49.286	49.286	49.286	49.286	49.286	73.135	101.266	89.400	75.190
35.24	93.398	72.755	49.286	49.286	49.286	49.286	49.286	49.286	73.124	101.255	89.389	75.179
35.38	93.376	72.733	49.286	49.286	49.286	49.286	49.286	49.286	73.102	101.233	89.367	75.158
35.52	93.365	72.722	49.286	49.286	49.286	49.286	49.286	49.286	73.091	101.222	89.356	75.147
35.66	93.343	72.701	49.286	49.286	49.286	49.286	49.286	49.286	73.069	101.200	89.334	75.125
35.81	93.343	72.701	49.286	49.286	49.286	49.286	49.286	49.286	73.069	101.200	89.334	75.125
35.95	93.332	72.690	49.286	49.286	49.286	49.286	49.286	49.286	73.059	101.189	89.323	75.114
36.09	93.289	72.646	49.286	49.286	49.286	49.286	49.286	49.286	73.015	101.146	89.279	75.070
36.23	93.289	72.646	49.286	49.286	49.286	49.286	49.286	49.286	73.015	101.146	89.279	75.070
36.38	93.278	72.635	49.286	49.286	49.286	49.286	49.286	49.286	73.004	101.135	89.268	75.060
36.52	93.223	72.581	49.286	49.286	49.286	49.286	49.286	49.286	72.950	101.080	89.214	75.005
36.66	93.190	72.548	49.286	49.286	49.286	49.286	49.286	49.286	72.917	101.047	89.181	74.973
36.80	93.168	72.527	49.286	49.286	49.286	49.286	49.286	49.286	72.895	101.025	89.159	74.951
36.95	93.157	72.516	49.286	49.286	49.286	49.286	49.286	49.286	72.884	101.014	89.148	74.940
37.09	93.157	72.516	49.286	49.286	49.286	49.286	49.286	49.286	72.884	101.014	89.148	74.940
37.23	93.146	72.505	49.286	49.286	49.286	49.286	49.286	49.286	72.874	101.003	89.137	74.929
37.38	93.124	72.483	49.286	49.286	49.286	49.286	49.286	49.286	72.852	100.981	89.115	74.907
37.52	93.113	72.472	49.286	49.286	49.286	49.286	49.286	49.286	72.841	100.970	89.104	74.896
37.66	93.102	72.461	49.286	49.286	49.286	49.286	49.286	49.286	72.830	100.959	89.093	74.885
37.80	93.091	72.450	49.286	49.286	49.286	49.286	49.286	49.286	72.819	100.948	89.082	74.875
37.95	93.091	72.450	49.286	49.286	49.286	49.286	49.286	49.286	72.819	100.948	89.082	74.875
38.09	93.091	72.450	49.286	49.286	49.286	49.286	49.286	49.286	72.819	100.948	89.082	74.875
38.23	93.080	72.439	49.286	49.286	49.286	49.286	49.286	49.286	72.808	100.937	89.071	74.864
38.37	93.070	72.429	49.286	49.286	49.286	49.286	49.286	49.286	72.797	100.927	89.060	74.853

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38.52	93.037	72.396	49.286	49.286	49.286	49.286	49.286	49.286	72.765	100.894	89.027	74.820
38.66	92.993	72.352	49.286	49.286	49.286	49.286	49.286	49.286	72.721	100.850	88.984	74.777
38.80	92.971	72.331	49.286	49.286	49.286	49.286	49.286	49.286	72.699	100.828	88.962	74.755
38.94	92.971	72.331	49.286	49.286	49.286	49.286	49.286	49.286	72.699	100.828	88.962	74.755
39.09	92.971	72.331	49.286	49.286	49.286	49.286	49.286	49.286	72.699	100.828	88.962	74.755
39.23	92.949	72.309	49.286	49.286	49.286	49.286	49.286	49.286	72.678	100.806	88.940	74.733
39.37	92.916	72.276	49.286	49.286	49.286	49.286	49.286	49.286	72.645	100.773	88.907	74.700
39.51	92.905	72.265	49.286	49.286	49.286	49.286	49.286	49.286	72.634	100.762	88.896	74.690
39.66	92.839	72.200	49.286	49.286	49.286	49.286	49.286	49.286	72.569	100.696	88.830	74.624
39.80	92.796	72.156	49.286	49.286	49.286	49.286	49.286	49.286	72.525	100.653	88.786	74.581
39.94	92.763	72.124	49.286	49.286	49.286	49.286	49.286	49.286	72.493	100.620	88.754	74.548
40.09	92.763	72.124	49.286	49.286	49.286	49.286	49.286	49.286	72.493	100.620	88.754	74.548
40.23	92.752	72.113	49.286	49.286	49.286	49.286	49.286	49.286	72.482	100.609	88.743	74.537
40.37	92.741	72.102	49.286	49.286	49.286	49.286	49.286	49.286	72.471	100.598	88.732	74.526
40.51	92.719	72.080	49.286	49.286	49.286	49.286	49.286	49.286	72.449	100.576	88.710	74.504
40.66	92.719	72.080	49.286	49.286	49.286	49.286	49.286	49.286	72.449	100.576	88.710	74.504
40.80	92.708	72.069	49.286	49.286	49.286	49.286	49.286	49.286	72.438	100.565	88.699	74.494
40.94	92.653	72.015	49.286	49.286	49.286	49.286	49.286	49.286	72.384	100.510	88.644	74.439
41.08	92.642	72.004	49.286	49.286	49.286	49.286	49.286	49.286	72.373	100.499	88.633	74.428
41.23	92.631	71.993	49.286	49.286	49.286	49.286	49.286	49.286	72.362	100.488	88.622	74.417
41.37	92.631	71.993	49.286	49.286	49.286	49.286	49.286	49.286	72.362	100.488	88.622	74.417
41.51	92.631	71.993	49.286	49.286	49.286	49.286	49.286	49.286	72.362	100.488	88.622	74.417
41.65	92.609	71.971	49.286	49.286	49.286	49.286	49.286	49.286	72.340	100.466	88.600	74.396
41.80	92.587	71.950	49.286	49.286	49.286	49.286	49.286	49.286	72.318	100.444	88.578	74.374
41.94	92.565	71.928	49.286	49.286	49.286	49.286	49.286	49.286	72.297	100.423	88.556	74.352
42.08	92.555	71.917	49.286	49.286	49.286	49.286	49.286	49.286	72.286	100.412	88.545	74.341
42.23	92.555	71.917	49.286	49.286	49.286	49.286	49.286	49.286	72.286	100.412	88.545	74.341
42.37	92.544	71.906	49.286	49.286	49.286	49.286	49.286	49.286	72.275	100.401	88.534	74.330
42.51	92.544	71.906	49.286	49.286	49.286	49.286	49.286	49.286	72.275	100.401	88.534	74.330
42.65	92.511	71.873	49.286	49.286	49.286	49.286	49.286	49.286	72.242	100.368	88.502	74.298
42.80	92.500	71.863	49.286	49.286	49.286	49.286	49.286	49.286	72.231	100.357	88.491	74.287
42.94	92.500	71.863	49.286	49.286	49.286	49.286	49.286	49.286	72.231	100.357	88.491	74.287
