49
37

Water Management for Lowland Rice Irrigation

by

Fathima Zeena Siddeek

Dissertation submitted to the Faculty of the

Virginia Polytechnic Institute and State University

in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

in

Agricultural Engineering

APPROVED:

T.A. Dillaha, Chairman

V.O. Shanholtz.

S. Mostaghimi

J.V. Perumpral

G.V. Loganathan

B.B. Ross

September, 1986

Blacksburg, Virginia

Water Management for Lowland Rice Irrigation

by

Fathima Zeena Siddeek

T.A. Dillaha, Chairman

Agricultural Engineering

(ABSTRACT)

A procedure was developed to estimate optimum irrigation requirements for lowland rice cultivation in Southeast Asia. The procedure uses a water balance equation of semi-stochastic nature to maintain minimum desired water depths in paddy fields at the end of each irrigation period. The procedure estimates weekly pan evaporation (EV) and rainfall (RF) at different probability levels, which is then used to determine weekly irrigation requirements at different probability levels.

To illustrate the use of the method, the Kalawewa irrigation scheme in Sri Lanka was selected for demonstration purposes. Different transformations were applied to RF and EV data in an attempt to normalize these variates and to obtain a unique distribution to describe their variations. Statistical analysis of weekly EV and RF showed that the power transformation was best able to transform the weekly RF and EV data to normality.

Comparison of the use of the model and current system practices showed that a significant amount of water could be saved even when the system was operated at high probability levels (90% reliability). The irrigation water required when the system was operated at the 72% probability level was about 21% less than the amount required when the system was operated at 90% probability level during some weeks.

The EXTRAN flow routing model was used to simulate water flow in the upper reaches of the main canal system for varying discharges at the head gate each day. The simulated water depths were used to determine the gate settings required at the turnout structures to divert the desired amount of irrigation water into the turnout areas.

The flow simulation for the demonstration area, showed that it was not possible to regulate irrigation water from the main reservoir to meet daily demands at all the turnouts. This

was due to the large distances between the regulating reservoir and turnouts that caused appreciable time lag for the flow to reach the turnouts farthest from the regulating reservoir.

Acknowledgements

During this study, I have received guidance and support from my graduate committe chairman, Dr. T.A Dillaha, without whom this work would have been impossible. My sincere appreciation to Dr. Dillaha, for his continued support, assistance and guidance during the years of my study and for providing shelter in his residence during the latter part of this work. His suggestions have greatly contributed to improvement of this dissertation.

I acknowledge Dr. V. O. Shanholtz, Dr. S. Mostaghimi, Dr. G. V. Loganathan, Dr. J. V. Perumpral and Dr. B. B. Ross, committee members, for their technical guidance. I wish to extend my appreciation to former graduate committee chairman, Dr. William L. Magette for his support during the first year of my graduate studies at Virginia Tech.

I would also like to thank Dr. Howard Massey, Director of International Studies, who provided financial assistance during part of my study.

I am deeply grateful to my parents, who have supported me in each of my decisions and in their own unique ways, encouraged me to reach out in life for the impossible dreams. Many thanks are due to my brother, and sisters, and who offered continued encouragement over the past years. Last but not least, I acknowledge my husband, for his encouragement and statistical consultation services.

Table of Contents

List of Tables

List of Figures

chapter 1

Introduction

Rice is the principal staple food for more than 40 percent of the world's population. It is the staple food for more than 90 percent of the population of Bangaladesh, Burma, Vietnam, Kampuchea and Sri Lanka and for more than 60 percent of the population in many other Far East and Southeast Asian countries (De Datta, 1981). In the Far East and Southeast Asia, rice production has been a major undertaking throughout most of recorded history.

In many countries in this region where rice is the staple food, its production has not increased as fast as the growth of the population. In most of these countries, increased food production will depend mostly on an increase in the yield per hectare and the number of crops produced per year (Zandstra, 1980). Therefore, research methods that increase annual output per unit area should continue.

1.1 Lowland Rice, Characteristics and Production

Unlike most other agricultural crops, the rice plant has the ability to thrive under moderately flooded conditions without suppressing its growth or grain production. This unique property of the rice plant has allowed its production under climatic and soil conditions that are unsuitable for other crops.

The rice plant is similar to grass with rather flat leaves and panicles at the end of branches. The rice plant is characterized by a fibrous shallow rooting system and therefore, relies on the uppermost portion of the soil profile for moisture. This is the area most susceptible to water loss from evaporation, so the soil surface must be saturated for the rice crop to survive (Moorman and van Beeman, 1978).

The ability of the rice plant to grow under inundated conditions permits level basin irrigation to be practiced. Level basin irrigation consists of smoothing the land and surrounding various sized fields with low dikes. This method has many advantages. Since paddy fields are surrounded with dikes, flooding can be achieved by applying the desired amount of water and there is little or no runoff. Where the terrain is sloping it is necessary to construct terraces and levees around each field. These practices greatly decrease the erosion hazard on sloping land and permit the flooding required for rice production.

Flooding the rice fields improves growth and produces higher grain yields than when rice is grown under non-flooded conditions. Flooding affects the physical character of the rice plant and the extent of weed growth. The height of the plant is directly related to the depth of water in the field while tiller number appears to be inversely related to water depth.

Water depth in the field also has a significant impact on the amount and type of weeds. When established, weeds compete with the crop for nutrients and space. Flooding during the early stages of crop growth has been found to be very effective for weed control. Later flooding is much less effective because as weeds become established they are much more difficult to control.

In many cases, the only water loss is evapotranspiration. Seepage and percolation losses are normally small for the types of soils used for rice cultivation. Labor requirements are relatively low and rainfall can be used efficiently, if managed properly, since there is little opportunity for runoff from fields enclosed by dikes.

In general, rice fields are located in alluvial areas where silt, clay and other adsorbed phases are deposited from the uplands. Soils most suitable for rice production generally have lighter textured surface layers which are underlain by dense, very slowly permeable clay. Soils with good drainage and permeability are normally considered poor for rice because they require excessive irrigation water due to high percolation losses.

Since rice is considered to be moderately salt tolerant, soil salinity has not been an important factor for rice production. Saline soils which are detrimental to other crops have been found to be suitable for rice production.

1.2 Effects of Climate on Rice Production

Rice is classified as a tropical crop because warm temperatures are critical for its production. Temperature greatly influences its growth pattern and length of the growing season for the rice plant. In general, low temperatures prolong the growth period of the crop and excessively low temperatures may damage the crop. The optimum temperature for the crop depends on the location. Southeast Asia is located in the tropics near the equator where the temperature varies little throughout the year. This is favorable for year round rice cultivation but since relatively lower temperatures are desirable during the ripening stage to extend the ripening period to allow more time for grain filling, optimum yields are not obtained in this region. This is one reason why grain yields are higher in temperate regions (eg. Japan and Spain) than in tropical regions.

The intensity of solar radiation affects rice cultivation and subsequent grain yield, with high solar radiation resulting in increased grain yields. Solar radiation is influenced by cloudiness and is therefore, lower in the rainy season than in the dry season. In general, rice yields are higher for the dry season crop than for the wet season crop if water supply is not limiting (Wickham and Sen 1978). Since all other climatic factors are essentially the same during both seasons, the difference in yields must be due to the higher intensity of solar radiation during the dry season. This is unfortunate with respect to rice cultivation in Southeast Asia because water supply is most favorable during the wet season when solar radiation is least favorable and yields therefore, do not achieve their true potentials.

The climate of Southeast Asia is tropical monsoon and characterized by monsoon rains. Changes in the monsoons cause distinct wet and dry seasons. Some Southeast Asian countries, notably, India, Burma and Sri Lanka, have tropical wet-dry climates which are characterized by a dry season with moderate rainfall and a wet season with heavy rainfall. Rainfall patterns in these regions are such that rain falls intensely for about half the year and the rest of the year is relatively dry.

In many rice growing areas, the year is divided into distinct wet and dry seasons. Most of the rice produced in these regions is grown in the wet seasons. In certain areas, depending on the availability of water, two rice crops per year are possible. In such areas, the wet season crop is heavily dependent on rainfall and requires only limited supplemental irrigation while the dry season crop is totally dependent on irrigation because it receives very little rainfall.

Many rice growing countries in Southeast Asia receive about 2,000 mm of rainfall annually. This would be adequate for two rice crops if the rainfall were more equally distributed between the monsoon seasons. Unfortunately, most rainfall is concentrated during the wet season. Variability in rainfall even within the wet season is such that rainfall is often inadequate or excessive during the growing season and irrigation is indispensable for a successful crop. For continuous rice production, rainfall is the single most important factor limiting production (Wickham and Valera, 1978).

1.3 Irrigation Demands

Irrigation is the water supplied to the crop to supplement rainfall. Irrigation plays an important role in rice production in Southeast Asia where temperatures are favorable for crop production throughout the year. Development of irrigation systems have dramatically increased cropping intensity where rainfall was seasonal or otherwise inadequate. Insufficient irrigation water however, is known to limit the area in which rice can be cultivated. The problem of insufficient irrigation water can be alleviated by using the available water more efficiently and maximizing the use of rainfall.

Studies of water requirement for rice with supplementary irrigation indicate water use efficiencies as low as 30% in areas that are well supplied with water (Kampen, 1970). Wickham and Valera (1978) reported that surface drainage often exceeded 50% of total water supply, for rice fields during the wet season in the Philippines. He also observed that reducing surface drainage losses offers the greatest opportunity for increasing water use efficiency.

The low water use efficiencies of present systems emphasize the tremendous potential to improve water management. Since irrigation accounts for 50 percent of the world's rice production (De Datta, 1981), expanded research is critically needed in this area.

Water allocation in an irrigation system is a complex problem; at each stage of crop growth one must determine whether or not to irrigate and how much water is required at each growth stage to meet the optimum growth requirement. The problem is further complicated by the randomness and non-stationarity of rainfall, and the variability of crop evapotranspiration (ET). Irrigation requirement estimates have often been based on average ET values recorded for an area and often disregard rainfall. Data on climatic variables such as rainfall and ET in a season are not typically used for estimating the irrigation requirement of rice in the humid tropics.

Effective rainfall, which is total rainfall minus rainfall that cannot be stored or used in rice production, is useful for determining plant water use requirements (Wickham and Valera, 1978). Effective use of rainfall is necessary to conserve supplemental irrigation water. Effective use of rainfall necessitates management decisions to capture and store as much rainfall as possible within the field. This can be done by reducing appropriately the supplemental irrigation, to provide more storage capacity within the fields for rainfall.

Because of the uncertainty in the amount and distribution of rainfall, farmers try to store as much water as possible in the fields whenever possible with dikes. Supplemental irrigation is used to "top off" the fields so that there is little additional available storage capacity to capture natural rainfall. This nullifies the effective use of rainwater since once the available storage capacity is filled, subsequent rainfall is lost through drainage.

If the irrigation requirement can be estimated by accounting for the rainfall that can be expected to occur in the future, significant amount of water can be saved by making maximum use of expected rainfall. An estimate of the amount of irrigation required during the growing season is therefore, an important factor in planning supplemental irrigation. Because of the variable nature of rainfall and evapotranspiration, irrigation requirements estimated this way, must be interpreted in a probabilistic sense. Based on assumed probability distributions, it is possible to make probability statements concerning irrigation requirements for optimum use of rainfall.

1.4 Irrigation Conveyance Systems

In the recent past, in Southeast Asia, the growth of irrigation has been very rapid, however, little attention has been devoted to long-term issues such as system management and efficient utilization of existing water resources. The need for improvement in irrigation system management is apparent in studies from the Philippines showing on farm water use efficiencies of only 38 percent in the wet season and 68 percent in the dry season (Levine and Wickham, 1977).

Irrigation conveyance systems are an integral part of the total irrigation system. Southeast Asian irrigation systems are predominantly gravity irrigation systems in which water flows freely from the main and branch canals to distributary channels and into field channels. Irrigation water supply is rather excessive, and water control is relatively weak. When excess water is released into the canals and fields, there is no alternative but for it to be lost to drainage. Flooded rice fields can hold only a limited amount of water beyond which all excess will drain from the fields. Therefore, more stringent management of conveyance systems is necessary for optimum water use efficiencies. As irrigation needs vary, the conveyance system must be able to respond to changing demands.

1.5 Research objectives

This study focuses on management issues such as the timing and the amount of water that must be supplied to satisfy changing crop demands, to be estimated from probabilities of irrigation requirements. Timing and amount of water supply is to be done via hydraulic flow routing in the conveyance system with computer modeling techniques. Water flow in the canal is simulated for the estimated volume of water needed for the recommended cropping schedule during the growing season.

The goal of this research is to develop a water management system to improve water use efficiencies in irrigated lowland rice production in Southeast Asia. In order to achieve the above goal, the following specific objectives were pursued:

1. Develop an irrigation scheduling method for lowland rice in Southeast Asia which makes maximum use of rainfall

2. Present an irrigation canal conveyance model for canal system design and management.

3. Illustrate the usefulness of the irrigation scheduling method and conveyance model for irrigation management on an irrigation system in Sri Lanka.

chapter 2

Literature Review

The literature review is divided into five sections. The first section is devoted to the cultural practices and the water requirements of the rice crop. Section two deals with water balance models used for rice research highlighting the ways in which the components of the water balance models are handled in different cases. The third section deals with methods for determining evapotranspiration. Widely accepted methods of estimating evapotranspiration and a few other methods that have been proposed for upland crops are summarized. Section four covers stochastic methods used by researchers to determine irrigation requirements for different crops around the world. The last section presents a brief discussion of the use of canal models in irrigation system design and management.

2.1 Cultural Practices and Water Requirement of Rice

2.1.1 Cultural Practices

2.1.1.1 Land Preparation

Successful rice cultivation requires that residual organic matter be converted into humus by incorporation into the soil. In Southeast Asian countries, this incorporation of organic matter is traditionally accomplished by plowing the field mechanically, manually or using animal power. To facilitate plowing, the land is initially soaked until the plow layer is saturated. Since plowing is done between the harvest of one crop and planting of the next, large quantities of water are required to maintain the fields in a moist tillable condition.

Through plowing, a deep tillage process organic residue from previous crops are incorporated into the soil and soil aggregates are broken down into a homogeneous material. Puddling, a shallow tillage process, follows plowing and is used to level the field and to reduce soil permeability. This initial decrease in permeability, may be appreciable and continue for a long period of time.

Important benefits which are associated with puddling include, lower percolation losses due to reduced permeability, improved smoothing of the land surface for transplanting, and eradication of weeds. Transplanting is initiated as soon as land preparation is complete.

Land preparation, as practiced in much of Southeast Asia, is a labor intensive operation. The time and duration of land preparation is a critical factor for the growth and yield of rice because early planting dates increase the chances of avoiding late-season drought (De Datta, 1981).