43.08	92.456	71.819	49.286	49.286	49.286	49.286	49.286	49.286	72.188	100.313	88.447	74.243
43.22	92.423	71.786	49.286	49.286	49.286	49.286	49.286	49.286	72.155	100.280	88.414	74.211
43.37	92.412	71.775	49.286	49.286	49.286	49.286	49.286	49.286	72.144	100.269	88.403	74.200
43.51	92.390	71.754	49.286	49.286	49.286	49.286	49.286	49.286	72.123	100.247	88.381	74.178
43.65	92.379	71.743	49.286	49.286	49.286	49.286	49.286	49.286	72.112	100.236	88.370	74.167
43.79	92.379	71.743	49.286	49.286	49.286	49.286	49.286	49.286	72.112	100.236	88.370	74.167
43.94	92.303	71.667	49.286	49.286	49.286	49.286	49.286	49.286	72.035	100.160	88.293	74.091
44.08	92.292	71.656	49.286	49.286	49.286	49.286	49.286	49.286	72.025	100.149	88.282	74.080
44.22	92.281	71.645	49.286	49.286	49.286	49.286	49.286	49.286	72.014	100.138	88.271	74.069
44.37	92.281	71.645	49.286	49.286	49.286	49.286	49.286	49.286	72.014	100.138	88.271	74.069
44.51	92.270	71.634	49.286	49.286	49.286	49.286	49.286	49.286	72.003	100.127	88.260	74.058
44.65	92.270	71.634	49.286	49.286	49.286	49.286	49.286	49.286	72.003	100.127	88.260	74.058
44.79	92.270	71.634	49.286	49.286	49.286	49.286	49.286	49.286	72.003	100.127	88.260	74.058
44.94	92.259	71.623	49.286	49.286	49.286	49.286	49.286	49.286	71.992	100.116	88.249	74.047
45.08	92.215	71.580	49.286	49.286	49.286	49.286	49.286	49.286	71.948	100.072	88.206	74.004
45.22	92.204	71.569	49.286	49.286	49.286	49.286	49.286	49.286	71.938	100.061	88.195	73.993
45.36	92.182	71.547	49.286	49.286	49.286	49.286	49.286	49.286	71.916	100.039	88.173	73.971
45.51	92.171	71.536	49.286	49.286	49.286	49.286	49.286	49.286	71.905	100.028	88.162	73.960
45.65	92.160	71.525	49.286	49.286	49.286	49.286	49.286	49.286	71.894	100.017	88.151	73.949
45.79	92.149	71.514	49.286	49.286	49.286	49.286	49.286	49.286	71.883	100.006	88.140	73.938
45.93	92.138	71.503	49.286	49.286	49.286	49.286	49.286	49.286	71.872	99.995	88.129	73.928
46.08	92.138	71.503	49.286	49.286	49.286	49.286	49.286	49.286	71.872	99.995	88.129	73.928
46.22	92.127	71.492	49.286	49.286	49.286	49.286	49.286	49.286	71.861	99.984	88.118	73.917

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46.36	92.116	71.482	49.286	49.286	49.286	49.286	49.286	49.286	71.850	99.973	88.107	73.906
46.50	92.116	71.482	49.286	49.286	49.286	49.286	49.286	49.286	71.850	99.973	88.107	73.906
46.65	92.105	71.471	49.286	49.286	49.286	49.286	49.286	49.286	71.840	99.962	88.096	73.895
46.79	92.094	71.460	49.286	49.286	49.286	49.286	49.286	49.286	71.829	99.951	88.085	73.884
46.93	92.061	71.427	49.286	49.286	49.286	49.286	49.286	49.286	71.796	99.918	88.052	73.851
47.08	92.051	71.416	49.286	49.286	49.286	49.286	49.286	49.286	71.785	99.908	88.041	73.841
47.22	92.007	71.373	49.286	49.286	49.286	49.286	49.286	49.286	71.742	99.864	87.997	73.797
47.36	91.996	71.362	49.286	49.286	49.286	49.286	49.286	49.286	71.731	99.853	87.987	73.786
47.50	91.996	71.362	49.286	49.286	49.286	49.286	49.286	49.286	71.731	99.853	87.987	73.786
47.65	91.985	71.351	49.286	49.286	49.286	49.286	49.286	49.286	71.720	99.842	87.976	73.775
47.79	91.974	71.340	49.286	49.286	49.286	49.286	49.286	49.286	71.709	99.831	87.965	73.764
47.93	91.908	71.275	49.286	49.286	49.286	49.286	49.286	49.286	71.644	99.765	87.899	73.699
48.07	91.897	71.264	49.286	49.286	49.286	49.286	49.286	49.286	71.633	99.754	87.888	73.688
48.22	91.864	71.231	49.286	49.286	49.286	49.286	49.286	49.286	71.600	99.721	87.855	73.656
48.36	91.831	71.199	49.286	49.286	49.286	49.286	49.286	49.286	71.567	99.688	87.822	73.623
48.50	91.820	71.188	49.286	49.286	49.286	49.286	49.286	49.286	71.557	99.677	87.811	73.612
48.64	91.744	71.112	49.286	49.286	49.286	49.286	49.286	49.286	71.480	99.601	87.735	73.536
48.79	91.744	71.112	49.286	49.286	49.286	49.286	49.286	49.286	71.480	99.601	87.735	73.536
48.93	91.733	71.101	49.286	49.286	49.286	49.286	49.286	49.286	71.469	99.590	87.724	73.525
49.07	91.733	71.101	49.286	49.286	49.286	49.286	49.286	49.286	71.469	99.590	87.724	73.525
49.22	91.733	71.101	49.286	49.286	49.286	49.286	49.286	49.286	71.469	99.590	87.724	73.525
49.36	91.700	71.068	49.286	49.286	49.286	49.286	49.286	49.286	71.437	99.557	87.691	73.492
49.50	91.678	71.046	49.286	49.286	49.286	49.286	49.286	49.286	71.415	99.535	87.669	73.470
49.64	91.667	71.035	49.286	49.286	49.286	49.286	49.286	49.286	71.404	99.524	87.658	73.460
49.79	91.667	71.035	49.286	49.286	49.286	49.286	49.286	49.286	71.404	99.524	87.658	73.460
49.93	91.634	71.003	49.286	49.286	49.286	49.286	49.286	49.286	71.372	99.491	87.625	73.427
50.07	91.623	70.992	49.286	49.286	49.286	49.286	49.286	49.286	71.361	99.480	87.614	73.416
50.21	91.612	70.981	49.286	49.286	49.286	49.286	49.286	49.286	71.350	99.469	87.603	73.405
50.36	91.579	70.948	49.286	49.286	49.286	49.286	49.286	49.286	71.317	99.436	87.570	73.373
50.50	91.579	70.948	49.286	49.286	49.286	49.286	49.286	49.286	71.317	99.436	87.570	73.373
50.64	91.579	70.948	49.286	49.286	49.286	49.286	49.286	49.286	71.317	99.436	87.570	73.373
50.78	91.568	70.937	49.286	49.286	49.286	49.286	49.286	49.286	71.306	99.425	87.559	73.362
50.93	91.568	70.937	49.286	49.286	49.286	49.286	49.286	49.286	71.306	99.425	87.559	73.362
51.07	91.557	70.926	49.286	49.286	49.286	49.286	49.286	49.286	71.295	99.414	87.548	73.351
51.21	91.536	70.905	49.286	49.286	49.286	49.286	49.286	49.286	71.274	99.393	87.526	73.329
51.36	91.536	70.905	49.286	49.286	49.286	49.286	49.286	49.286	71.274	99.393	87.526	73.329
51.50	91.514	70.883	49.286	49.286	49.286	49.286	49.286	49.286	71.252	99.371	87.504	73.307
51.64	91.426	70.796	49.286	49.286	49.286	49.286	49.286	49.286	71.165	99.283	87.417	73.220
51.78	91.426	70.796	49.286	49.286	49.286	49.286	49.286	49.286	71.165	99.283	87.417	73.220
51.93	91.393	70.763	49.286	49.286	49.286	49.286	49.286	49.286	71.132	99.250	87.384	73.187
52.07	91.360	70.731	49.286	49.286	49.286	49.286	49.286	49.286	71.099	99.217	87.351	73.155
52.21	91.360	70.731	49.286	49.286	49.286	49.286	49.286	49.286	71.099	99.217	87.351	73.155
52.35	91.349	70.720	49.286	49.286	49.286	49.286	49.286	49.286	71.089	99.206	87.340	73.144
52.50	91.338	70.709	49.286	49.286	49.286	49.286	49.286	49.286	71.078	99.195	87.329	73.133
52.64	91.338	70.709	49.286	49.286	49.286	49.286	49.286	49.286	71.078	99.195	87.329	73.133
52.78	91.327	70.698	49.286	49.286	49.286	49.286	49.286	49.286	71.067	99.184	87.318	73.122
52.92	91.316	70.687	49.286	49.286	49.286	49.286	49.286	49.286	71.056	99.173	87.307	73.111
53.07	91.316	70.687	49.286	49.286	49.286	49.286	49.286	49.286	71.056	99.173	87.307	73.111
53.21	91.262	70.633	49.286	49.286	49.286	49.286	49.286	49.286	71.001	99.119	87.252	73.057
53.35	91.262	70.633	49.286	49.286	49.286	49.286	49.286	49.286	71.001	99.119	87.252	73.057
53.49	91.262	70.633	49.286	49.286	49.286	49.286	49.286	49.286	71.001	99.119	87.252	73.057
53.64	91.262	70.633	49.286	49.286	49.286	49.286	49.286	49.286	71.001	99.119	87.252	73.057
53.78	91.240	70.611	49.286	49.286	49.286	49.286	49.286	49.286	70.980	99.097	87.230	73.035
53.92	91.218	70.589	49.286	49.286	49.286	49.286	49.286	49.286	70.958	99.075	87.209	73.013
54.07	91.207	70.578	49.286	49.286	49.286	49.286	49.286	49.286	70.947	99.064	87.198	73.002

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54.21	91.174	70.546	49.286	49.286	49.286	49.286	49.286	49.286	70.914	99.031	87.165	72.970
54.35	91.163	70.535	49.286	49.286	49.286	49.286	49.286	49.286	70.903	99.020	87.154	72.959
54.49	91.163	70.535	49.286	49.286	49.286	49.286	49.286	49.286	70.903	99.020	87.154	72.959
54.64	91.152	70.524	49.286	49.286	49.286	49.286	49.286	49.286	70.893	99.009	87.143	72.948
54.78	91.130	70.502	49.286	49.286	49.286	49.286	49.286	49.286	70.871	98.987	87.121	72.926
54.92	91.097	70.469	49.286	49.286	49.286	49.286	49.286	49.286	70.838	98.954	87.088	72.894
55.06	91.097	70.469	49.286	49.286	49.286	49.286	49.286	49.286	70.838	98.954	87.088	72.894
55.21	91.053	70.426	49.286	49.286	49.286	49.286	49.286	49.286	70.795	98.910	87.044	72.850
55.35	91.031	70.404	49.286	49.286	49.286	49.286	49.286	49.286	70.773	98.889	87.022	72.828
55.49	91.021	70.393	49.286	49.286	49.286	49.286	49.286	49.286	70.762	98.878	87.012	72.817
55.63	90.999	70.371	49.286	49.286	49.286	49.286	49.286	49.286	70.740	98.856	86.990	72.796
55.78	90.977	70.350	49.286	49.286	49.286	49.286	49.286	49.286	70.718	98.834	86.968	72.774
55.92	90.966	70.339	49.286	49.286	49.286	49.286	49.286	49.286	70.708	98.823	86.957	72.763
56.06	90.966	70.339	49.286	49.286	49.286	49.286	49.286	49.286	70.708	98.823	86.957	72.763
56.21	90.955	70.328	49.286	49.286	49.286	49.286	49.286	49.286	70.697	98.812	86.946	72.752
56.35	90.944	70.317	49.286	49.286	49.286	49.286	49.286	49.286	70.686	98.801	86.935	72.741
56.49	90.933	70.306	49.286	49.286	49.286	49.286	49.286	49.286	70.675	98.790	86.924	72.730
56.63	90.922	70.295	49.286	49.286	49.286	49.286	49.286	49.286	70.664	98.779	86.914	72.719
56.78	90.900	70.273	49.286	49.286	49.286	49.286	49.286	49.286	70.642	98.757	86.892	72.698
56.92	90.889	70.263	49.286	49.286	49.286	49.286	49.286	49.286	70.631	98.746	86.881	72.687
57.06	90.856	70.230	49.286	49.286	49.286	49.286	49.286	49.286	70.599	98.713	86.848	72.654
57.20	90.856	70.230	49.286	49.286	49.286	49.286	49.286	49.286	70.599	98.713	86.848	72.654
57.35	90.845	70.219	49.286	49.286	49.286	49.286	49.286	49.286	70.588	98.702	86.837	72.643
57.49	90.812	70.186	49.286	49.286	49.286	49.286	49.286	49.286	70.555	98.669	86.805	72.611
57.63	90.747	70.121	49.286	49.286	49.286	49.286	49.286	49.286	70.490	98.604	86.739	72.545
57.77	90.692	70.067	49.286	49.286	49.286	49.286	49.286	49.286	70.435	98.549	86.685	72.491
57.92	90.626	70.001	49.286	49.286	49.286	49.286	49.286	49.286	70.370	98.483	86.620	72.426
58.06	90.626	70.001	49.286	49.286	49.286	49.286	49.286	49.286	70.370	98.483	86.620	72.426
58.20	90.615	69.990	49.286	49.286	49.286	49.286	49.286	49.286	70.359	98.472	86.609	72.415
58.35	90.593	69.969	49.286	49.286	49.286	49.286	49.286	49.286	70.338	98.450	86.587	72.393
58.49	90.527	69.903	49.286	49.286	49.286	49.286	49.286	49.286	70.272	98.384	86.522	72.328
58.63	90.517	69.892	49.286	49.286	49.286	49.286	49.286	49.286	70.261	98.374	86.511	72.317
58.77	90.484	69.860	49.286	49.286	49.286	49.286	49.286	49.286	70.229	98.341	86.478	72.284
58.92	90.473	69.849	49.286	49.286	49.286	49.286	49.286	49.286	70.218	98.330	86.467	72.273
59.06	90.429	69.805	49.286	49.286	49.286	49.286	49.286	49.286	70.174	98.286	86.424	72.230
59.20	90.418	69.795	49.286	49.286	49.286	49.286	49.286	49.286	70.163	98.275	86.413	72.219