The total amount of water needed for land preparation depends on the soil type, its water holding capacity and the type of land preparation. It is estimated that land preparation uses one third of the total water required for a rice crop (Valera and Wickham, 1978). During land preparation, water is lost due to evaporation from the wetted fields, seepage and percolation beyond the root zone.

As indicated, the water requirement is heavily dependent on the duration of land preparation. The duration of land preparation, varies between 3-8 weeks, depending on the supply of water and available labor. Normally 400-800 mm of water is required for the whole operation. But in many cases, savings of up to 150 mm of water lost by evaporation could be achieved by reducing land preparation time to 5 weeks.

2.1.1.2 *Crop Establishment*

Crop establishment for lowland rice is accomplished either by transplanting seedlings raised in seedbeds, or by broadcasting pre germinated seeds directly into the puddled fields. Both methods are commonly used in Southeast Asia.

Transplanting is preferred in some areas because it provides better root anchorage and establishment with the soil. For rainfed culture, the onset of monsoon is the primary factor determining the date of sowing. In the case of irrigated rice, sowing can be done at any time of the year. In Sri Lanka, sowing starts in mid September during the wet season (Maha season) and mid April during the dry season (Yala season), but the advent of rains and amount of rainfall determine actual sowing dates.

For transplanted rice, seedlings are established in seed beds by broadcasting. The soil in the seed bed is brought to saturation for germination by flooding the field to shallow depths and then draining off the excess water. The seedlings are then transplanted to production fields 30-40 days later. One hundred and fifty to 200 mm of water are usually required during the nursery stage.

2.1.2 Water Requirements of Rice

2.1.2.1 Rice Growth Stages

For water management purposes, the development of the rice plant can be divided into three main phases (De Datta, 1981):

1. the vegetative phase, which runs from germination to panicle initiation,

2. the reproductive stage, which runs from panicle initiation to flowering, and

3. a ripening phase, which runs from flowering to maturity.

For the rice varieties commonly grown in the tropics, the first leaf comes out of the seed three days after sowing. Roots develop during the time between the first emergence of the leaf and appearance of the first tiller (De Datta, 1981). Leaves continue to develop at a rate of one every three or four days during the early stages.

The reproductive growth stage begins with primitive panicle development when maximum tiller production is complete. Panicle initiation begins approximately 40 days after seeding pre germinated seeds for short duration rice varieties (105 days from seed to maturity) (De Datta, 1981). In long duration varieties (135-160 days), panicle initiation begins only after the stems elongate considerably. Panicles continue to develop and flowering occurs 25 days after panicle initiation.

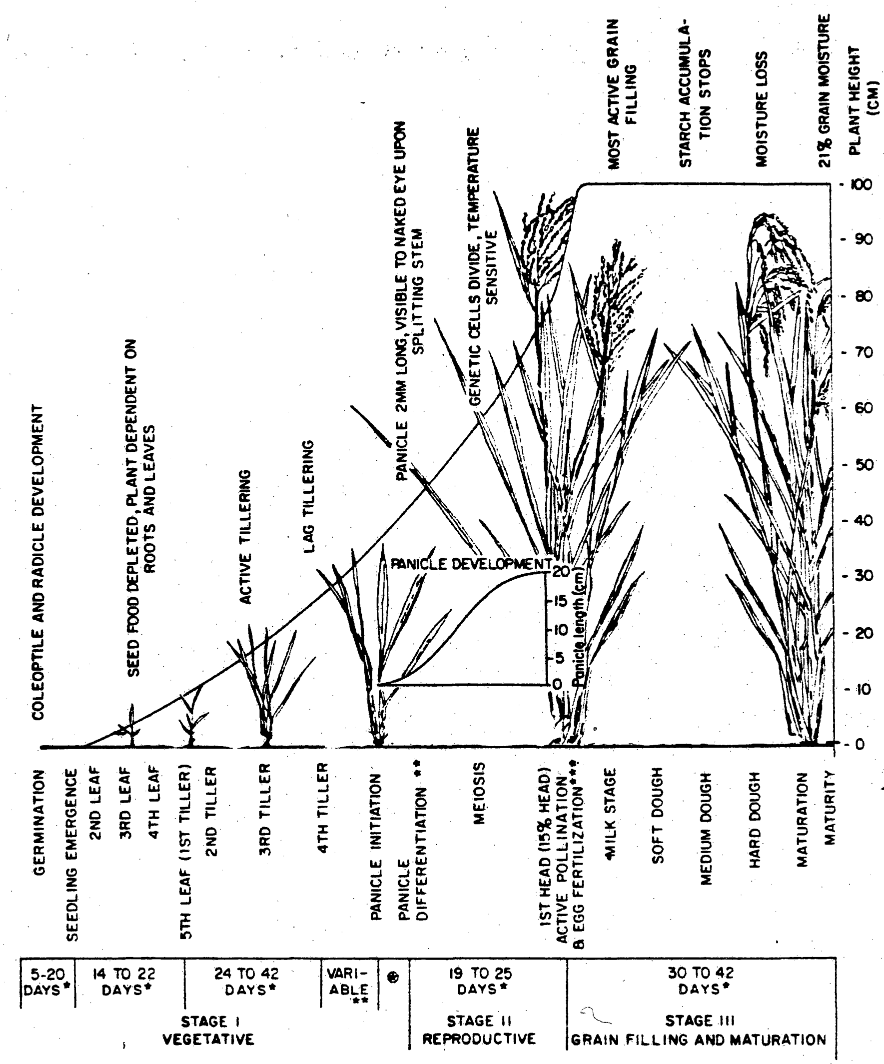
The ripening phase begins with the development of grains after pollination of the florets. Grain development undergoes characteristic changes before full maturity. In general, the ripening stage takes 25-35 days in the tropics, regardless of the variety (De Datta, 1981). In temperate regions, owing to lower temperatures, the ripening stage is prolonged, allowing more time for grain filling and higher grain yields than in the tropics. Figure 2.1 shows the rice growth stages and the height of the plant at different stages.

2.1.2.2 Water Use

Lowland rice culture adapted to tropical monsoon climatic conditions is grown under flooded conditions during the major part of the crop's development period. Rice grown in this way produce higher yields than those of any other type of rice cultivation. New varieties and the use of fertilizer have increased yields, but adequate water management is essential to achieve potential yileds. The salient feature of lowland rice is the maintenance of a layer of water on the field throughout the growing period of the crop. It would seem logical therefore, to assume that there is some optimum depth of water. This depth could be different for different varieties and different stage of the crop.

Experiments in the Philippines indicate that continuous flooding is not essential for high grain yields and that improved rice varieties can tolerate up to 15 cm of water. The presence of a water layer, however, is found to have the advantages of weed control, higher efficiency of fertilizer use and better insect and pest control. Also, experiments conducted in tanks with flooding depths of 1.0, 2.5, 7.5 and 15 cm did not show significant difference in yields from rice variety IR 8, although more water was required with increasing depths due to higher percolation (De Datta *et al.*, 1973).

In the subsequent wet season of 1968, under natural paddy conditions, IR 8 yielded 6.0 tons/ha and 5.6 tons/ha when continually flooded with 15 and 2.5 cm of water (De Datta *et al.*, 1973). Studies on the influence of water depth, carried out by Matsushima (1962) in Malaya, gave ralative average yields of 79%, 100%, 96% and 89% for stagnant water depths of 0, 6, 13 and 26 cm, respectively. With water depths of 0, 1, 3 and 6 cm he found, average relative yields of 59%, 88%, 100% and 93% respectively, indicating that a depth of 3 cm was optimal. In still another experiment, Lenka *et al.* (1971) found in India that IR 8 yielded 2.54,



* Under warm conditions use the lower number of days and for cool conditions use the larger number of days.

** Variable time, 0 - 25 days dependent upon variety.

Figure 2.1. Rice growth stages (cited in De Datta, 1981).

2.93 and 2.66 tons/ha with a continuously moist soil, continuous shallow (4 - 5 cm) and deep continuous (8 - 10 cm) submergence, respectively. A study conducted at the International Rice Research Institute (IRRI, 1973) showed that IR 8 yield decreased considerably when the water level was gradually raised from 5 to 30 cm, starting 20 days after transplanting (3 cm/day), and then maintained for the rest of the season. Compared with a constant depth of 5 cm this yield decline amounted to 35%. If the water level was brought to 92 cm, the crop failed completely.

Summarizing these results it can be concluded that the optimum water level ranges from 6 - 10 cm, and the permissible level, i.e. with acceptable yield reduction, from 2.5 to 15 cm.

2.1.2.3 Water Stress

Having established from yield experiments that the depth of the water should be 2.5 to 15 cm, the question arises as to whether it is necessary to maintain this level throughout the entire growing season of the rice crop. In other words, does a lower or higher water level during a particular growth stage significantly affect yield.

Various authors believe that there are critical crop growth stages, during which yield is reduced by water stress than during other periods. According to Salter & Goode (1976), cereals show a marked sensitivity to water stress during the formation of the reproductive organs and during flowering, which agrees fairly well with Matsushima (1962), who reported that rice is most sensitive to water stress during the reduction division stage, (from approximately 20 days before to 5 days after heading). Krug (1971), describing flooded rice culture in Monsoon Asia, reported that drought during rooting and during panicle primordia development up to flowering would result in serious yield reduction. He adds however, that a certain amount of drainage during the later tillering generally is advantageous, because it promotes tillering and enhances downward rooting. Drainage should follow the ripening stage to promote regular ripening. Further evidence that crop stages differ in drought sensitivity is presented by Yamada (1965) who reported yield decreases of about 30% when drought occurred from rooting through tillering or from young panicle formation through the booting stages; ie. at the beginning of both the vegetative and reproductive periods.

Although the above results supported the influence of water stress on different crop stages, there are other experiments which indicate that crop stages may not be very important in relation to water stress. In India, Chaudhry and Pandey (1969) found no significant differences in IR 8 grain yield between nine water management treatments, which varied from continuous submergence to irrigation only when the soil had completely cracked. One of the treatments consisted of 2 - 5 cm standing water till maximum tillering, followed by drainage and then 5 - 8 cm water until the dough stage of the crop. Drainage at maximum tillering did not increase yields. De Datta *et al.* (1973) also could not establish any beneficial effect on yield of drainage at maximum tillering.

The results of past studies indicate a general yield reduction if stress occurred, the size of the reduction being more related to the intensity and the duration of the moisture stress than to the stages of plant growth at which stress occurred. There is no widely accepted permissible duration and intensity of soil moisture stress during any stage of the rice crop. This would suggest that under favorable water supply conditions, it would be wise to avoid water stress until more is known concerning the effects of moisture stress on rice yields.

In the past, relatively little attention has been paid to crop damage resulting from excessive water levels during rice growth. The most extreme form of high water level is a complete submergence of the crop. Obviously this will occur at lower water levels during early crop stages when the plant is small.

2.2 *Water Balance Models for Lowland Rice*

The PADIWATER simulation model, developed by Bolton and Zandstra (1981) predicts the yields of rainfed rice under drought conditions in Iloilo Province, Philippines. For a rice crop in standing water, the water balance model used was;

$$W_i = W_{i-1} + RF_i - ET_i - S_i - P_i + IF_i - OF_i \qquad [2.1]$$

where: W = water depth

RF = rainfall

ET = evapotranspiration

S = lateral seepage through dikes

P = percolation

IF = inflow from higher fields over the spillway

OF = outflow or surface drainage from the paddy over the spillway, and

i = the time interval between measurements

The unsaturated water balance for paddy without standing water used was;

$$SM_i = SM_{i-1} + RF_i - ET_i + CP_i \qquad [2.2]$$

where: SM = soil moisture in the root zone

CP = capillary rise from a shallow water table into the root zone

When there was no standing water, percolation was assumed to be zero. Moisture extraction was assumed to occur only within the top 30 cm of the soil profile. The 30 cm root zone was adopted based on the observation (in their field trials) that 90% of the root were within the top 20 cm. When there was standing water, a pan factor of 0.93 was used to obtain potential ET. When no standing water was present, ET was assumed to be a function of the moisture content of the root zone. Net seepage and percolation rates of 0.5 and 0.8 mm/d were assumed for fields located in the plains and plateaus, respectively.

Inflow from higher fields to the reference field during rainfall was considered negligible because before inflow occurred, the reference field was already full to spillway height. However, they observed that with heavy rainfall (greater than 10 mm) there was inflow from the higher fields that continued for up to 2 days after the rainfall ceased.

Ground water contribution (capillary rise) was observed to represent up to a third of the input to the unsaturated water balance in some years. In the simulation, ground water depth was increased during rainless days and reduced on rainy days by a height proportional to the amount of rainfall received. No attempt was made to relate deep percolation rate to ground water recharge in the equations for the water balance.

Zandstra *et al.* (1982) analyzed the effects of different seepage and percolation rates and spillway heights on the critical growing season events. The components of the PADIWATER model were modified for factors such as seepage and percolation losses and the subsoil water contribution as;

$$W_i = W_{i-1} + RF_i - ET_i - SP_i - OF_i + GW_i \qquad [2.3]$$

where: GW_i = groundwater contribution to the top 30 cm of the soil on day i, and

W_i = is the soil water in or standing on the top 300 mm of the soil on day i.

Evaporation of soil water is calculated from the water content (WL) of the top 50 mm of the soil layer and pan evaporation as follows;

$$ET_i = EP \qquad \text{for } WL_i > WL_S \qquad [2.4a]$$

$$ET_i = EP\,(WL_i^2 / WL_S^2) \qquad \text{for } WL_i \leq WL_S \qquad [2.4b]$$

where: W_i = water content of the top 50 mm of soil at time i,

WL_s = saturated water content of the top 50 mm of the soil, and

EP = average value for class A evaporation for that month.

Small rainfall contributions to the water balance can be modified to reflect evaporation losses. When the rainfall is less than 15 mm for soil with WL less than 10 mm, rainfall evaporation loss (E_r) is related to EP and RF_i as follows:

$$E_r = 0.167 \text{ EP RF}_i \qquad [2.5]$$

Seepage and percolation were combined to form an index term, SP, which was related to an existing hydrologic classification of rainfed wetland rice field soils (Table 2.1). According to the classification, SP indexes vary from 0 to 6 mm/d. The SP value for a typical wetland field will be in the range of 1 - 3 mm/d, and for lower lying irrigated fields with heavier textured soils, the corresponding range will be 0 - 2 mm/d.

In the model, the SP index is modified to form a potential seepage and percolation term, SP_p:

$$SP_p = (SP + 1) - SSP/2, \quad \text{bounded by } SP_p > SP \qquad [2.6]$$

so that daily seepage and percolation is:

$$SP_i = 0.5\,SP_p + 1.5\,SP_p\,(W_f/H) \quad \text{for } W_i > W_s \qquad [2.7a]$$

$$SP_i = 0.5\,SP_p\,(W_i - W_o)/(W_s - W_o) \quad \text{for } W_s > W_i > W_o \qquad [2.7b]$$

$$SP_i = 0 \quad \text{for } W_i < W_o \qquad [2.7c]$$

where: SSP = accumulated seepage and percolation

W_f = standing water ($W_i - W_s$ for $W_i \leq W_s$)

H = paddy spillway height, and

W_o = water content (300 mm layer) below which no percolation occurs

The ground water contribution was defined as the amount of water supplied to the top 300 mm of the soil profile from underlying ground water. The ground water contribution was considered negligible when SSP was less than 10(SP + 1) and when the field loses its water

Table 2.1. SP Classification index

General association of hydrology class to landscape position, ponding and drainage potential, and seepage and percolation index used for the PADIWATER model (Zandstra *et al.*, 1982).