59.34	90.418	69.795	49.286	49.286	49.286	49.286	49.286	49.286	70.163	98.275	86.413	72.219
59.49	90.396	69.773	49.286	49.286	49.286	49.286	49.286	49.286	70.142	98.253	86.391	72.197
59.63	90.385	69.762	49.286	49.286	49.286	49.286	49.286	49.286	70.131	98.242	86.380	72.186
59.77	90.341	69.718	49.286	49.286	49.286	49.286	49.286	49.286	70.087	98.198	86.337	72.143
59.91	90.330	69.707	49.286	49.286	49.286	49.286	49.286	49.286	70.076	98.187	86.326	72.132
60.06	90.319	69.697	49.286	49.286	49.286	49.286	49.286	49.286	70.065	98.176	86.315	72.121
60.20	90.308	69.686	49.286	49.286	49.286	49.286	49.286	49.286	70.055	98.165	86.304	72.110
60.34	90.308	69.686	49.286	49.286	49.286	49.286	49.286	49.286	70.055	98.165	86.304	72.110
60.49	90.275	69.653	49.286	49.286	49.286	49.286	49.286	49.286	70.022	98.132	86.271	72.077
60.63	90.265	69.642	49.286	49.286	49.286	49.286	49.286	49.286	70.011	98.122	86.261	72.066
60.77	90.254	69.631	49.286	49.286	49.286	49.286	49.286	49.286	70.000	98.111	86.250	72.055
60.91	90.243	69.620	49.286	49.286	49.286	49.286	49.286	49.286	69.989	98.100	86.239	72.045
61.06	90.243	69.620	49.286	49.286	49.286	49.286	49.286	49.286	69.989	98.100	86.239	72.045
61.20	90.232	69.609	49.286	49.286	49.286	49.286	49.286	49.286	69.978	98.089	86.228	72.034
61.34	90.188	69.566	49.286	49.286	49.286	49.286	49.286	49.286	69.935	98.045	86.184	71.990
61.48	90.177	69.555	49.286	49.286	49.286	49.286	49.286	49.286	69.924	98.034	86.173	71.979
61.63	90.177	69.555	49.286	49.286	49.286	49.286	49.286	49.286	69.924	98.034	86.173	71.979
61.77	90.155	69.533	49.286	49.286	49.286	49.286	49.286	49.286	69.902	98.012	86.152	71.958
61.91	90.144	69.522	49.286	49.286	49.286	49.286	49.286	49.286	69.891	98.001	86.141	71.947

62.05	90.111	69.490	49.286	49.286	49.286	49.286	49.286	49.286	69.859	97.968	86.108	71.914
62.20	90.089	69.468	49.286	49.286	49.286	49.286	49.286	49.286	69.837	97.946	86.086	71.892
62.34	90.056	69.435	49.286	49.286	49.286	49.286	49.286	49.286	69.804	97.913	86.054	71.860
62.48	90.002	69.381	49.286	49.286	49.286	49.286	49.286	49.286	69.750	97.859	85.999	71.805
62.62	90.002	69.381	49.286	49.286	49.286	49.286	49.286	49.286	69.750	97.859	85.999	71.805
62.77	90.002	69.381	49.286	49.286	49.286	49.286	49.286	49.286	69.750	97.859	85.999	71.805
62.91	89.980	69.359	49.286	49.286	49.286	49.286	49.286	49.286	69.728	97.837	85.978	71.783
63.05	89.980	69.359	49.286	49.286	49.286	49.286	49.286	49.286	69.728	97.837	85.978	71.783
63.20	89.969	69.348	49.286	49.286	49.286	49.286	49.286	49.286	69.717	97.826	85.967	71.773
63.34	89.947	69.326	49.286	49.286	49.286	49.286	49.286	49.286	69.695	97.804	85.945	71.751
63.48	89.859	69.239	49.286	49.286	49.286	49.286	49.286	49.286	69.608	97.716	85.858	71.664
63.62	89.826	69.207	49.286	49.286	49.286	49.286	49.286	49.286	69.576	97.683	85.825	71.631
63.77	89.815	69.196	49.286	49.286	49.286	49.286	49.286	49.286	69.565	97.672	85.814	71.620
63.91	89.793	69.174	49.286	49.286	49.286	49.286	49.286	49.286	69.543	97.650	85.793	71.598
64.05	89.782	69.163	49.286	49.286	49.286	49.286	49.286	49.286	69.532	97.639	85.782	71.587
64.19	89.739	69.120	49.286	49.286	49.286	49.286	49.286	49.286	69.489	97.596	85.738	71.544
64.34	89.706	69.087	49.286	49.286	49.286	49.286	49.286	49.286	69.456	97.563	85.705	71.511
64.48	89.673	69.054	49.286	49.286	49.286	49.286	49.286	49.286	69.423	97.530	85.673	71.479
64.62	89.673	69.054	49.286	49.286	49.286	49.286	49.286	49.286	69.423	97.530	85.673	71.479
64.76	89.651	69.033	49.286	49.286	49.286	49.286	49.286	49.286	69.401	97.508	85.651	71.457
64.91	89.640	69.022	49.286	49.286	49.286	49.286	49.286	49.286	69.391	97.497	85.640	71.446
65.05	89.607	68.989	49.286	49.286	49.286	49.286	49.286	49.286	69.358	97.464	85.607	71.413
65.19	89.585	68.967	49.286	49.286	49.286	49.286	49.286	49.286	69.336	97.442	85.586	71.392
65.34	89.585	68.967	49.286	49.286	49.286	49.286	49.286	49.286	69.336	97.442	85.586	71.392
65.48	89.541	68.924	49.286	49.286	49.286	49.286	49.286	49.286	69.293	97.398	85.542	71.348
65.62	89.530	68.913	49.286	49.286	49.286	49.286	49.286	49.286	69.282	97.387	85.531	71.337
65.76	89.508	68.891	49.286	49.286	49.286	49.286	49.286	49.286	69.260	97.365	85.510	71.315
65.91	89.487	68.869	49.286	49.286	49.286	49.286	49.286	49.286	69.238	97.344	85.488	71.294
66.05	89.487	68.869	49.286	49.286	49.286	49.286	49.286	49.286	69.238	97.344	85.488	71.294
66.19	89.476	68.858	49.286	49.286	49.286	49.286	49.286	49.286	69.227	97.333	85.477	71.283
66.33	89.454	68.837	49.286	49.286	49.286	49.286	49.286	49.286	69.206	97.311	85.455	71.261
66.48	89.454	68.837	49.286	49.286	49.286	49.286	49.286	49.286	69.206	97.311	85.455	71.261
66.62	89.432	68.815	49.286	49.286	49.286	49.286	49.286	49.286	69.184	97.289	85.433	71.239
66.76	89.377	68.761	49.286	49.286	49.286	49.286	49.286	49.286	69.129	97.234	85.379	71.185
66.90	89.366	68.750	49.286	49.286	49.286	49.286	49.286	49.286	69.118	97.223	85.368	71.174
67.05	89.366	68.750	49.286	49.286	49.286	49.286	49.286	49.286	69.118	97.223	85.368	71.174
67.19	89.300	68.684	49.286	49.286	49.286	49.286	49.286	49.286	69.053	97.157	85.303	71.109
67.33	89.300	68.684	49.286	49.286	49.286	49.286	49.286	49.286	69.053	97.157	85.303	71.109