Hydrology	Water table	Landscape position	Ponding potential	Drainage potential	S&P index
Pluvic	Deep water table nonpaddy	Knolls and summits high internal	Very low,	High surface,	> 6
Perfluxic	Deep water table; highly fluctuating perched water table	Upper side slopes of knolls and summits	Low	High surface, moderate internal	4-6
Orthofluxic	Deep water table; less fluctuating perched water table	Lower side slopes and steep waterways	Moderate	High surface, imperfect internal	2-4
Orthocumulic	Water table or perched water table, close to the surface during wet and intermediate months	Lowest paddies on the side slopes, high plains	High	Moderate surface, low internal	1-2
Percumulic	Water table is almost consistently above ground surface during wet months	Waterways in high plains; low plains	Very high	Low surface, very low internal	0-1
Orthodelugic	Water table rises more than 30 but less than 50 cm above ground level for more than two weeks	Waterways and back swamps in low plains subject to inundation	Shallow flooded	No surface drainage, no internal	0
Perdelugic	Water table rises beyond 50 cm but less than 100 cm above ground level	Similar to Orthodelugic	Deep flooded	No surface drainage, no internal	0

in the top 300 mm of the profile. The ground water depth was assumed to be 30 cm depth whenever W_i exceeded field capacity and its subsidence of 4 cm/day in the absence of rains was used to simulate the behavior of the ground water contribution.

Changes in spillway height were observed to have a greater effect on field water conditions than changes in the SP index. The effects of changes in spillway height were less for fields with a high SP index than for fields with low SP.

A water balance model was developed for the subcoastal plain of the Adelaide River to estimate the frequency of success of rainfed rice (Chapman and Kininmonth, 1971). To accommodate differential evapotranspiration, the soil water storage was partitioned into three stores: A, B and C, with each store assigned an assumed storage capacity. Water depths were limited to $\leq$ 100 mm and $\leq$ 130 mm during the first and second fortnights, respectively, and thereafter it was allowed to increase up to 250 mm. For the area included in this study, downward movement of water was assumed to be zero. Evapotranspiration from unflooded fields was assumed to be a stepped ET function from the assumed three stores, with EP coefficient values ranging from 0.75 to 0.19.

Daily estimates of soil water storage and depth of ponded water for each wet season were calculated for the years for which rainfall records were available. Rainfall was regarded as adequate providing there were: (a) at least 14 days of pondage $\geq$ 75 mm for wet tillage before sowing, (b) at least 80 days between sowing date and last date at which ponded water was present on the field, and (c) not more than 10 consecutive zero pondage days between 50 and 80 days after sowing.

Phien (1983) developed a water balance type mathematical model, incorporating two sub models for generating daily rainfall and for estimating daily potential ET. The model was developed primarily to determine the potential planting dates for rainfed culture, based on the number of stress days. He proposed to estimate ET by multiplying potential evapotranspiration (ETP) values with a crop coefficient C_k. However, due to missing pan evaporation data for the study area, the following formula was used to compute ETP:

$$ETP = (0.00043\,T + 0.00133)\,R_S \quad [2.8]$$

where: T = daily temperature in °C, and

R_s = the daily solar radiation

The values of R_s were obtained from daily sunshine duration

$$R_S = (0.29 + 0.41\,SS/S)\,R_a \quad [2.9]$$

where: S = the monthly possible sunshine duration in h/d

SS = actual sunshine duration in h/d, and

R_a = the monthly global shortwave radiation above the atmosphere

The following factors were introduced in the water balance equation:

1. Water holding capacity (WHC) is given by:

$$WHC = FC\,.\,B\,.\,D \quad [2.10]$$

where: FC = field capacity in percentage

B = bulk ratio of the soil, and

D = depth of the root zone

2. Upper limit of the water depth (UP) is the maximum depth of water to be ponded. For the study area, it was equal to 135 mm for paddy field rice.

3. Lower limit of water depth (DMIN), is the theoretical limit coinciding with the wilting point (WTP).

$$DMIN = WHC \quad \text{for paddy} \quad [2.11]$$

4. Deep percolation (PERC), for paddy was assumed when there was ponded water on the soil surface. PERC was assumed constant and equal to 3 mm/d.

The water balance was carried out by first computing the water depth on day i:

$$W_i = W_{i-1} + RF_i - ET_i - PERC_i \qquad [2.12]$$

where: W_i = water depth on day i,

RF_i = rainfall on day i,

ET_i = evapotranspiration on day i, and

$PERC_i$ = deep percolation on day i.

The water balance computation was carried out on a day by day basis throughout the entire growing season for the period of record, to determine the number of stress days and their frequency of occurrence. Stress days were defined as those days on which the water depth was less than or equal to DMIN. Simulations were repeated by changing the planting dates and an optimum planting schedule with the minimum number of stress days was determined. He also proposed the use of his model to estimate supplementary water requirements.

In general, modeling rice moisture needs under rainfed conditions is confronted by two restrictions; there is little available literature on the unsaturated conditions which are important in defining the water balance relationships and there is a critical lack of meteorological stations in Southeast Asia for collecting data required by the models. Rainfall is often the only dependable climatic data available for these areas. These restrictions automatically rule out the use of more sophisticated and descriptive models.

The foregoing models were developed mainly for rainfed rice without irrigation. The purpose of irrigation is to avoid the occurrence of the unsaturated condition. Therefore, for rice with supplemental irrigation, the unsaturated condition will not normally exist. If a water balance equation with only standing water is applicable then the resulting equations will be much simpler.

If irrigation is provided to satisfy the optimum crop requirement, the inflow component from higher fields into the reference field of the PADIWATER model (Bolton and Zandstra,

1981) will essentially be equivalent to the amount of irrigation applied. Furthermore, outflow from adjacent fields will not exist, since only the desired amount of irrigation is applied.

2.3 Evapotranspiration Estimates for Irrigation Scheduling

Evapotranspiration (ET) is the combined process of water movement into the atmosphere resulting from plant transpiration and surface evaporation. The two processes are difficult to separate under field conditions but this is not important as it is their combined effect that is important in crop water management.

Blaney and Criddle (1952) developed a procedure for estimating monthly and seasonal consumptive water use from average monthly temperatures and daylight hours. In addition to these two variables, their formula also made use of a consumptive use coefficient, which was used to account for foliage density, stage of crop growth, and other crop variables. Estimation of the consumptive use coefficients is difficult and makes the use of the method somewhat questionable.

An empirical formula based on latitude and average air temperature as the only variables is given by Thornthwaite (1948). The formula is easy to use as only temperature data are needed but it is inappropriate for use in many areas because the data from which it was derived are not representative of all climatic and crop conditions. This is especially true in tropical and subtropical areas.

Penman (1948) studied losses by evaporation from open water surfaces, bare soil and turf in England and developed a formula for plants that cover the soil completely and are well supplied with water by either rain or irrigation. The chief disadvantages of Penman's formula are that it is complicated and requires extensive climatic data which are typically found only in developed areas. This formula however, has a sound theoretical basis and often is used as an independent check on values obtained by other methods.

Pruitt and Jensen (1955) compared consumptive use rates of four crops with values obtained using procedures developed by Blaney-Criddle (1952) and Thornthwaite (1948) and evaporation from an evaporation pan. High correlation coefficients were obtained with each of the three methods when compared with measured consumptive use values. However, they found that with the Blaney-Criddle method, the value of the crop coefficient varied throughout the season. Estimates of consumptive use with the Thornthwaite procedure fell short of observed consumptive use, but by applying a variable crop factor, closer correlation was achieved.

A common method of using consumptive use data for management decisions is to average past seasonal values as did van Bavel and Wilson (1952). They observed close agreement between the dates of irrigation computed from long term averages of meteorological factors and those determined from tensiometer readings for a tobacco irrigation experiment and proposed the use of the method for irrigation scheduling.

The concept of drought days was proposed by van Bavel (1953). He made extensive use of Thornthwaite's approach in estimating drought hazards. The method used by van Bavel involved a relatively simple method of soil moisture bookkeeping. Each day an estimated value for ET was subtracted from soil moisture storage and the precipitation for that day was added. Daily ET was assumed to equal potential ET at all times unless soil moisture was at the wilting point. Any day on which available moisture storage was at the wilting point or on which the available moisture storage was zero was considered a drought day.

Utilizing measured water losses from lysimeters at Coshocton, Ohio, Pierce (1960) developed a procedure for estimating daily ET. This procedure involved the use of a potential ET figure derived by empirical means. This figure was then multiplied by factors for crop stage, soil dryness, and rainy day correction. The empirically derived soil dryness correction factor had an initial value of 1.0 which was reduced as soil moisture was depleted.

Stewart *et al.* (1974) investigated the relationship between cumulative maximum ET and ET under non irrigated conditions and developed a linear yield function for researched crops. The model generates irrigation requirements to satisfy maximum ET, and irrigation scheduling takes into account ET deficits such that severe ET deficits do not occur during critical plant-growth stages.

Although numerous methods have been proposed for determining ET, most have not been suitable for tropical conditions. Juntharasri (as sited in Wickham and Sen, 1978) observed from experiments conducted in Thailand using 7 different methods for estimating evapotranspiration that only Penman's estimates correlated closely with pan evaporation. The Penman estimates still tended to overestimate evaporation in the dry season and underestimate in the wet season. Furthermore, he concluded that because of the complex calculations required for the simplest methods of estimating ET and because of the difficulty and expense of collecting the necessary data, these models are not practical for estimating evaporative demand in the humid tropics. It is therefore, generally accepted that evaporation from open pans provides a more satisfactory means of estimating potential ET and hence, ET of rice under flooded conditions than any other available technique (Wickham and Sen, 1978).

Ratios of actual crop ET to pan evaporation (EP) have been established for the different growth stages of rice (De Datta, 1981). Although the ET/EP ratio for rice depends on location, the average ratio is 1.0 for the first three weeks after seedling, 1.15 for the next 5 to 6 weeks and a maximum of about 1.3-1.4 at heading. Average ET therefore, generally exceeds EP during most rice growth stages.

2.4 Stochastic Methods for Determining Irrigation Requirements

Whenever irrigation requirements are estimated for individual periods from long term records, the results must be interpreted on a probability basis because of the high variability of natural precipitation. Advantages associated with using a distribution function to interpret irrigation water requirements include 'smoothing' and removing 'noise' from the data and allowing estimates to be extrapolated over time. The development of stochastic models for irrigation scheduling has received the attention of many researchers (Yonts *et al.*, 1979).

The normal distribution is commonly used as a starting point in the formulation of distribution functions. Determination of needed probabilities and associated parameters is relatively straightforward if the distribution is normal. Irrigation requirement distributions are often not symmetric and tend to be skewed. Therefore, the use of the normal distribution function is inappropriate unless the data can be transformed. Baier *et al.* (1969) were able to satisfactorily use the normal distribution with irrigation requirement data, linearized by a cube root transformation, to estimate irrigation requirement for the humid area along the Fraser River near Vancouver, British Columbia.

Pruitt *et al.* (1972) illustrated the use of probability levels to determine crop water requirements. They examined daily ET values to define the frequency distribution of irrigated grass in weighing lysimeters at Davis, California. The distributions ranged from highly skewed in winter to a near normal distribution during summer.

Khanjani and Busch (1980) related probability distributions of accumulated ET for different durations and available soil moisture to determine irrigation frequencies. The log-normal distribution was observed to best fit the time of peak water use for crops grown in the Snake River Valley Irrigation District in Idaho.

Rojiani *et al.* (1982) tested various theoretical distributions to describe the probability density function of the amount of plant available water on a given day in Wise county, Virginia. Based on the results and flexibility, they choose to use the beta distribution to represent the probability density function.

Wiser (1969) described the effects of weather patterns on crop growth using a single parameter drought index, d, calculated according to:

$$d = \frac{z \,.\, PE - ET}{PE} MSC \qquad \text{if } ET < z \,.\, PE \qquad [2.13a]$$

$$d = 0 \qquad \text{if } ET > z \,.\, PE \qquad [2.13b]$$

in which PE and ET are the potential and actual evapotranspiration volumes, respectively, MSC is the maximum storage capacity, and z is a proportionality constant usually taken as 0.5. By relating the drought index to yield response, he calculated yield responses for the years for which climatalogical data were available. He then used a water balance model to determine the required number of irrigations per season. Irrigation requirements were assumed to follow a binomial distribution since the actual distribution of the data was unknown.

A nomogram to estimate effective rainfall from seasonal total rainfall, seasonal consumptive use and application amount was developed by Hershfield (1960). He observed that the frequency distribution of seasonal effective rainfall varied from one station to another or even at the same station for varying application amounts. This eliminated the opportunity for using a common distribution to determine effective rainfall frequencies for all stations.

In an attempt to investigate the monthly variation of irrigation water requirement for Alfalfa, Yonts *et al.* (1979) found that neither the normal nor the 2-parameter Weibull distribution were able to adequately describe irrigation water requirements for months when more than half of the data were zero. However, the 2-parameter Weibull distribution resulted in relatively better results than the normal distribution because of skewness present in the distribution.

Fitting a distribution to irrigation requirement poses a major concern when half or more of the data is equal to zero. Burman *et al.* (1982) proposed a means for dealing with the frequent occurrence of zero irrigation requirement, by defining a probability that a zero irrigation requirement will occur. They proposed a mixed distribution with a point mass placed at the origin equal to the probability of zero irrigation requirement and a positive distribution represented by a conditional probability. Thus, producing a discrete distribution combined with a continuous distribution to produce a mixed probability distribution. The probabilities were weighted for zero irrigation requirement using the following equation:

$$P'(y) = \frac{N'}{N} + \left(1 - \frac{N'}{N}\right) P(y) \qquad [2.14]$$

where:

y = irrigation requirement for which probability P(y) is to be calculated,

N′ = number of years with irrigation requirement equal to zero,

N = total number of years of record, and

P′(y) = weighted probability.

Burman *et al.* (1982) also investigated the ability of the 3-parameter Weibull distribution to describe P(y) in equation 2.14.

From the foregoing discussion it is clear that no single distribution is completely reliable for describing irrigation requirement distribution. A wide variety of distributions have been in use, and the results are influenced by the choice of distribution. The transformation methods can be used to advantage by finding a unique distribution, thus avoiding the assumption that a set of data follows a particular distribution.

The power transformation was first proposed by Box and Cox (1964) and is of the form:

$$y = \frac{(x^{\lambda} - 1)}{\lambda} \qquad \text{when } \lambda \neq 0 \quad \text{or} \qquad [2.15a]$$

$$y = \ln x \qquad \text{when } \lambda = 0 \qquad [2.15b]$$

where: x = variables of the given series (irrigation requirement in this case),

y = the transformed variables,

λ = a constant for transformation.

The value of λ that produces a transformed sample approximating a normal distribution is the most suitable. The coefficient of skew (C_s) and the coefficient of kurtosis (C_k) serve to indicate how close the transformed values of the sample actually come to the normal distribution. The coefficient of skew and the coefficient of kurtosis are defined as follows:

$$C_s = \frac{M_3}{M_2^{1.5}} \qquad [2.16]$$

$$C_k = \frac{M_4}{M_2^2} \qquad [2.17]$$

where: M_k is the k th moment of the sample about the mean and is calculated as:

$$M_k = \frac{1}{n}\Sigma(y_i - \mu_y)^k \qquad [2.18]$$

where: μ_y = mean of the transformed values and

n = sample size (number of years for which irrigation requirement is calculated).

Chander *et al.* (1978) used the power transformation for flood frequency analysis. They observed that the annual maximum discharges calculated based on power transformation gave good approximations to the observed data for some representive rivers.

The SMEMAX transformation suggested by Bethlahmy (1977) transforms a given set of data to near normal distribution. The transformation is derived from the trignometric solution of a right angled triangle whose vertices are the **S**mallest, **ME**dian and **MAX**imum. Points along the base and the height of the triangle represent the observed values and suitably projected points of these values on the hypotenuse represent the transformed values. These transformed values are assumed to follow a normal distribution.

The transformation equations necessary to transform the sample require that the difference between the smallest value and the median is equal to the difference between the median and the largest value. Two equations are required: the first applies when $x_i \leq x_m$ (where, x_i is a variate in the original sample and and x_m is the median value in the sample) and the second applies when $x_i > x_m$. The two transformation equations are as follows:

$$y_i = \frac{(x_l - x_s)}{2 \cos A} \qquad \text{for } x_i \leq x_m \qquad [2.19a]$$

$$y_i = \frac{[(x_m - x_s) + (x_i - x_m) \cot A]}{2 \cos A} \qquad \text{for } x_i > x_m \qquad [2.19b]$$

where: x_s = smallest value in the original sample

x_l = largest value in the original sample and

A = $\arctan\left[\frac{x_l - x_m}{x_m - x_s}\right]$

The effectiveness of the transformation for normalization can be checked once again by the values of the coefficients of skew and coefficient of kurtosis.

Aldabagh *et al.* (1982) tried the power, SMEMAX, log transformations and distributions such as the Gumbel and log-Pearson type III distribution to analyze the occurrence of dry days for supplemental irrigation for 10 stations in Iraq. The power and SMEMAX transformations gave the best agreement between observed and estimated dry days, with the values estimated by power transformation being closer to observed values than the SMEMAX curve.

Gupta and Chauhan (1986) developed a periodic stochastic model for weekly irrigation requirement time series for the paddy crop. They found that weekly time series of irrigation requirements is trend free and periodic-stochastic in nature, with periodicity of 15 weeks. The periodic component was represented by the first harmonic and the time-dependent of the stochastic portion was approximated by the second order autoregressive model with constant autoregressive coefficients.

2.5 Canal Conveyance Model

Numerical methods for computing flow profiles for non uniform flow in canals were given by Henderson (1966), Chow (1955) and Prasad (1970). Prasad (1970) illustrated a method for solving flow equations with lateral inflow. These methods involve tedious hand calculations, particularly when the canals are long and canal sections irregular in shape. Calculations are even more complex when structures are introduced into the canal network. Subramanaya and Awasthy (1972) developed a method to solve problems in side flow weirs and Smith (1973) developed a computer program to determine water profiles over side flow weirs. These are methods to solve problems in hydraulic flow in control sections. However, for irrigation canals problems of hydraulic flow have to be solved with the system considered as a whole. Therefore, models that solve the equations governing the flow in canals have to be explored.

Currently available computer software for canal flow routing vary in complexity from simple models based on the one dimensional steady free surface flow equations to unsteady flow equations. The applicability of the simple models is limited to canal reaches without backwater effects.

Davis and De Vries (1977) developed a steady state computer model to simulate water flow in the California aqueduct. Hamilton and De Vries (1986) presented a computer model to be used in microcomputers for non branching canals. The model of Hamilton and De Vries (1986) was restricted to check structures of the radial gate type.

The present study requires an unsteady state one dimensional computer model for routing water flow in an irrigation canal. An unsteady state model is required since the flow in the irrigation canals vary with time to allow changing demands. A one dimensional flow model is prefered since one does not expect severe flow currents to be present in irrigation canals. The purpose of the computer model is to simulate water flow in irrigation canals where there are backwater effects due to lateral discharge or downstream level regulation/variation. Backwater effects are common in irrigation canals since check structures are often provided near turnouts to head up the water. Some of the important uses associated with this type of simulation are to evaluate, various methods of canal operation to vary discharges and to evaluate the hydrographs of lateral discharges at the turnout structures.

The ILLUDAS model was developed by the Illinois State Water Survey (Terstriep and Stall, 1974, as cited in Chiang and Bedient, 1986) for the hydrographic simulation of storm drainage systems in urban areas. The pressurized ILLUDAS backwater simulator (PIBS) is an extension of the ILLUDAS model to incorporate backwater effects (Chiang and Bedient, 1986). These models were developed for simple pipe systems, with no weir diversions, and cannot be used to simulate water flow in irrigation canals.

The extended transport model (EXTRAN), developed by Roesner *et al.* (1983), originally developed for storm drainage, is a very versatile transient flow model able to handle looping pipes, weir diversions, pumps and a variety of structures, such as side flow weirs, transverse weirs and orifices, and water storage facilities at points along the canals. In addition, EXTRAN can handle variable cross sections such as rectangular, horse shoe, egg, basket handle, circular and trapezoidal channels. This can be an advantage when simulating flows in unlined canals where the cross section can be approximated to any one of the shapes listed. The ability of EXTRAN to handle looped systems is especially advantageous in irrigation schemes where drainage canals are connected to irrigation canals to utilize return flows. Storage and pump facilities are common in irrigation canals and EXTRAN also can simulate these systems.

EXTRAN has been tested extensively by the authors of EXTRAN and the results have been compared to the solution by the Method of Characteristics by Kassam and Wisner (1980). The model has been proved capable to perform surface/underground flow routing hydrographs when the underground system is flooded (Roesner, *et al.*, 1981). The applicability of EXTRAN to the sewer systems in South Boston, Massachusetts asssisted in analyzing the hydraulic behaviour of the system for overflow problems (Camp Dresser and McKee Inc., 1979, cited in Roesner *et al*, 1981).

2.5.1 EXTRAN Model

2.5.1.1 Background

EXTRAN is a general purpose program for hydraulic flow routing in open channel and closed conduit systems. The program performs dynamic flow routing of water flow through canal systems to outfall points in the receiving water system. Simulation output takes the form of water surface elevations and discharge at selected system locations.

The specific function of EXTRAN is to route inlet hydrographs through the network of pipes, junctions and flow diversion structures of the main system to the receiving water outfalls. EXTRAN uses a link-node description of the canal system which facilitates the discrete representation of the physical system and the mathematical solution to the gradually varied unsteady flow equations (Saint-Venant equation) which form the mathematical basis of the model.

The equation for unsteady spatially varied equation used in EXTRAN is:

$$\frac{\partial Q}{\partial t} = -gAS_f + 2V\frac{\partial A}{\partial t} + V^2\frac{\partial A}{\partial x} - gA\frac{\partial H}{\partial x} \qquad [2.20]$$

where:

- Q = discharge through the conduit
- V = velocity through the conduit
- A = cross section area of the flow
- H = hydraulic head and
- S_f = friction slope

The friction slope is defined by Manning's equation:

$$S_f = \left(\frac{n}{1.49}\right)^2 \frac{1}{AR^{4/3}} \qquad [2.21]$$

The model also uses the continuity equation:

$$\frac{\partial H}{\partial t} = \frac{1}{B}\frac{\partial Q}{\partial x} \qquad [2.22]$$

where B is the surface width.

The equations are converted to finite difference form and numerical integration is done by a two step, modified Euler technique. This produces a completely explicit solution. Explicit methods usually involve fairly simple numerical calculations compared to implicit methods and require less storage space. However, they are known to be less stable and often require very short time steps. From a practical standpoint, experience with EXTRAN has indicated that the program is stable numerically when the following inequalities are met:

conduits: $$t \le \frac{L}{\sqrt{gd}} \qquad [2.23a]$$

nodes: $$t \le \frac{c' A_s H_{max}}{Q} \qquad [2.23b]$$

where: c' = a dimensionless constant determined by experience to be approximately 0.10

H_{max} = maximum water surface rise in time step t

A_s = the corresponding surface area of the node, and

Q = net inflow into the junction

A time step of 10 seconds is nearly always sufficiently small to produce outflow hydrographs which are free from spurious oscillations and satisfy mass continuity. A detailed description of the model is given in the EXTRAN User's Manual Version III (Roesner, *et al.*, 1983).

2.5.1.2 Flow Control Devices

Orifices: EXTRAN simulates outlet orifices by converting the orifice to an equivalent pipe. The conversion is made by equating the orifice discharge equation and the Manning pipe flow equation as follows.

$$\frac{1.49}{n} A\, R^{2/3}\, S^{1/2} = C_0\, A \sqrt{2gh} \qquad [2.24]$$

where: C_0 = discharge coefficient

A = cross sectional area of the orifice, and

h = hydraulic head at the orifice.

Letting $S=h/L$ where, L is the equivalent pipe length and substituting $R=D/4$ (where, D is the orifice diameter) into equation 2.24 and simplifying, yields:

$$n = \frac{1.49}{\sqrt{2g}\ L\,C_0}\left(\frac{D}{4}\right)^{2/3} \qquad [2.25]$$

The length of the equivalent pipe is computed as:

$$L = 2\,\Delta t\sqrt{gD} \qquad [2.26]$$

Weirs: Flow over a weir is computed by the following equation:

$$Q_W = C_W L_W \{(h + \frac{v^2}{2g})^a - (\frac{v^2}{2g})^a\} \qquad [2.27]$$

where: C_w = discharge coefficient

L_w = Weir length

h = driving head on the weir

v = approach velocity, and

a = weir exponent; 3/2 for transverse weirs and 5/3 for side flow weirs.

Normally the driving head on the weir is computed as the difference

$$h = y_1 - y_c \qquad [2.28]$$

where: y_1 = water depth on the upstream side of the weir

y_c = height of the weir crest above the node invert

However, if the downstream depth y_2 also exceeds the weir crest height the weir is submerged and the flow is computed as follows:

$$Q_W = C_S C_W L_W (y_1 - y_c)^{3/2} \qquad [2.29]$$

where C_s is a submergence coefficient representing the reduction in driving head.

2.5.1.3 *Limitations of EXTRAN*

Types of channels that can be simulated by EXTRAN are restricted to regular sections such as rectangular, horse-shoe, egg, basket handle, circular and trapezoidal channels. This limitation can be overcome, by approximating the canal section to any one of the above sections. EXTRAN also does not account for canal conveyance losses, which poses another restriction in the simulation of unlined irrigation canals with percolation losses.

Canal conveyance losses can be accounted for at discrete node points. For simulation purposes, a cumulative loss is calculated for each canal reach. An equivalent amount is then assumed to flow out of the system at each node point. Since, actual canal losses are distributed along the canal length, node points should be selected at close intervals to approximate uniform losses. But since conveyance losses are normally small they may be accounted for at more widely spaced nodes whose locations are dependent upon structures in the canal system.

chapter 3

Model Development

3.1 Introduction

The water requirement for lowland rice consists of evapotranspiration, seepage and percolation losses. Although, the only true requirement for crop production is the water used by the plant through transpiration, additional water is lost to evaporation from the soil water surface and through seepage and percolation. These losses cannot be eliminated for lowland rice and are therefore, treated as requirements.

The main objective of this dissertation is to propose a method for conserving irrigation water by applying the minimum amount of water required by the crop and taking into account the probability of rainfall that might occur during each irrigation period. In order to achieve the above objective, one needs to estimate rainfall and evapotranspiration at different probability levels.

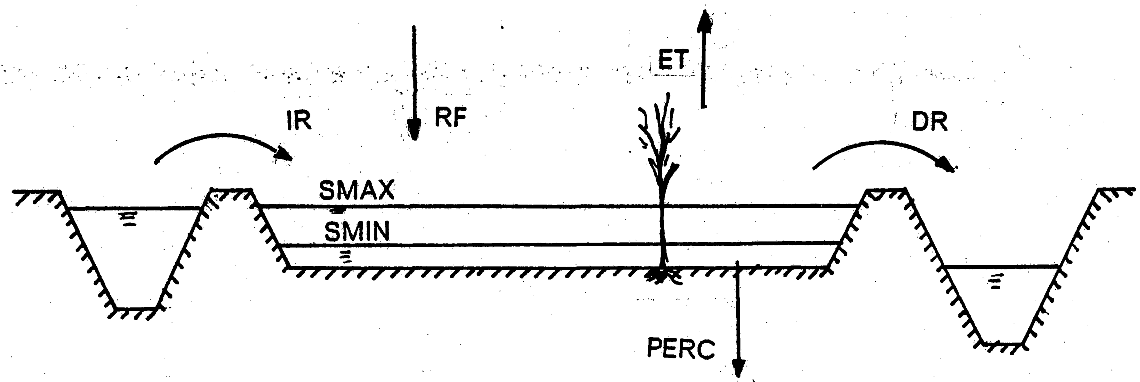
In some irrigation schemes of Southeast Asia, water is applied to rice fields on a rotational basis and where farmers are allowed to irrigate at regular intervals of once a week.

To estimate irrigation requirements for such a scheme one needs to know in advance the seepage and percolation losses and the amount of rainfall and evapotranspiration that can be expected to occur during each irrigation period. Unlike rainfall and evapotranspiration, seepage and percolation losses can be determined from field trials. Rainfall and evapotranspiration are random variables with rainfall having a high variability while evapotranspiration has a relatively low variability. Evapotranspiration in rice fields, has typically been estimated using mean weather data for the time of the year under consideration. Rainfall however, is highly variable and has always been difficult to estimate. Because of this, it has been common practice to disregard rainfall in computing irrigation requirement. When irrigation requirements are estimated this way, any rainfall that occurs after irrigation has been applied, will be lost to drainage since the paddy fields may be already full to spillway height and there is little or no storage capacity left to capture rainfall.

3.2 The Water Balance

The water management model presented herein uses the water balance method to determine water levels on the surface of the fields. The terms of the water balance (input, output and storage) in a flooded rice field can readily be expressed in mm of water depth. The elements of water balance in a flooded rice field for a given period is represented in Figure 3.1.