67.48	89.289	68.673	49.286	49.286	49.286	49.286	49.286	49.286	69.042	97.146	85.292	71.098
67.62	89.289	68.673	49.286	49.286	49.286	49.286	49.286	49.286	69.042	97.146	85.292	71.098
67.76	89.278	68.663	49.286	49.286	49.286	49.286	49.286	49.286	69.031	97.135	85.281	71.087
67.90	89.267	68.652	49.286	49.286	49.286	49.286	49.286	49.286	69.020	97.124	85.270	71.076
68.05	89.235	68.619	49.286	49.286	49.286	49.286	49.286	49.286	68.988	97.092	85.237	71.043
68.19	89.213	68.597	49.286	49.286	49.286	49.286	49.286	49.286	68.966	97.070	85.216	71.021
68.33	89.191	68.575	49.286	49.286	49.286	49.286	49.286	49.286	68.944	97.048	85.194	71.000
68.47	89.180	68.565	49.286	49.286	49.286	49.286	49.286	49.286	68.933	97.037	85.183	70.989
68.62	89.158	68.543	49.286	49.286	49.286	49.286	49.286	49.286	68.912	97.015	85.161	70.967
68.76	89.136	68.521	49.286	49.286	49.286	49.286	49.286	49.286	68.890	96.993	85.139	70.945
68.90	89.092	68.478	49.286	49.286	49.286	49.286	49.286	49.286	68.846	96.949	85.096	70.902
69.04	89.048	68.434	49.286	49.286	49.286	49.286	49.286	49.286	68.803	96.905	85.052	70.858
69.19	89.037	68.423	49.286	49.286	49.286	49.286	49.286	49.286	68.792	96.894	85.041	70.847
69.33	89.004	68.390	49.286	49.286	49.286	49.286	49.286	49.286	68.759	96.861	85.009	70.815
69.47	88.983	68.369	49.286	49.286	49.286	49.286	49.286	49.286	68.738	96.840	84.987	70.793
69.61	88.972	68.358	49.286	49.286	49.286	49.286	49.286	49.286	68.727	96.829	84.976	70.782
69.76	88.961	68.347	49.286	49.286	49.286	49.286	49.286	49.286	68.716	96.818	84.965	70.771

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69.90	88.950	68.336	49.286	49.286	49.286	49.286	49.286	49.286	68.705	96.807	84.954	70.760
70.04	88.906	68.292	49.286	49.286	49.286	49.286	49.286	49.286	68.661	96.763	84.911	70.717
70.19	88.884	68.271	49.286	49.286	49.286	49.286	49.286	49.286	68.640	96.741	84.889	70.695
70.33	88.862	68.249	49.286	49.286	49.286	49.286	49.286	49.286	68.618	96.719	84.867	70.673
70.47	88.851	68.238	49.286	49.286	49.286	49.286	49.286	49.286	68.607	96.708	84.856	70.662
70.61	88.851	68.238	49.286	49.286	49.286	49.286	49.286	49.286	68.607	96.708	84.856	70.662
70.76	88.818	68.205	49.286	49.286	49.286	49.286	49.286	49.286	68.574	96.675	84.824	70.630
70.90	88.807	68.195	49.286	49.286	49.286	49.286	49.286	49.286	68.563	96.664	84.813	70.619
71.04	88.807	68.195	49.286	49.286	49.286	49.286	49.286	49.286	68.563	96.664	84.813	70.619
71.18	88.796	68.184	49.286	49.286	49.286	49.286	49.286	49.286	68.552	96.653	84.802	70.608
71.33	88.763	68.151	49.286	49.286	49.286	49.286	49.286	49.286	68.520	96.620	84.769	70.575
71.47	88.763	68.151	49.286	49.286	49.286	49.286	49.286	49.286	68.520	96.620	84.769	70.575
71.61	88.763	68.151	49.286	49.286	49.286	49.286	49.286	49.286	68.520	96.620	84.769	70.575
71.75	88.731	68.118	49.286	49.286	49.286	49.286	49.286	49.286	68.487	96.588	84.737	70.543
71.90	88.698	68.086	49.286	49.286	49.286	49.286	49.286	49.286	68.454	96.555	84.704	70.510
72.04	88.687	68.075	49.286	49.286	49.286	49.286	49.286	49.286	68.444	96.544	84.693	70.499
72.18	88.676	68.064	49.286	49.286	49.286	49.286	49.286	49.286	68.433	96.533	84.682	70.488
72.33	88.654	68.042	49.286	49.286	49.286	49.286	49.286	49.286	68.411	96.511	84.661	70.466
72.47	88.643	68.031	49.286	49.286	49.286	49.286	49.286	49.286	68.400	96.500	84.650	70.455
72.61	88.643	68.031	49.286	49.286	49.286	49.286	49.286	49.286	68.400	96.500	84.650	70.455
72.75	88.632	68.020	49.286	49.286	49.286	49.286	49.286	49.286	68.389	96.489	84.639	70.445
72.90	88.621	68.009	49.286	49.286	49.286	49.286	49.286	49.286	68.378	96.478	84.628	70.434
73.04	88.577	67.966	49.286	49.286	49.286	49.286	49.286	49.286	68.335	96.434	84.584	70.390
73.18	88.544	67.933	49.286	49.286	49.286	49.286	49.286	49.286	68.302	96.401	84.552	70.358
73.32	88.489	67.879	49.286	49.286	49.286	49.286	49.286	49.286	68.248	96.346	84.497	70.303
73.47	88.489	67.879	49.286	49.286	49.286	49.286	49.286	49.286	68.248	96.346	84.497	70.303
73.61	88.468	67.857	49.286	49.286	49.286	49.286	49.286	49.286	68.226	96.325	84.476	70.281
73.75	88.457	67.846	49.286	49.286	49.286	49.286	49.286	49.286	68.215	96.314	84.465	70.270
73.89	88.435	67.824	49.286	49.286	49.286	49.286	49.286	49.286	68.193	96.292	84.443	70.249
74.04	88.435	67.824	49.286	49.286	49.286	49.286	49.286	49.286	68.193	96.292	84.443	70.249
74.18	88.424	67.814	49.286	49.286	49.286	49.286	49.286	49.286	68.182	96.281	84.432	70.238
74.32	88.391	67.781	49.286	49.286	49.286	49.286	49.286	49.286	68.150	96.248	84.399	70.205
74.47	88.380	67.770	49.286	49.286	49.286	49.286	49.286	49.286	68.139	96.237	84.388	70.194
74.61	88.380	67.770	49.286	49.286	49.286	49.286	49.286	49.286	68.139	96.237	84.388	70.194
74.75	88.380	67.770	49.286	49.286	49.286	49.286	49.286	49.286	68.139	96.237	84.388	70.194
74.89	88.314	67.705	49.286	49.286	49.286	49.286	49.286	49.286	68.074	96.171	84.323	70.129
75.04	88.314	67.705	49.286	49.286	49.286	49.286	49.286	49.286	68.074	96.171	84.323	70.129
75.18	88.248	67.639	49.286	49.286	49.286	49.286	49.286	49.286	68.008	96.105	84.258	70.064
75.32	88.227	67.618	49.286	49.286	49.286	49.286	49.286	49.286	67.986	96.084	84.236	70.042
75.46	88.216	67.607	49.286	49.286	49.286	49.286	49.286	49.286	67.976	96.073	84.225	70.031