For the water balance computations the crop growing season is divided into several equal periods and the length of each period should be equal to the length of the irrigation interval. For convenience, the beginning and end of each period are assumed to coincide with specific cultural practices, such as land preparation, transplanting and harvesting and specific growth stages of the crop.



$$S_i = S_{i-1} - ET_i - PERC_i + RF_i \quad [3.1a]$$

$$\text{If } S_i > SMAX_i \text{ then } DR_i = S_i - SMAX_i \quad [3.1b]$$

$$\text{If } S_i \leq SMIN_i \text{ then } IR_i = SMIN_i - S_i \quad [3.1c]$$

where:

S_i = water level in the paddy field in mm

ET_i = evapotranspiration for the period in mm

$PERC_i$ = seepage and percolation losses for the perod in mm

RF_i = total rainfall during the period in mm

$SMAX_i$ = maximum allowable water level in mm

$SMIN_i$ = minimum desired water level in mm

IR_i = irrigation water supplied during the period in mm when S is less than SMIN

DR_i = drainage from the field during the period when S exceeds SMAX

i = time period

Figure 3.1. Elements of water balance in a rice field.

3.3 Components of Water Balance

3.3.1 Evapotranspiration (ET)

For lowland flooded rice fields in the tropics, pan evaporation (EV) provide the best means to determine crop ET. Crop ET is calculated by multiplying EV values with already established ET/EV ratios (Toole, as cited in De Datta, 1981). Values of the ET/EV ratio have been found to vary between 1.0 and 1.3 for different growth stages of rice in the humid tropics. Values of ET/EV ratios for the first three weeks of the vegetative growth period is 1.0 and it gradually increases to 1.2 near the end of the vegetative growth period and to a maximum of 1.3 during the reproductive growth period. After the first week of maturation and grain filling ET/EV decreases to 1.0 (Toole, as cited in De Datta, 1981).

Long term records of daily EV values are not commonly available in the tropics in most instances. Daily evaporation data, however, can be obtained from data generation using Monte Carlo techniques, if a few years of daily evaporation values are available. Daily evaporation values can also be obtained if a relationship between daily rainfall and pan evaporation can be established as suggested by Bolton and Zandstra (1981).

The purpose of data generation is to simulate a large number of data points having the same statistical properties as the observed data (parent distribution). Therefore, to generate daily pan evaporation data using Monte Carlo simulation, an appropriate statistical distribution that best fits the daily pan evaporation data must be identified.

Relationships to generate random variates for widely used distributions are given by Haan (1977). For example, random variates for any normal distribution can be generated from the relationship:

$$x = \sigma R_N + \mu \qquad [3.2]$$

where, R_N is a standard random normal deviate and μ and σ are parameters of the desired normal distribution X.

Evaporation is known to vary with season of the year. For example, long-term mean and standard deviation for evaporation will have a different value in January as opposed to September, if the climate is seasonal. It is therefore, necessary to generate daily evaporation data on a monthly basis. If for example, daily pan evaporation data for a given month follows the normal distribution, then equation 3.2 can be used to generate the data for that month. Using this procedure, daily evaporation data can be simulated for as many years as desired and weekly evaporation data can be obtained by summing the daily data.

To estimate the weekly irrigation requirements using the water balance equation, estimates of weekly EV at different probability levels are required. Therefore, functional relationships between the weekly evaporation and the probability associated with its occurrence must be determined. Although daily evaporation data may follow a particular distribution, weekly evaporation data may not necessarily follow the same distribution.

To determine the best distribution, available distributions can be tested for their ability to describe the observed data, and the distribution that provides the best fit with the data can be selected. With this approach, one could end up with different distributions for the different periods (weeks) under consideration. Alternatively, the data may be normalized using various transformations which can result in a unique distribution and allow the simple properties of the normal distribution function to be used to advantage.

As discussed in Chapter 2, the coefficients of skew and kurtosis serve to indicate whether a set of data is distributed normally. Computer programs written by McCormick (1984) were used to apply the power transformation and SMEMAX transformation methods to EV data. The power transformation uses an iterative process to estimate the value of λ in equation 2.15a. The λ values were assumed to fall between -4 and 4. The proper value of λ was determined when the coefficient of skew (C_s) changed its sign. The program listing is given in Appendix C.

3.3.2 Rainfall (RF)

The water balance equation requires estimates of weekly rainfall values at different probability levels. Daily rainfall observations are required to determine weekly rainfall data. Because of the highly variable character of rainfall, a minimum of at least 30 years of daily rainfall observations are necessary to arrive at reasonably good distributions. Unlike pan evaporation which is bounded by 0 and a maximum of approximately 10 mm/d, daily rainfall data can vary between 0 to more than 200 mm/d depending on the climate in the region. Further, there can be many days with zero rainfall. Although, daily evaporation data can be generated with a few years of observations, it is difficult and unacceptable to generate daily rainfall values by Monte Carlo simulation, with only a few years of available record. Long term daily rainfall observations are therefore required for use in the proposed model.

Weekly rainfall data (similar to weekly evaporation data) can usually be transformed as was proposed for EV in order to normalize their distributions. The rainfall at different probability levels can then be determined for use in the water balance equation.

3.3.3 Seepage and Percolation Losses (PERC)

Seepage and percolation losses are the horizontal and vertical movement of subsurface water, respectively. Seepage usually flows laterally through the field dikes to streams and drainage ways, while percolation is the downward vertical flow of water to the water table. Because the separation of the two is difficult under field conditions, seepage and percolation are usually considered together. Combined seepage and percolation losses will be low for fields located at lower elevations with heavier textured soils and high for light textured soils at higher topographic positions.

Net seepage and percolation (PERC) rates can be determined from the following equation in a trial field:

$$PERC_i = WD_i - WD_{i-1} - ET_i + RF_i \qquad [3.3]$$

where: WD is the water depth and i is the time interval between measurements.

Estimates of seepage and percolation rates need to be estimated from field trials. When seepage and percolation cannot be estimated, the method proposed by Zandra and Samarita (1982) can be used to estimate PERC. For the soils chosen for lowland rice cultivation, net seepage and percolation rates are generally 0-3 mm/d during the wet season.

When water is first applied to the field prior to land preparation, the dry soil is first brought to saturation. This process is commonly known as land soaking and is usually limited to the first week of land preparation. The amount of irrigation water required for land soaking depends on the residual organic matter, soil moisture, soil texture, depth of soil to be saturated (or depth to the hard pan). There is no percolation beyond the plow layer during this period and percolation losses for the first week are therefore zero. Equations 3.1a should be modified under these conditions with the amount of water needed for land soaking, in place of the of PERC (section 3.3.6).

3.3.4 Maximum and Minimum Water Levels (SMIN and SMAX)

The upper limit of water depth (SMAX) is the maximum allowable depth of ponded water on the surface of the field. This value will vary with the stage of the crop. When plants are small it is not desirable to flood the field to great depths. However, as the plant grows taller it has the ability to survive greater flooding depths. Modifying field spillway height is a management technique that allows adjustment of the ponded water depth for cultural practices and to trap rainfall.

The lower limit of water depth (SMIN) is the minimum required water depth for weed control and improved crop production. The difference between SMIN and SMAX is the available surface storage capacity to capture and store rainfall. To make maximum use of rainfall, water levels should be maintained as near SMIN as possible so that maximum possible surface storage is available to capture rainfall.

During initial periods of land preparation, relatively high water levels are required for plowing and puddling. During the latter part of land preparation shallow water depths are desired, to facilitate transplanting or broadcasting pregerminated seeds.

For all rice varieties, plants grow up to approximately 50 mm, during the latter part of the vegetative growth period, and the plants can survive water depths of up to 100 mm. As the plant elongate to its full height during the reproductive growth stage, it can survive flooding depths up to about 150 mm. During maturation and grain filling, water requirements are low.

Table 3.1 is prepared from the discussion of section 2.1.2.2 (Chapter 2) and gives the desired water levels for a short duration (growth duration 15 weeks) broadcasted rice with three weeks of land preparation. Field durations for rice varieties of longer growth periods will be higher. For transplanted rice, seeding is done in seedbeds and transplanting occurs 3-4 weeks after seeding. The transplanted seedlings have the ability to survive deeper flooding depths which allows higher surface storage in the field.

3.3.5 Drainage (DR)

From equation 3.1c, when rainfall and initial water level in the paddy field exceeds the total requirement and the maximum allowable water level (SMAX), excess water will overflow from the paddy dike spillway to drainage according to the following equation.

$$DR_i = (RF_i + S_{i-1}) - (ET_i + PERC_i + SMAX) \qquad [3.4]$$

Table 3.1. SMIN and SMAX for short duration rice crop.

	Land preparation		Vegetative growth period		Reproductive growth period	Grain filling and maturation	
no of weeks	1	2	3	4	3	4	1
SMIN (mm)	50	25	25	25	50	0	0
SMAX (mm)	150	50	50	100	150	75	0

Theoretically, irrigation and drainage should never occur simultaneously since the conditions desired for their occurrence are mutually exclusive.

3.3.6 Irrigation Requirement (IR)

Rewriting the water balance equation 3.1b with IR_i on the left hand side of the equation gives:

$$IR_i = (ET_i + PERC_i + SMIN) - (RF_i + S_{i-1}) \quad [3.5]$$

All of the terms except ET_i and RF_i can be determined in the field. Rainfall and ET_i are the only random variables and are determined from probability distributions of weekly rainfall and evapotranspiration derived from historic records. Since the model employs probabilities of RF_i and ET_i, irrigation requirement estimated this way will be interpreted on a probability basis.

During the first week of land preparation when water is applied to saturate the soil, equation 3.5 can be modified to:

$$IR_i = (EV_i + d\,\eta + SMIN) - (RF_i + S_{i-1}) \quad [3.6]$$

where, EV is the open water evaporation (mm), d is the depth of the plow layer and η is the porosity of the soil. Equations 3.5 and 3.6 are the same except that PERC has been replaced by d η. The depth of the plow layer is usually assumed to be 300 mm and the porosity varies from about 0.3 to 0.45, depending on the soil type.

Irrigation requirements must be estimated for all weeks in the growing season. The date on which land preparation begins may vary from year to year and further, all farmers may not begin land preparation and cultivate according to a fixed calendar. Also, different rice varieties may be grown within a single irrigation system with different growth periods. The age of the crop within the scheme can therefore be variable and crop evapotranspiration which is a function of the age of the plant can be different. Therefore, irrigation requirement estimates should be flexible enough to accommodate the variable conditions that can be encountered.

Substituting $ET = k \cdot EV$ and rearranging equation 3.5 gives:

$$IR_i = (k \cdot EV_i - RF_i) + PERC_i + SMIN - S_{i-1} \qquad [3.7]$$

Since EV and RF are the only random variables, the terms within parenthesis can be analyzed separately. Having obtained probability functions for RF and EV, probability functions of ($k \cdot EV - RF$), can be determined for different values of k. Values of k ranging from 1.0 to 1.3 covers all stages of the crop growth periods. Therefore, ($k \cdot EV - RF$) can be estimated at different probability levels for $k=1.0$, $k=1.1$, $k=1.2$ and $k=1.3$. With this approach estimates of (ET - RF) for the water balance equation can be obtained for all stages of the crop when it coincides with different periods of the monsoon (rice growing period).

Irrigation requirement based on probability levels gives an indication of the percentage of times when irrigation will be adequate to meet the crop water needs. For example, the 85% probability level corresponds to an irrigation requirement that is equal to or less than the given amount 17 out of 20 years, while the 95% level states that 19 out 20 years the irrigation requirement will be equal to or less than the given amount. In other words, when operated at 85% probability, there is 85% chance that the irrigation applied will be equal or greater than the actual required amount in the given period. During critical periods, when the plant is most sensitive to moisture stress (reproductive growth stage) the system can be operated at higher probability levels (such as 90%). while during all other less critical periods lower probability levels can be used.

It should be noted that when values of EV and RF have been estimated at a certain probability level, the value of ($k \cdot EV - RF$) will correspond to a probability level greater than the product of the individual probability levels at which EV and and RF are estimated. This can be shown in the following way:

Let $P\{EV \leq a\}$ = probability that EV will be less than or equal to the value a and

$P\{RF \geq b\}$ = probability that RF will be greater than or equal to the value b.

$$\{EV \leq a \text{ and } RF \geq b\} = \{EV \leq a\} \cap \{RF \geq b\} \qquad [3.8]$$

Since EV and RF are idependent, therefore,

$$P\{EV \leq a \text{ and } RF \geq b\} = P\{EV \leq a\} \cdot P\{RF \geq b\} \qquad [3.9]$$

$$\text{but} \qquad \{EV \leq a \text{ and } RF \geq b\} \leq \{(EV - RF) \leq (a - b)\} \qquad [3.10]$$

$$\text{therefore,} \qquad P\{EV \leq a \text{ andRF} \geq b\} \leq P\{(EV - RF) \leq (a - b)\} \qquad [3.11]$$

From equation 3.9, the inequality in equation 3.11 can be written as:

$$P\{EV \leq a\} \cdot P\{RF \geq b\} \leq P\{(EV - RF) \leq (a - b)\}$$

To illustrate how probabilities are determined, consider for example a and b to be the values of EV and RF estimated at 95% probability

$$\text{i.e.} \qquad P\{EV \leq a\} = 0.95 \text{ and } P\{RF \geq b\} = 0.95$$

$$\text{then} \qquad P\{(EV - RF) \leq (a - b)\} \geq 0.95 \cdot 0.95 = 0.90$$

Estimates of (ET - RF) can be interpreted as the amount of irrigation water required when PERC, SMIN and S_{i-1} are equal to zero. Values of S_{i-1} will have to be measured in the field prior to irrigation. Minimum required water level (SMIN) is a function of age of plant and PERC is dependent on soil type and field location. If percolation losses are estimated at 3 mm/d (from field observations), then the total percolation losses for a week would be 21 mm. Similarly if PERC were 2 mm/d or 1 mm/d its weekly value would be 14 mm or 7 mm, respectively. Therefore, irrigation requirement will be determined by substituting the (ET - RF) value estimated at the desired probability level and values for PERC, SMIN and S_{i-1} from field measurements, in equation 3.7. Irrigation requirements estimated this way will enable the irrigator to update estimates based on the available conditions in the field prior to irrigation.

3.4 Distribution System Scheduling

The scheduling of irrigations to individual fields is important towards achieving high irrigation efficiencies for site specific field conditions and irrigation methods. However, the scheduling of field irrigations alone will not achieve the goal of optimum water use efficiency for an irrigation project. It is also important that on farm water management practices be incorporated into the distribution system to achieve the overall goal of conserving water. For example, if more water than needed is released, the excess water will be lost to drainage, unless drainage water is utilized somewhere downstream for useful purposes. On the other hand, if less than the required amount of water is supplied, yields will decline.

During each week, a carefully estimated quantity of water (taking into account the probable rainfall) should be diverted into each turnout area. Field irrigation scheduling must not only take into account the irrigation facilities, equipment capabilities and field characteristics, but also the delivery of water to the farm turnout at the proper time and in the quantity required. Therefore, to achieve full potential of water savings, management decisions for the system must be made and gate settings in the canals changed to reflect changing demands.

3.5 Turnout Schedules

Each turnout must be scheduled before a canal or lateral system can be scheduled. The turnout schedule identifies the acreage, the initial water level in the fields, the stage of growth of the crop and hence the irrigation requirement. Each block (cluster of fields) in an irrigation project is associated with a turnout, distributary canal, and/or branch canal and main canal.

This part of the analysis will develop a canal conveyance model for designing and managing irrigation canals. Since the objective of this dissertation is to propose a method to conserve water, it is necessary to divert only the estimated amount of water required for each period of crop growth. The EXTRAN hydraulic flow routing model was evaluated for its ability to simulate water depths in an irrigation canal system. These depths then were used to determine how the irrigation structures in the main canals and distributary canals had to be operated to divert the required amounts of water into the fields.

chapter 4

Model Demonstration

4.1 Description of Demonstration Area

4.1.1 Rice Cultivation in Sri Lanka

Rice cultivation is by far the dominant agricultural enterprise in Sri Lanka where more than 90% of the population of 15 million depend on rice as their major food source. The basic factor limiting rice production is inadequate supply of water. To increase the rice production, regional water management and irrigation schemes have been designed and constructed. However, the strategy adopted to increase the area of cultivation by constructing large irrigation systems has not yielded optimum results because management practices required for increased output have been overlooked.

In 1981, Sri Lanka produced enough to meet 90% of its rice requirement (Alwis *et al.*, 1983). While total paddy production has been increasing, it has been achieved mainly through increased acreage and through the use of high yielding varieties. Much greater improvement in productivity could be achieved by intensifying the use of available land and water.

4.1.2 Dry Zone and Wet Zone

The island of Sri Lanka lies approximately 7 degrees north of the equator. Depending on availability of rainfall, the island is conventionally divided into two regions, the Dry Zone and Wet Zone (Figure 4.1). The southwestern quarter of the island, the Wet Zone, receives rainfall from both the southeast monsoon (*Yala* season, April to September) and the northeast monsoon (*Maha* season, October to March) with an annual rainfall of more than 2,000 mm. The rest of the island, the Dry Zone, receives only the northeast monsoon (Maha season). During the Yala season, this part of the country is dry with only small amounts of rainfall.

The Wet Zone contains only one-fourth of the total land area of Sri Lanka. It is densely populated and all available land is used. The Dry Zone on the other hand, has not been developed for centuries primarily because of low agricultural productivity due to inadequate precipitation during the dry season. There is a dilemma concerning paddy cultivation in Sri Lanka. The Wet Zone has abundant moisture but a shortage of land while the Dry Zone has a shortage of water but available land. In recent years, much emphasis has been placed on the development of the Dry Zone through both rehabilitation of old irrigation systems and construction of new systems.

4.1.3 Paddy in the Dry Zone

The total annual rainfall in the Dry Zone is less than 2,000 mm. The seasonality in rainfall distribution and its variability is noted in Figure 4.2. The rainfall distribution is bimodal with major peaks occurring in the months of September-December and March-April. About 70

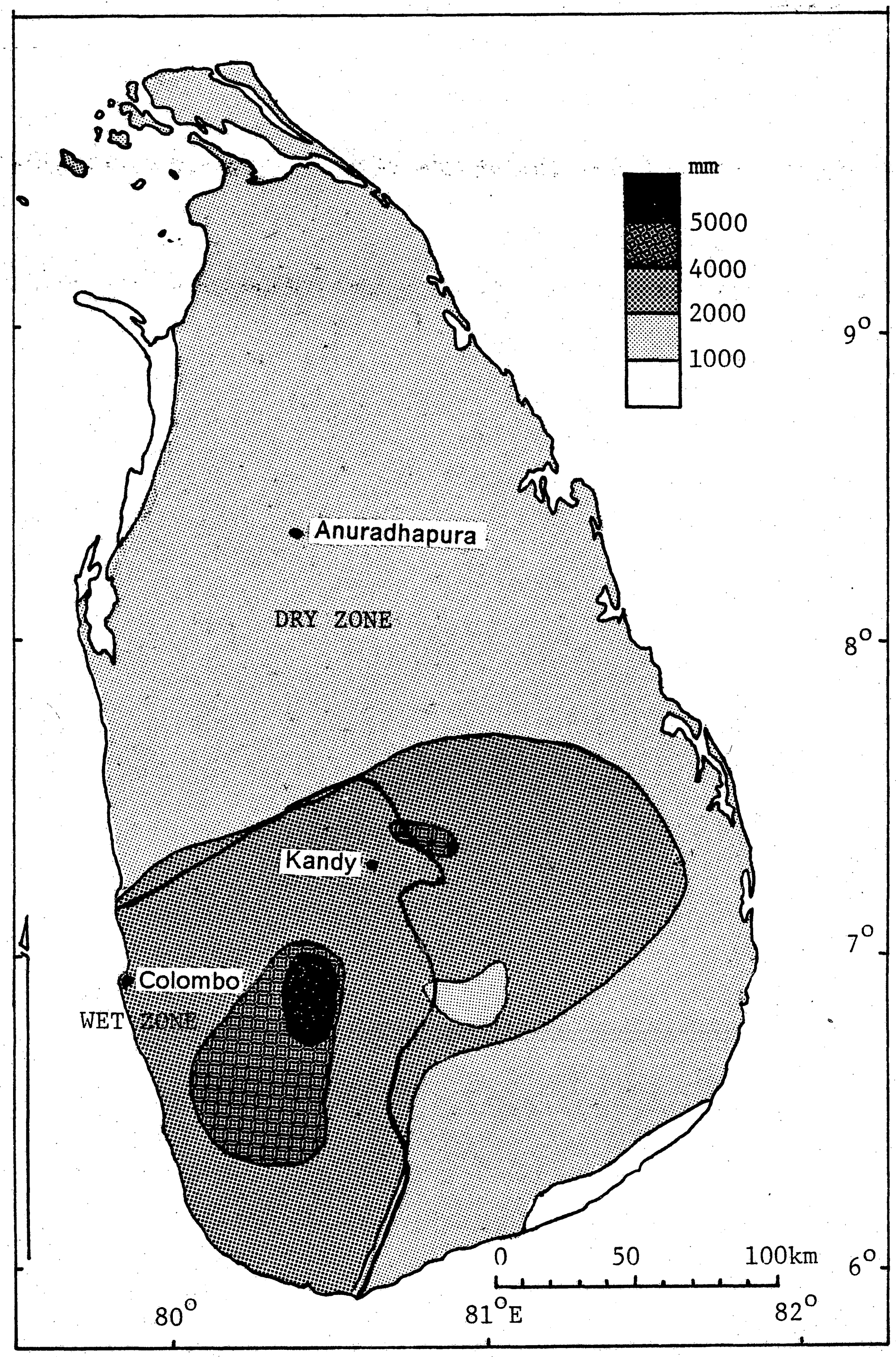


Figure 4.1. Sri Lanka, mean annual rainfall (cited in Johnson, 1981).

percent of the total annual rainfall occurs during the months of September through December which coincides with the major cultivation season (Maha season). The heavy rains are followed by a short dry spell from January to mid March. Most of the remaining rainfall occurs during the first two months of the Yala season between late March and early May. Because of its erratic nature, however, water for three quarters of the Yala crop is dependent on irrigation from reservoirs or tanks. Relatively small areas of the Dry Zone are used for cultivation during the southwest monsoon because it is almost entirely dependent on irrigation which is generally inadequate.

4.1.4 Mahaweli Ganga

To alleviate the water shortage problem in the Dry Zone, Sri Lanka's largest river, the Mahaweli Ganga, is being developed as a source of irrigation water. This river produces one fifth of the island's total runoff and has its headwaters in the Wet Zone highlands. One third of its average flow of 2,462 x $10^6 m^3$ occurs during the Yala season when water is scarce (Johnson, 1981). Since the river flows from the Wet to the Dry Zone, substantial quantities of water are brought to the region where it is most needed. An important feature of the river is that its flow is well in excess of the irrigation needs of the lowlands within the Mahaweli basin.

The Mahaweli Development Scheme was developed to harness the resources of the Mahaweli and its tributaries for irrigation. To develop the full irrigation possibilities within the basin and adjacent river basins, it was decided to transfer surplus water into the upper reaches of the Kala Oya river and other Dry Zone rivers. Water will then be stored in existing and new reservoirs to make possible double cropping of rice and other crops. Water is diverted across Mahaweli near Kandy through a 8 km tunnel to a power station on a tributary of the *Amban Ganga*. A reservoir at *Bowatenna diverts* some flow through a 6.4 km tunnel and canals lead to branches of the *Kala Oya River* and to Kalawewa resevoir and other nearby reservoirs (Figure 4.3).

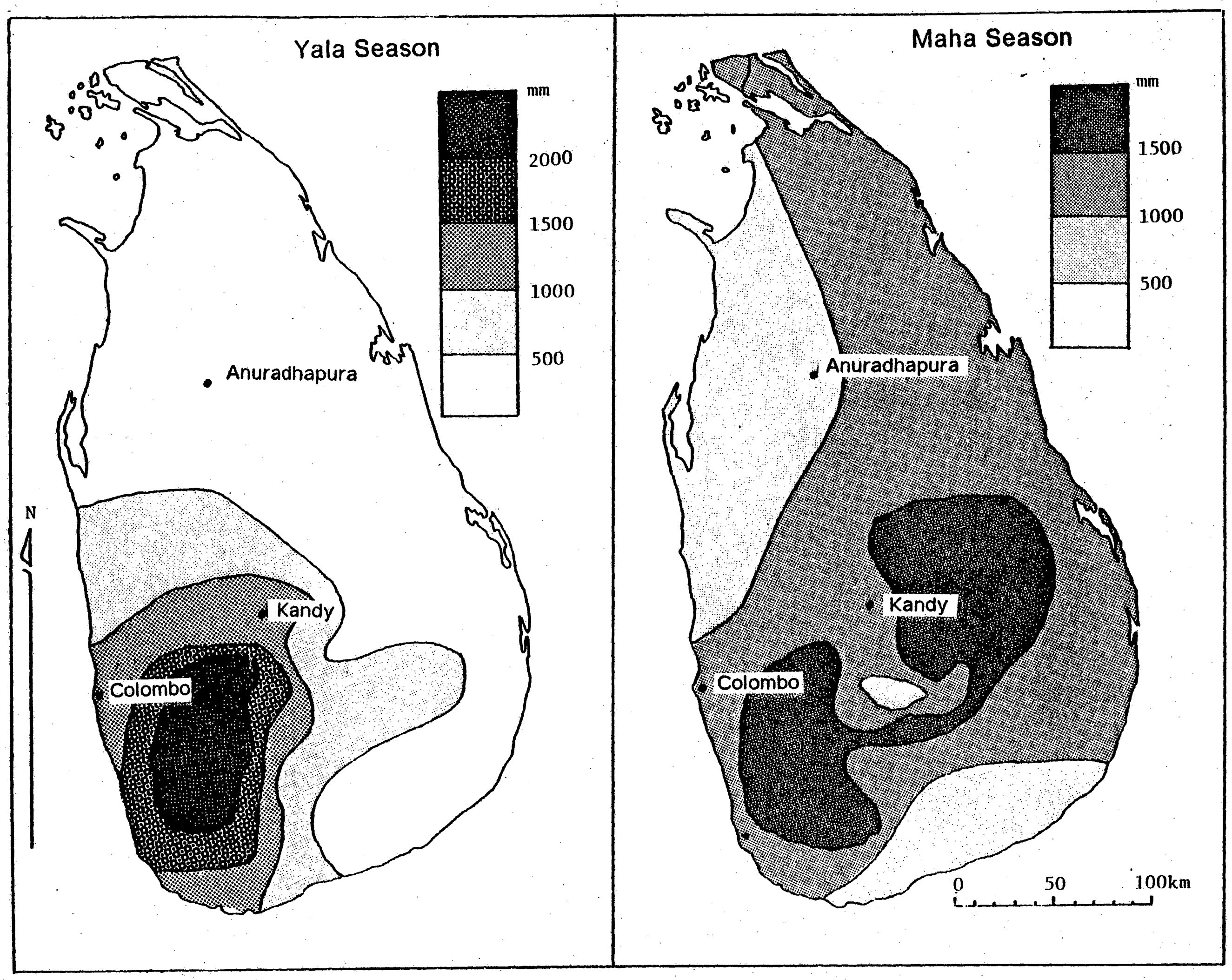


Figure 4.2. Sri Lanka rainfall by season (cited in Johnson, 1981).

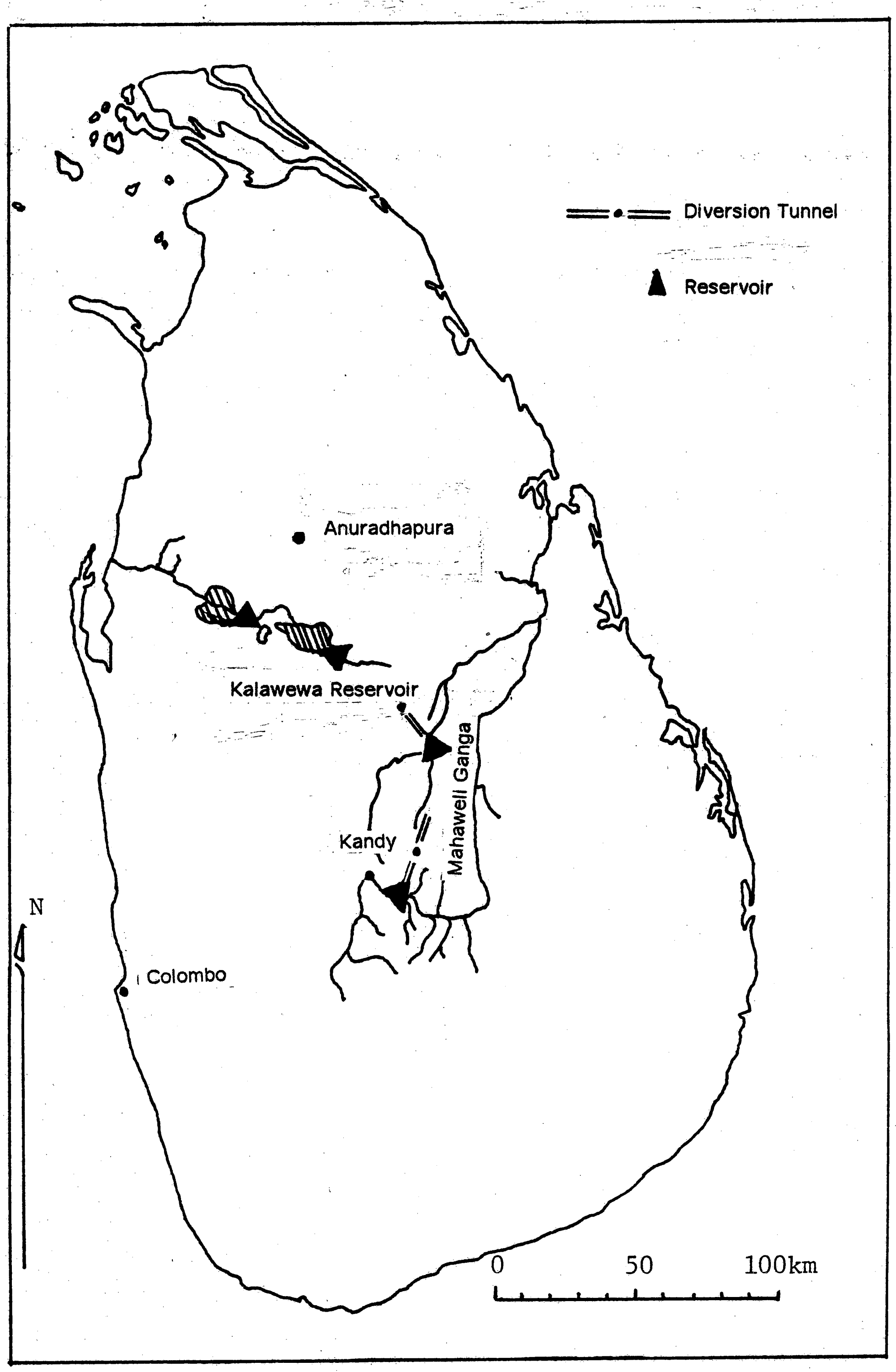


Figure 4.3. Location map of study area.