75.61	88.205	67.596	49.286	49.286	49.286	49.286	49.286	49.286	67.965	96.062	84.214	70.020
75.75	88.172	67.563	49.286	49.286	49.286	49.286	49.286	49.286	67.932	96.029	84.182	69.987
75.89	88.172	67.563	49.286	49.286	49.286	49.286	49.286	49.286	67.932	96.029	84.182	69.987
76.03	88.161	67.552	49.286	49.286	49.286	49.286	49.286	49.286	67.921	96.018	84.171	69.977
76.18	88.161	67.552	49.286	49.286	49.286	49.286	49.286	49.286	67.921	96.018	84.171	69.977
76.32	88.161	67.552	49.286	49.286	49.286	49.286	49.286	49.286	67.921	96.018	84.171	69.977
76.46	88.150	67.541	49.286	49.286	49.286	49.286	49.286	49.286	67.910	96.007	84.160	69.966
76.60	88.139	67.531	49.286	49.286	49.286	49.286	49.286	49.286	67.899	95.996	84.149	69.955
76.75	88.106	67.498	49.286	49.286	49.286	49.286	49.286	49.286	67.867	95.963	84.116	69.922
76.89	88.062	67.454	49.286	49.286	49.286	49.286	49.286	49.286	67.823	95.919	84.073	69.879
77.03	88.062	67.454	49.286	49.286	49.286	49.286	49.286	49.286	67.823	95.919	84.073	69.879
77.18	88.051	67.443	49.286	49.286	49.286	49.286	49.286	49.286	67.812	95.908	84.062	69.868
77.32	87.942	67.335	49.286	49.286	49.286	49.286	49.286	49.286	67.703	95.799	83.953	69.759
77.46	87.931	67.324	49.286	49.286	49.286	49.286	49.286	49.286	67.693	95.788	83.942	69.748
77.60	87.898	67.291	49.286	49.286	49.286	49.286	49.286	49.286	67.660	95.755	83.910	69.715

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77.75	87.887	67.280	49.286	49.286	49.286	49.286	49.286	49.286	67.649	95.744	83.899	69.704
77.89	87.887	67.280	49.286	49.286	49.286	49.286	49.286	49.286	67.649	95.744	83.899	69.704
78.03	87.843	67.237	49.286	49.286	49.286	49.286	49.286	49.286	67.606	95.700	83.855	69.661
78.17	87.810	67.204	49.286	49.286	49.286	49.286	49.286	49.286	67.573	95.667	83.822	69.628
78.32	87.799	67.193	49.286	49.286	49.286	49.286	49.286	49.286	67.562	95.656	83.812	69.617
78.46	87.799	67.193	49.286	49.286	49.286	49.286	49.286	49.286	67.562	95.656	83.812	69.617
78.60	87.755	67.150	49.286	49.286	49.286	49.286	49.286	49.286	67.518	95.612	83.768	69.574
78.74	87.503	66.899	49.286	49.286	49.286	49.286	49.286	49.286	67.268	95.360	83.518	69.324
78.89	87.492	66.888	49.286	49.286	49.286	49.286	49.286	49.286	67.257	95.349	83.507	69.313
79.03	87.492	66.888	49.286	49.286	49.286	49.286	49.286	49.286	67.257	95.349	83.507	69.313
79.17	87.427	66.823	49.286	49.286	49.286	49.286	49.286	49.286	67.192	95.284	83.441	69.247
79.32	87.405	66.801	49.286	49.286	49.286	49.286	49.286	49.286	67.170	95.262	83.420	69.226
79.46	87.405	66.801	49.286	49.286	49.286	49.286	49.286	49.286	67.170	95.262	83.420	69.226
79.60	87.372	66.769	49.286	49.286	49.286	49.286	49.286	49.286	67.137	95.229	83.387	69.193
79.74	87.251	66.649	49.286	49.286	49.286	49.286	49.286	49.286	67.018	95.108	83.267	69.073
79.89	87.229	66.627	49.286	49.286	49.286	49.286	49.286	49.286	66.996	95.086	83.246	69.051
80.03	87.197	66.595	49.286	49.286	49.286	49.286	49.286	49.286	66.963	95.054	83.213	69.019
80.17	87.197	66.595	49.286	49.286	49.286	49.286	49.286	49.286	66.963	95.054	83.213	69.019
80.31	87.131	66.529	49.286	49.286	49.286	49.286	49.286	49.286	66.898	94.988	83.148	68.953
80.46	87.120	66.518	49.286	49.286	49.286	49.286	49.286	49.286	66.887	94.977	83.137	68.943
80.60	87.076	66.475	49.286	49.286	49.286	49.286	49.286	49.286	66.844	94.933	83.093	68.899
80.74	87.032	66.431	49.286	49.286	49.286	49.286	49.286	49.286	66.800	94.889	83.050	68.855
80.88	86.956	66.355	49.286	49.286	49.286	49.286	49.286	49.286	66.724	94.813	82.973	68.779
81.03	86.956	66.355	49.286	49.286	49.286	49.286	49.286	49.286	66.724	94.813	82.973	68.779
81.17	86.923	66.322	49.286	49.286	49.286	49.286	49.286	49.286	66.691	94.780	82.941	68.747
81.31	86.891	66.290	49.286	49.286	49.286	49.286	49.286	49.286	66.659	94.747	82.908	68.714
81.46	86.869	66.268	49.286	49.286	49.286	49.286	49.286	49.286	66.637	94.725	82.886	68.692
81.60	86.858	66.257	49.286	49.286	49.286	49.286	49.286	49.286	66.626	94.714	82.876	68.681
81.74	86.858	66.257	49.286	49.286	49.286	49.286	49.286	49.286	66.626	94.714	82.876	68.681
81.88	86.847	66.246	49.286	49.286	49.286	49.286	49.286	49.286	66.615	94.703	82.865	68.670
82.03	86.815	66.214	49.286	49.286	49.286	49.286	49.286	49.286	66.582	94.670	82.832	68.638
82.17	86.804	66.203	49.286	49.286	49.286	49.286	49.286	49.286	66.572	94.659	82.821	68.627
82.31	86.760	66.159	49.286	49.286	49.286	49.286	49.286	49.286	66.528	94.615	82.778	68.583
82.45	86.760	66.159	49.286	49.286	49.286	49.286	49.286	49.286	66.528	94.615	82.778	68.583
82.60	86.738	66.137	49.286	49.286	49.286	49.286	49.286	49.286	66.506	94.593	82.756	68.562
82.74	86.695	66.094	49.286	49.286	49.286	49.286	49.286	49.286	66.463	94.550	82.712	68.518
82.88	86.673	66.072	49.286	49.286	49.286	49.286	49.286	49.286	66.441	94.528	82.690	68.496
83.02	86.630	66.029	49.286	49.286	49.286	49.286	49.286	49.286	66.397	94.484	82.647	68.453
83.17	86.619	66.018	49.286	49.286	49.286	49.286	49.286	49.286	66.386	94.473	82.636	68.442
83.31	86.586	65.985	49.286	49.286	49.286	49.286	49.286	49.286	66.354	94.440	82.603	68.409
83.45	86.542	65.941	49.286	49.286	49.286	49.286	49.286	49.286	66.310	94.396	82.560	68.366
83.59	86.532	65.931	49.286	49.286	49.286	49.286	49.286	49.286	66.299	94.385	82.549	68.355