4.1.5 Kalawewa Reservoir

The Kalawewa reservoir is a regulating reservoir, serving a major portion of system H in the Mahaweli diversion scheme. The prime objective of this reservoir is to store water to make double cropping of rice possible in its commanded area. At present, the right-bank and left-bank main canals provide irrigation water through new irrigation facilities to 19,295 ha and 6,160 ha of land, respectively (Alwis *et al.*,1983).

The diversion of Mahaweli water into the Kalawewa reservoir brought about development of the region which had been relatively unpopulated. Previously, the land in production was cultivated only during the Maha season. The Mahaweli diversion increased water availability to allow crop production during both seasons. However, inefficient use of irrigation water during the wet season, leaves insufficient water in the reservoir for the Yala season crop. This is a common problem in many of the major irrigation schemes in Sri Lanka. These problems and their implications have made it essential to improve water management techniques so that the full benefits of Dry Zone development can be achieved.

4.1.6 Study Area

System H of Mahaweli development covers about 39,855 ha of irrigable land at present. The area is divided into several subsections, H_1 to H_{12}. Sections H_1 to H_5 and H_{10} receive water from the Kalawewa reservoir. The demonstration area selected to demaonstrate the water management system presented herein is located in the left bank of Kalawewa main canal (Figure 4.4, sections H_6 to H_9 are on to the right side of Kalawewa reservoir and is not shown in Figure 4.4). The demonstration area is approximately 38 km southeast of Anuradhapura, the capital of the north central province. Paddy varieties of short growth duration (105 days) such as BG 276-5 and BG 34-8 along with chili are the predominent crops in the area. Rice

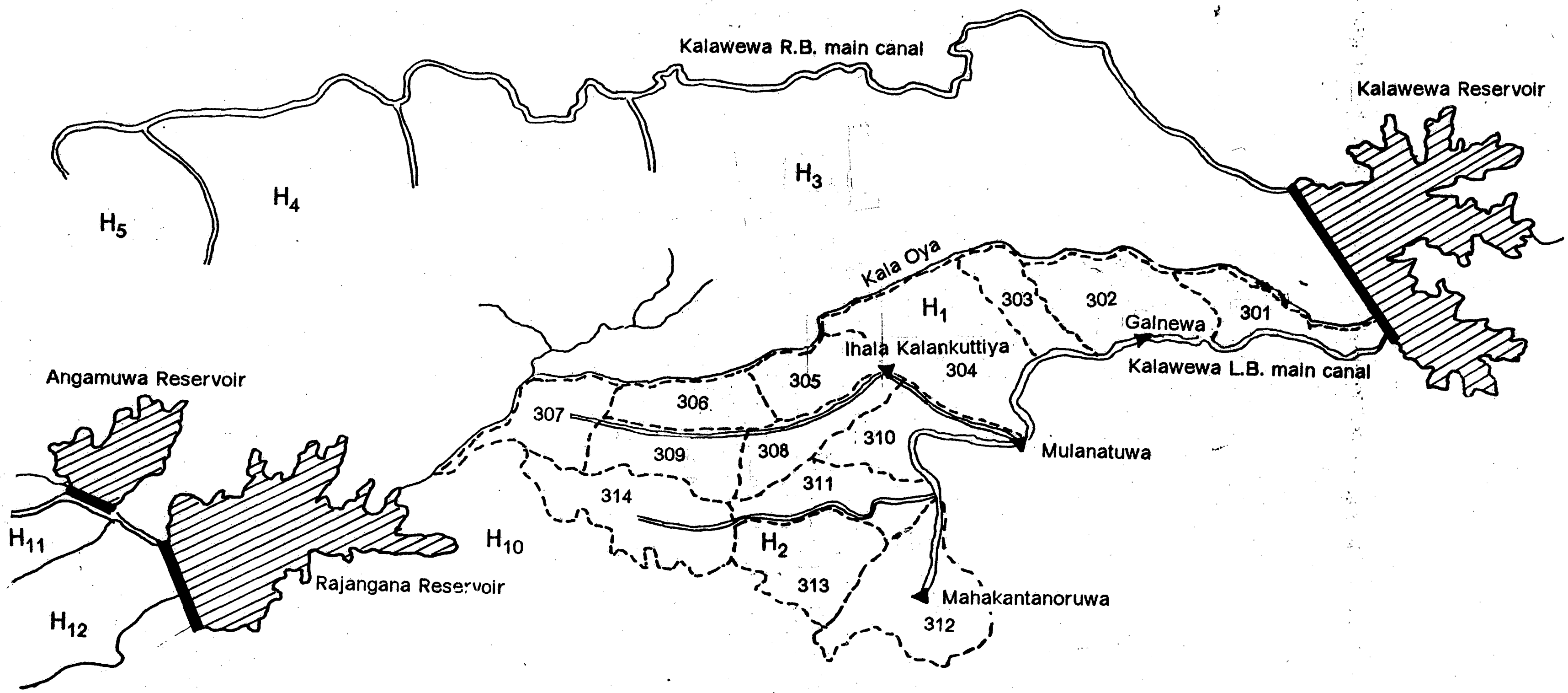


Figure 4.4. Map of study site in system H of Kalawewa.

is planted primarily using the broadcast method. Data collected by the On Farm Diagnostic Analysis of Farm Irrigation Systems group in August 1982 (Alwis *et al.*, 1983) was chosen to demonstrate the usefulness of the water management system.

4.1.6.1 Soil Type

Soil textures range from sandy clay loams to heavy clays. The well drained soils at the upper reaches of the turnout area are sandy clay loams to a depth of 30 cm overlain by sandy clays approximately 10 cm thick. The soil in the lower reaches has a very high clay content and is nearly impermeable.

4.1.7 Kalawewa Canal Network Description

The left bank main canal feeds a large number of distributary channels (D-channels). D-channels in blocks 301, 302, 303, 304 and 310 are supplied directly from the left bank main canal. Three tanks, namely, the Galnewa, Mulanatuwa and Mahakantanoruwa tanks are located on the left bank main canal. These tanks are supplied with water from their local catchments and supplemented by the Kalawewa reservoir. These small tanks act as storage reservoirs in the left bank main canal. The left bank main canal branches off (in block 311) to supply irrigation water to the D-channels in block 311, 313 and 314. D-channels in block 312 are fed from the Mahakantanoruwa tank. The Mulanatuwa tank feeds water to the Ihala Kalankuttiya tank which in turn feeds water to the D-channels in blocks 305, 306, 308 and 309.

4.1.8 Operation of Irrigation System

Turnout structures with cast-iron gates are provided to control water from the main and branch canals to D-channels. D-channels supply water to field channels (F-channels) via turnout structures (T.O.) into turnout areas. Each turnout area serves about 14 to 16 ha farms. Water to the individual fields are supplied through the F-channels. Farm turnouts are provided with 15 cm diameter circular orifices. Figure 4.5 is a plan view of F-channel 1 which carries water from T.O. 5 (block 302) to serve 16 fields (fields 50-65).

The following procedures are planned to operate the system and issue water to the commanded areas:

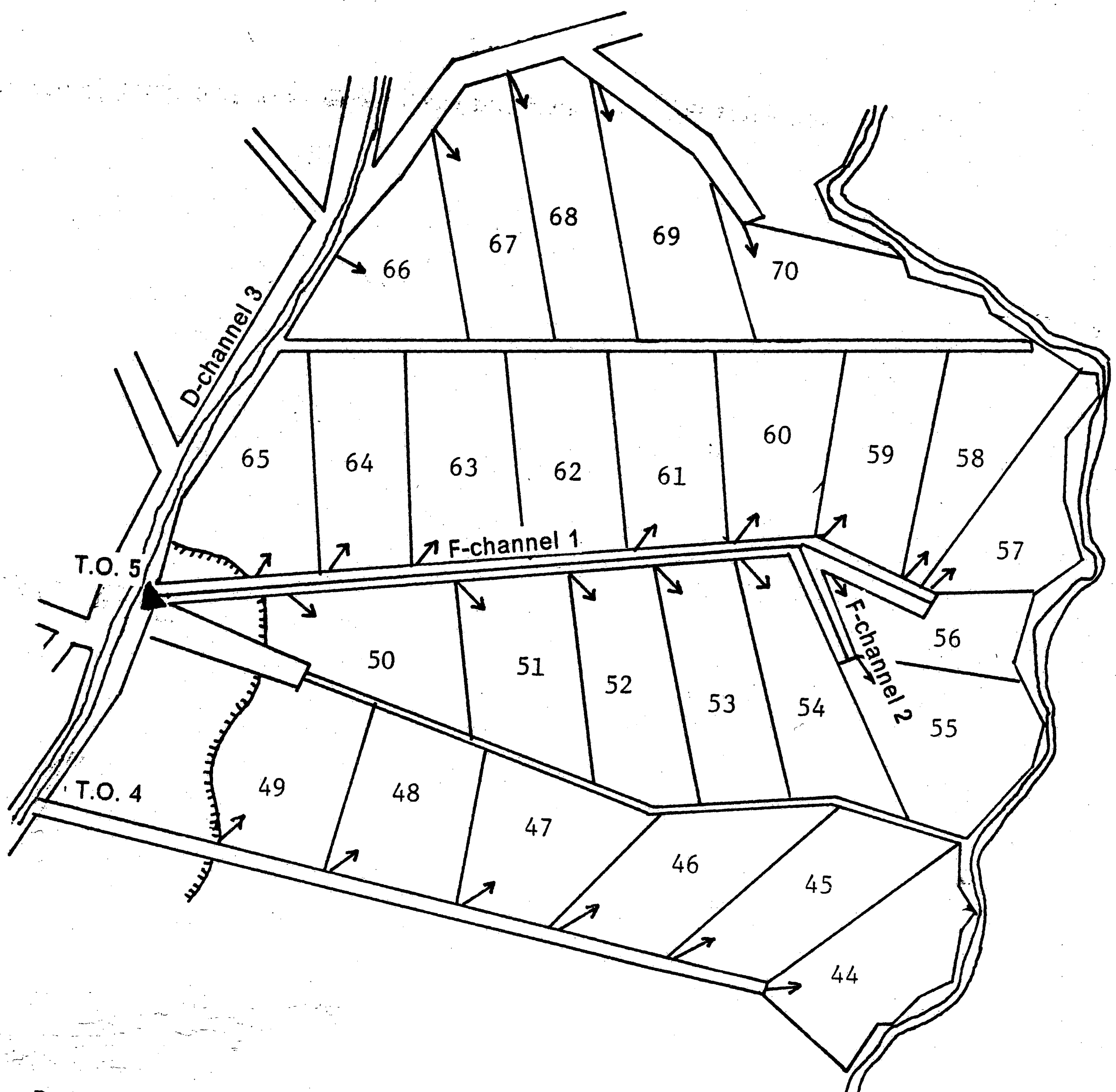
1. Main canal: continuous water issue, sufficient to maintain downstream reservoirs and D-channels upstream of next reservoir.

2. Branch canal: issue scheduled for 7 days of the week,

3. D-channel: continuous or intermittent, but 3-4 days issue prefered,

4. F-channel: depending on the number of allotments to feed, F-channels are kept open for four days with a discharge of 28 l/s (1-cusec) to supply every four allotments (4 ha) per day at the rate of 64 mm of water for a week's period.

According to the present design for lowland paddy, 270 mm of water is supplied for the first and second flooding, over a period of 3 weeks. Thereafter, 64 mm per week is supplied until 15 days before harvest. The estimate of 64 mm per week is based on, seepage and percolation losses of 3.0 mm/d, constant evapotranspiration losses of 6 mm/d and 15% canal conveyance loss in F-channels.



D-channel 3 T.O. 5 (F-channels 1 and 2)

Scale: 49 m 1 cm

Figure 4.5. Map of F-channel 1 T.O. 5

4.1.8.1 Conveyance Losses

The channel network was designed to supply daily peak requirements based on the crop's water requirements and allowed for conveyance losses of 6 percent in D-channels and 15 percent in F-channels. The left bank main canal feeds a large number of D-channels. Main and branch canals are lined and therefore there are no conveyance losses in the main and branch canals.

At several sections, the canal cross sections are different from the original design and the cross sections vary significantly along the length of the canal. Except for 137 m of lined section at the beginning of D-channel 3, the balance of the earthen sections are irregular in shape. The average width of the existing channel was 3 m at the time of the survey which is much greater than its design width of 1 m. Erosion has obviously been a serious problem in the canal system.

The measured conveyance losses in the D-channels ranged from 2.5 to 17.4 percent per 1,000 m channel length (Alwis *el al.*, 1983). The high percolation losses in the channels were due to poor maintenance resulting from erosion. The excessive loss of 17.4 percent in the distributary channels were due to leaks in the turnouts and channel overflow caused by elevated crest levels (Alwis *et al.*, 1983) of the turnout structures.

4.2 Irrigtion Scheduling Model Application

In principle, the proposed irrigation scheduling model is applicable to both the wet and dry cropping seasons, but emphasis in this research is directed towards the wet season crop when the primary water source is rainfall. The wet season is considered, because of its relatively low irrigation efficiencies, and because of its potential to improve irrigation application efficiencies which can result in significant water savings. The water thus saved could then be used to expand the irrigated area in the dry season.