83.74	86.445	65.843	49.286	49.286	49.286	49.286	49.286	49.286	66.212	94.298	82.462	68.268
83.88	86.434	65.833	49.286	49.286	49.286	49.286	49.286	49.286	66.201	94.287	82.451	68.257
84.02	86.423	65.822	49.286	49.286	49.286	49.286	49.286	49.286	66.191	94.276	82.440	68.246
84.17	86.401	65.800	49.286	49.286	49.286	49.286	49.286	49.286	66.169	94.254	82.418	68.224
84.31	86.390	65.789	49.286	49.286	49.286	49.286	49.286	49.286	66.158	94.243	82.407	68.213
84.45	86.390	65.789	49.286	49.286	49.286	49.286	49.286	49.286	66.158	94.243	82.407	68.213
84.59	86.172	65.571	49.286	49.286	49.286	49.286	49.286	49.286	65.940	94.024	82.190	67.996
84.74	86.162	65.561	49.286	49.286	49.286	49.286	49.286	49.286	65.929	94.013	82.179	67.985
84.88	86.118	65.517	49.286	49.286	49.286	49.286	49.286	49.286	65.886	93.969	82.135	67.941
85.02	86.064	65.463	49.286	49.286	49.286	49.286	49.286	49.286	65.831	93.914	82.081	67.887
85.16	86.064	65.463	49.286	49.286	49.286	49.286	49.286	49.286	65.831	93.914	82.081	67.887
85.31	86.053	65.452	49.286	49.286	49.286	49.286	49.286	49.286	65.820	93.903	82.070	67.876
85.45	86.031	65.430	49.286	49.286	49.286	49.286	49.286	49.286	65.799	93.881	82.048	67.854

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85.59	85.987	65.386	49.286	49.286	49.286	49.286	49.286	49.286	65.755	93.837	82.005	67.811
85.73	85.955	65.354	49.286	49.286	49.286	49.286	49.286	49.286	65.723	93.804	81.972	67.778
85.88	85.857	65.256	49.286	49.286	49.286	49.286	49.286	49.286	65.625	93.706	81.874	67.680
86.02	85.835	65.234	49.286	49.286	49.286	49.286	49.286	49.286	65.603	93.684	81.852	67.658
86.16	85.824	65.223	49.286	49.286	49.286	49.286	49.286	49.286	65.592	93.673	81.841	67.647
86.31	85.781	65.180	49.286	49.286	49.286	49.286	49.286	49.286	65.548	93.629	81.798	67.604
86.45	85.770	65.169	49.286	49.286	49.286	49.286	49.286	49.286	65.537	93.618	81.787	67.593
86.59	85.748	65.147	49.286	49.286	49.286	49.286	49.286	49.286	65.516	93.596	81.765	67.571
86.73	85.704	65.103	49.286	49.286	49.286	49.286	49.286	49.286	65.472	93.552	81.722	67.528
86.88	85.693	65.092	49.286	49.286	49.286	49.286	49.286	49.286	65.461	93.541	81.711	67.517
87.02	85.693	65.092	49.286	49.286	49.286	49.286	49.286	49.286	65.461	93.541	81.711	67.517
87.16	85.683	65.082	49.286	49.286	49.286	49.286	49.286	49.286	65.450	93.531	81.700	67.506
87.30	85.617	65.016	49.286	49.286	49.286	49.286	49.286	49.286	65.385	93.465	81.635	67.441
87.45	85.606	65.005	49.286	49.286	49.286	49.286	49.286	49.286	65.374	93.454	81.624	67.430
87.59	85.530	64.929	49.286	49.286	49.286	49.286	49.286	49.286	65.298	93.377	81.548	67.353
87.73	85.519	64.918	49.286	49.286	49.286	49.286	49.286	49.286	65.287	93.366	81.537	67.343
87.87	85.454	64.853	49.286	49.286	49.286	49.286	49.286	49.286	65.222	93.300	81.471	67.277
88.02	85.410	64.809	49.286	49.286	49.286	49.286	49.286	49.286	65.178	93.257	81.428	67.234
88.16	85.225	64.624	49.286	49.286	49.286	49.286	49.286	49.286	64.993	93.070	81.243	67.049
88.30	85.106	64.505	49.286	49.286	49.286	49.286	49.286	49.286	64.874	92.950	81.123	66.929
88.45	85.073	64.472	49.286	49.286	49.286	49.286	49.286	49.286	64.841	92.917	81.090	66.896
88.59	85.030	64.429	49.286	49.286	49.286	49.286	49.286	49.286	64.797	92.873	81.047	66.853
88.73	84.964	64.363	49.286	49.286	49.286	49.286	49.286	49.286	64.732	92.807	80.982	66.787
88.87	84.877	64.276	49.286	49.286	49.286	49.286	49.286	49.286	64.645	92.720	80.895	66.700
89.02	84.866	64.265	49.286	49.286	49.286	49.286	49.286	49.286	64.634	92.709	80.884	66.689
89.16	84.866	64.265	49.286	49.286	49.286	49.286	49.286	49.286	64.634	92.709	80.884	66.689
89.30	84.779	64.178	49.286	49.286	49.286	49.286	49.286	49.286	64.547	92.621	80.797	66.602
89.44	84.768	64.167	49.286	49.286	49.286	49.286	49.286	49.286	64.536	92.610	80.786	66.592
89.59	84.747	64.146	49.286	49.286	49.286	49.286	49.286	49.286	64.514	92.588	80.764	66.570
89.73	84.703	64.102	49.286	49.286	49.286	49.286	49.286	49.286	64.471	92.544	80.720	66.526
89.87	84.670	64.069	49.286	49.286	49.286	49.286	49.286	49.286	64.438	92.512	80.688	66.494
90.01	84.649	64.048	49.286	49.286	49.286	49.286	49.286	49.286	64.416	92.490	80.666	66.472
90.16	84.518	63.917	49.286	49.286	49.286	49.286	49.286	49.286	64.286	92.358	80.535	66.341
90.30	84.485	63.884	49.286	49.286	49.286	49.286	49.286	49.286	64.253	92.325	80.503	66.309
90.44	84.485	63.884	49.286	49.286	49.286	49.286	49.286	49.286	64.253	92.325	80.503	66.309
90.58	84.453	63.852	49.286	49.286	49.286	49.286	49.286	49.286	64.220	92.292	80.470	66.276
90.73	84.442	63.841	49.286	49.286	49.286	49.286	49.286	49.286	64.210	92.281	80.459	66.265
90.87	84.420	63.819	49.286	49.286	49.286	49.286	49.286	49.286	64.188	92.260	80.437	66.243
91.01	84.366	63.765	49.286	49.286	49.286	49.286	49.286	49.286	64.133	92.205	80.383	66.189
91.16	84.355	63.754	49.286	49.286	49.286	49.286	49.286	49.286	64.123	92.194	80.372	66.178
91.30	84.311	63.710	49.286	49.286	49.286	49.286	49.286	49.286	64.079	92.150	80.329	66.134
91.44	84.039	63.438	49.286	49.286	49.286	49.286	49.286	49.286	63.807	91.876	80.056	65.862
91.58	84.028	63.427	49.286	49.286	49.286	49.286	49.286	49.286	63.796	91.865	80.046	65.851
91.73	84.017	63.416	49.286	49.286	49.286	49.286	49.286	49.286	63.785	91.854	80.035	65.840
91.87	83.996	63.395	49.286	49.286	49.286	49.286	49.286	49.286	63.763	91.832	80.013	65.819
92.01	83.974	63.373	49.286	49.286	49.286	49.286	49.286	49.286	63.742	91.810	79.991	65.797
92.15	83.789	63.188	49.286	49.286	49.286	49.286	49.286	49.286	63.557	91.624	79.806	65.612
92.30	83.767	63.166	49.286	49.286	49.286	49.286	49.286	49.286	63.535	91.602	79.784	65.590
92.44	83.745	63.144	49.286	49.286	49.286	49.286	49.286	49.286	63.513	91.580	79.763	65.568
92.58	83.734	63.133	49.286	49.286	49.286	49.286	49.286	49.286	63.502	91.569	79.752	65.558
92.72	83.723	63.122	49.286	49.286	49.286	49.286	49.286	49.286	63.491	91.558	79.741	65.547
92.87	83.669	63.068	49.286	49.286	49.286	49.286	49.286	49.286	63.437	91.503	79.686	65.492
93.01	83.658	63.057	49.286	49.286	49.286	49.286	49.286	49.286	63.426	91.493	79.675	65.481
93.15	83.636	63.035	49.286	49.286	49.286	49.286	49.286	49.286	63.404	91.471	79.654	65.460
93.30	83.625	63.024	49.286	49.286	49.286	49.286	49.286	49.286	63.393	91.460	79.643	65.449

93.44	83.604	63.003	49.286	49.286	49.286	49.286	49.286	49.286	63.371	91.438	79.621	65.427
93.58	83.604	63.003	49.286	49.286	49.286	49.286	49.286	49.286	63.371	91.438	79.621	65.427
93.72	83.549	62.948	49.286	49.286	49.286	49.286	49.286	49.286	63.317	91.383	79.567	65.372
93.87	83.484	62.883	49.286	49.286	49.286	49.286	49.286	49.286	63.252	91.317	79.501	65.307
94.01	83.462	62.861	49.286	49.286	49.286	49.286	49.286	49.286	63.230	91.295	79.480	65.285
94.15	83.440	62.839	49.286	49.286	49.286	49.286	49.286	49.286	63.208	91.273	79.458	65.264
94.29	83.419	62.818	49.286	49.286	49.286	49.286	49.286	49.286	63.186	91.251	79.436	65.242
94.44	83.332	62.731	49.286	49.286	49.286	49.286	49.286	49.286	63.099	91.164	79.349	65.155
94.58	83.147	62.546	49.286	49.286	49.286	49.286	49.286	49.286	62.914	90.978	79.164	64.970
94.72	83.103	62.502	49.286	49.286	49.286	49.286	49.286	49.286	62.871	90.934	79.120	64.926
94.86	83.092	62.491	49.286	49.286	49.286	49.286	49.286	49.286	62.860	90.923	79.109	64.915
95.01	83.059	62.458	49.286	49.286	49.286	49.286	49.286	49.286	62.827	90.890	79.077	64.883
95.15	83.005	62.404	49.286	49.286	49.286	49.286	49.286	49.286	62.773	90.835	79.022	64.828
95.29	82.972	62.371	49.286	49.286	49.286	49.286	49.286	49.286	62.740	90.802	78.990	64.796
95.44	82.918	62.317	49.286	49.286	49.286	49.286	49.286	49.286	62.686	90.747	78.935	64.741
95.58	82.864	62.263	49.286	49.286	49.286	49.286	49.286	49.286	62.631	90.693	78.881	64.687
95.72	82.450	61.849	49.286	49.286	49.286	49.286	49.286	49.286	62.218	90.276	78.467	64.273
95.86	82.308	61.707	49.286	49.286	49.286	49.286	49.286	49.286	62.076	90.134	78.326	64.132
96.01	82.145	61.544	49.286	49.286	49.286	49.286	49.286	49.286	61.913	89.969	78.163	63.968
96.15	81.927	61.326	49.286	49.286	49.286	49.286	49.286	49.286	61.695	89.750	77.945	63.751
96.29	81.862	61.261	49.286	49.286	49.286	49.286	49.286	49.286	61.630	89.685	77.880	63.685
96.43	81.449	60.848	49.286	49.286	49.286	49.286	49.286	49.286	61.216	89.268	77.466	63.272
96.58	81.394	60.793	49.286	49.286	49.286	49.286	49.286	49.286	61.162	89.213	77.412	63.217
96.72	81.383	60.782	49.286	49.286	49.286	49.286	49.286	49.286	61.151	89.202	77.401	63.206
96.86	81.361	60.760	49.286	49.286	49.286	49.286	49.286	49.286	61.129	89.181	77.379	63.185
97.00	81.253	60.652	49.286	49.286	49.286	49.286	49.286	49.286	61.020	89.071	77.270	63.076
97.15	81.176	60.575	49.286	49.286	49.286	49.286	49.286	49.286	60.944	88.994	77.194	63.000
97.29	80.959	60.358	49.286	49.286	49.286	49.286	49.286	49.286	60.727	88.775	76.976	62.782
97.43	80.839	60.238	49.286	49.286	49.286	49.286	49.286	49.286	60.607	88.655	76.856	62.662
97.57	80.828	60.227	49.286	49.286	49.286	49.286	49.286	49.286	60.596	88.644	76.846	62.651
97.72	80.752	60.151	49.286	49.286	49.286	49.286	49.286	49.286	60.520	88.567	76.769	62.575
97.86	80.513	59.911	49.286	49.286	49.286	49.286	49.286	49.286	60.280	88.326	76.530	62.336
98.00	80.317	59.716	49.286	49.286	49.286	49.286	49.286	49.286	60.084	88.129	76.334	62.140
98.15	80.164	59.563	49.286	49.286	49.286	49.286	49.286	49.286	59.932	87.975	76.182	61.987
98.29	79.859	59.258	49.286	49.286	49.286	49.286	49.286	49.286	59.627	87.669	75.877	61.683
98.43	79.761	59.160	49.286	49.286	49.286	49.286	49.286	49.286	59.529	87.570	75.779	61.585
98.57	79.446	58.845	49.286	49.286	49.286	49.286	49.286	49.286	59.214	87.252	75.463	61.269
98.72	78.325	57.724	49.286	49.286	49.286	49.286	49.286	49.286	58.093	86.130	74.342	60.148
98.86	77.889	57.288	49.286	49.286	49.286	49.286	49.286	49.286	57.657	85.694	73.907	59.713
99.00	77.563	56.962	49.286	49.286	49.286	49.286	49.286	49.286	57.331	85.368	73.580	59.386
99.14	77.356	56.755	49.286	49.286	49.286	49.286	49.286	49.286	57.124	85.161	73.373	59.179
99.29	75.669	55.068	49.286	49.286	49.286	49.286	49.286	49.286	55.437	83.474	71.686	57.492
99.43	74.744	54.143	49.286	49.286	49.286	49.286	49.286	49.286	54.512	82.549	70.761	56.567
99.57	74.254	53.653	49.286	49.286	49.286	49.286	49.286	49.286	54.022	82.059	70.271	56.077
99.71	73.253	52.652	49.286	49.286	49.286	49.286	49.286	49.286	53.020	81.058	69.270	55.076
99.86	73.133	52.532	49.286	49.286	49.286	49.286	49.286	49.286	52.901	80.938	69.150	54.956