4.2.1 Wet Season Cropping Schedule

The date on which the wet season crop production starts, depends on rainfall distribution for the season and the field duration of the crop. For Kalawewa, maximum rainfall is experienced from October to December. For maximum water use efficiency, it is important that the vegetative and reproductive growth stages occur from early October to late December and the ripening periods to occur during the drier months. With broadcast seeding, the rice growing period would be 105 days (15 weeks) for the rice varieties commonly grown in the area. Allowing 3 weeks for land preparation, the total field duration for the crop would be 18 weeks ($\cong$ 4.2 months). Since the monsoon peak occurs from the middle of October to the middle of January, the most promising calendar in terms of making maximum use of rainfall, would be to begin land preparation during the middle of September.

Although, it is most desirable to begin land preparation during the second week of September, farmers do not necessarily adhere to a fixed schedule and land preparation may begin anytime in September. Therefore, the proposed method should be flexible enough to estimate irrigation requirement independent of the date on which land preparation commences.

Depending on the distribution of rainfall and evapotranspiration, irrigation requirement will vary for different weeks beginning on different days. For example, irrigation requirement estimated for the week beginning September 10, would differ from that estimated for the week beginning September 11. Estimates of irrigation requirement should therefore, be made for at least 19 weeks beginning on the 10th, 11th., ... 16th of September. If land preparation were to begin on any day after the 16th of September, for example on the 17th of September, then the first week of land preparation would coincide with the 2nd week of the weekly series beginning September 10. Similarly, if land preparation were to begin on the 18th of September, then first week of land preparation would begin on the 2nd week of the weekly series beginning on the 11th of September. With this approach, there would be 7x19 (=133) weeks to be analyzed to estimate irrigation requirements. Therefore, weekly rainfall and evaporation will be analyzed for 133 weeks under consideration, ie., 133 data sets each of rainfall and evaporation to determine its distributions.

4.2.2 Basic Data

4.2.2.1 Rainfall Data

The rainfall data used in the analysis were obtained from the research station at Maha Iluppallama near Kalawewa. A total of 34 years of daily rainfall data between 1952-1985 were available. Records were not available for December 1960, January 1961 and from November 27 to December 19, 1968 (Table A1, Appendix A). Table A1 clearly demonstrate the character of the rainfall in the area.

Weekly rainfall data were obtained from daily rainfall data for all weeks beginning on all days from September 10 to January 20.

4.2.2.2 Evaporation Data

Evaporation data for Maha Iluppallama were available from 1957 to 1965 and 1970 to 1984. However, daily records were not complete for the available years of record. During some months of the years no records were available and there were days within months when records were not available. When heavy rainfall occurred, the evaporation pan often overflowed and observations were not possible. This was common in November and December when rainfall was heavy, resulting in gaps of one to 4 days in daily evaporation records. Further, from 1959 to 1963 observations were recorded with an evaporimeter, while all other observations used an evaporation pan. To be used in the proposed model, it was necessary that the observations be continuous for the entire rainfall record and that all observations be recorded with a evaporation pan. Since rainfall observations were available for the years 1952 to 1985 it was necessary to generate evaporation data to cover the missing periods.

During 1964 and 1965 daily observations were continuous with recordings made both with a evaporation pan as well as with an evaporimeter. Therefore, it was possible to determine a relationship between the recordings of the two apparatus by carrying out a regression analysis between daily observations of pan evaporation and evaporimeter. Figure 4.6 shows the plotted points of daily observations for 1964 and 1965 with the two instruments.

A quadratic regression provided the best fit with a correlation coefficient (r^2) of 0.751. The relationship between pan evaporation and evaporimeter recordings was determined to be:

$$y = 0.635 - 0.026x + 0.971x^2 \qquad [4.1]$$

where y is the pan evaporation estimate and x is an evaporimeter observation. Using the above relationship, daily pan evaporation data were estimated for the years during which only evaporimeter records were available.

It was necessary to develop pan evaporation data for the years during which rainfall records were available and pan evaporation was not recorded. Since the analysis is for wet season, it was necessary only to simulate evaporation data for the months of September to February. Available daily observation for each of these months were analyzed to determine the distributions that gave a good fit.

The normal distribution was found to give an adequate fit for daily observation of evaporation for each of the months under consideration. Grand mean and standard deviations for the months in the wet season were determined to be:

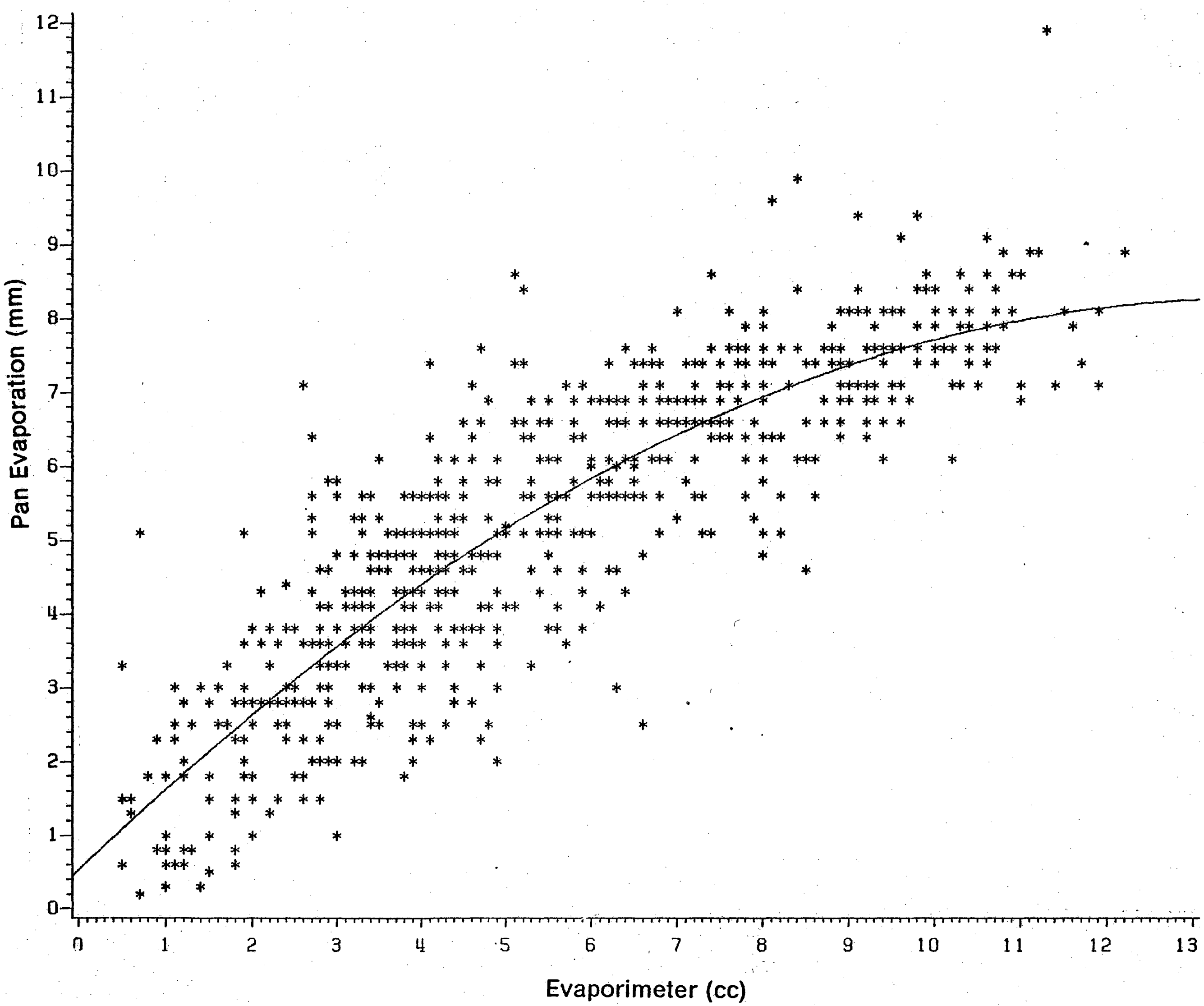


Figure 4.6. Relationship between pan evaporation and evaporimeter recordings.

	September	October	November	December	January	February
mean (mm)	3.638	4.461	6.581	4.832	3.084	3.052
Std. dev. (mm)	1.366	1.518	1.609	2.083	1.387	1.344

Having determined that the normal distribution adequately fitted the daily evaporation data and having obtained the means and the standard deviations for the months of interest, it was possible to use equation 3.2 to simulate pan evaporation data. Relationships used to generate data for the months in the wet season were:

September $x = 1.366\ R_N + 3.638$ [4.2a]

October $x = 1.518\ R_N + 4.631$ [4.2b]

November $x = 1.609\ R_N + 6.581$ [4.2c]

December $x = 2.083\ R_N + 4.832$ [4.2d]

January $x = 1.387\ R_N + 3.084$ [4.2e]

February $x = 1.344\ R_N + 3.052$ [4.2f]

where, R_N is a random variable with mean 0 and variance 1 (properties of the standard normal distribution), the coefficient associated with R_N is the standard deviation, the other independent coefficient is the mean for the corresponding month, and x is the generated value.

To investigate the relationship between rainfall and evporation, daily pan evaporation observed in December (month with maximum rainfall) was plotted against daily rainfall for December. If a relationship could be established between the two variables, it would be more appropriate to use the relationship between rainfall and pan evaporation to fill gaps in pan evaporation observations on days when the evaporation pan overflowed. However, from figure 4.7 it is seen that there is no definite relationship between the two variables.

Since no relationship between daily rainfall and pan evaporation were obtained, the Monte Carlo simulation described earlier was used to fill all gaps in evaporation records. Observed and simulated daily pan evaporation data are given in Table A2, Appendix A.

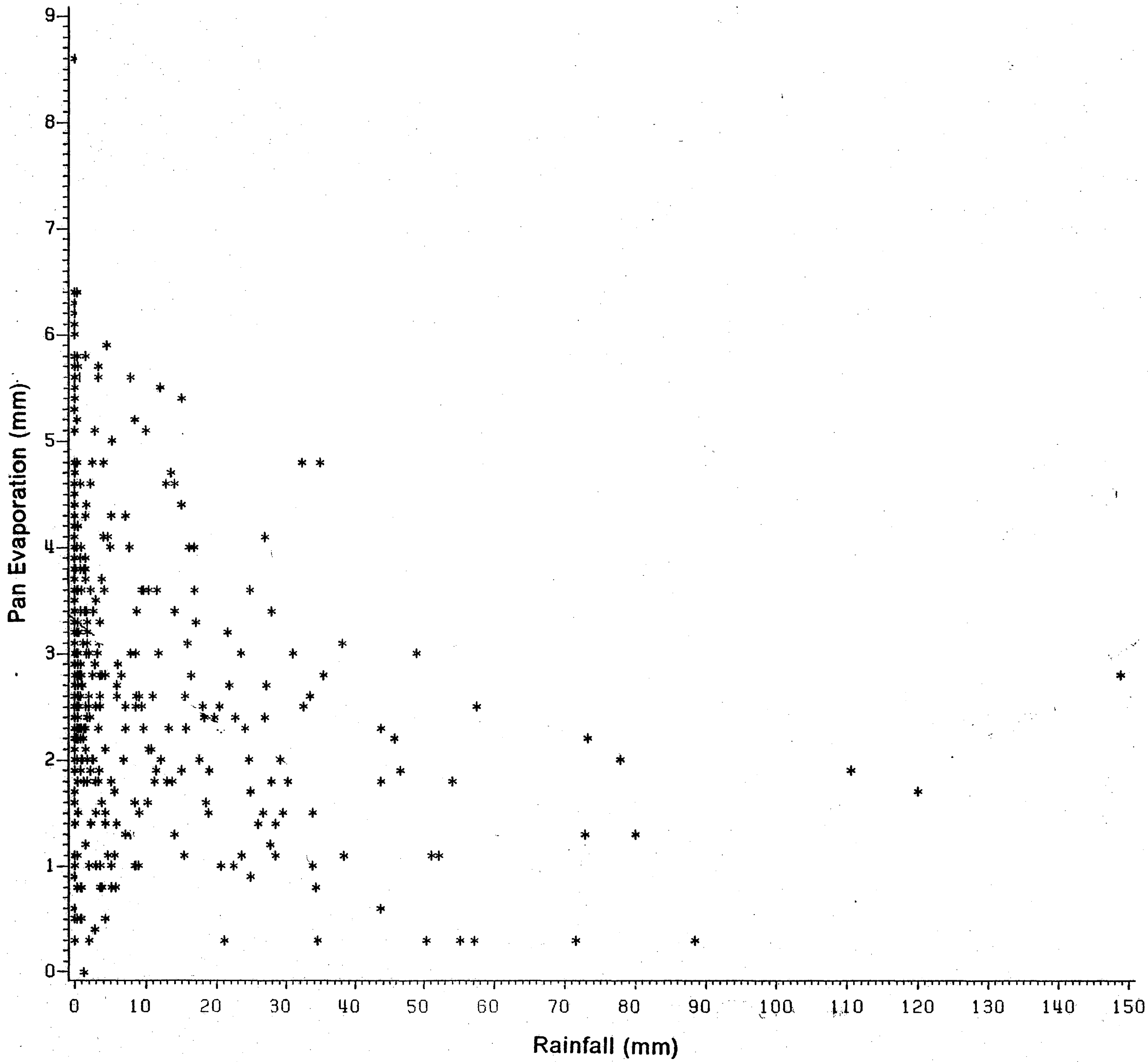


Figure 4.7. Relationship between daily rainfall and pan evaporation

Having obtained daily evaporation data, weekly evaporation data were determined to cover all weeks in the wet season. Although, no relationship between the two variables were observed, longterm mean weekly RF and EV, when plotted against time showed an inverse relationship between the variables (Figure 4.8). i.e. when rainfall was high, pan evaporation was low. The relationship was weak however, and could not be represented by an equation.

4.2.3 Analysis of Weekly Rainfall Data

There were 133 data sets of weekly rainfall data for which distributions were tested. The data sets consisted of 31 to 34 years of record. Whenever, rainfall records were missing for part or all of a week (December 1960, January 1961, and November 27 to December 19, 1968) such periods were eliminated from calculations. During September, January and early February (beginning and end of the Maha season) approximately one third of the data were equal to zero. Therefore, a mixed distribution with a point distribution to represent the zero rainfall should theoretically give the best results. For the present data sets however, which has a maximum of only 34 data points per period and with approximately one third of the data being equal to zero, the remaining data points were inadequate to fit any distribution.

The following distributions and transformations were evaluated to assess their suitability to describe the distribution of weekly rainfall values.

1. Normal distribution

2. Power transformation

3. SMEMAX transformation

A necessary condition for normality is that the coefficient of skew (C_s) and coefficient of kurtosis (C_k) should equal zero and three, respectively. Values C_s and C_k calculated from the

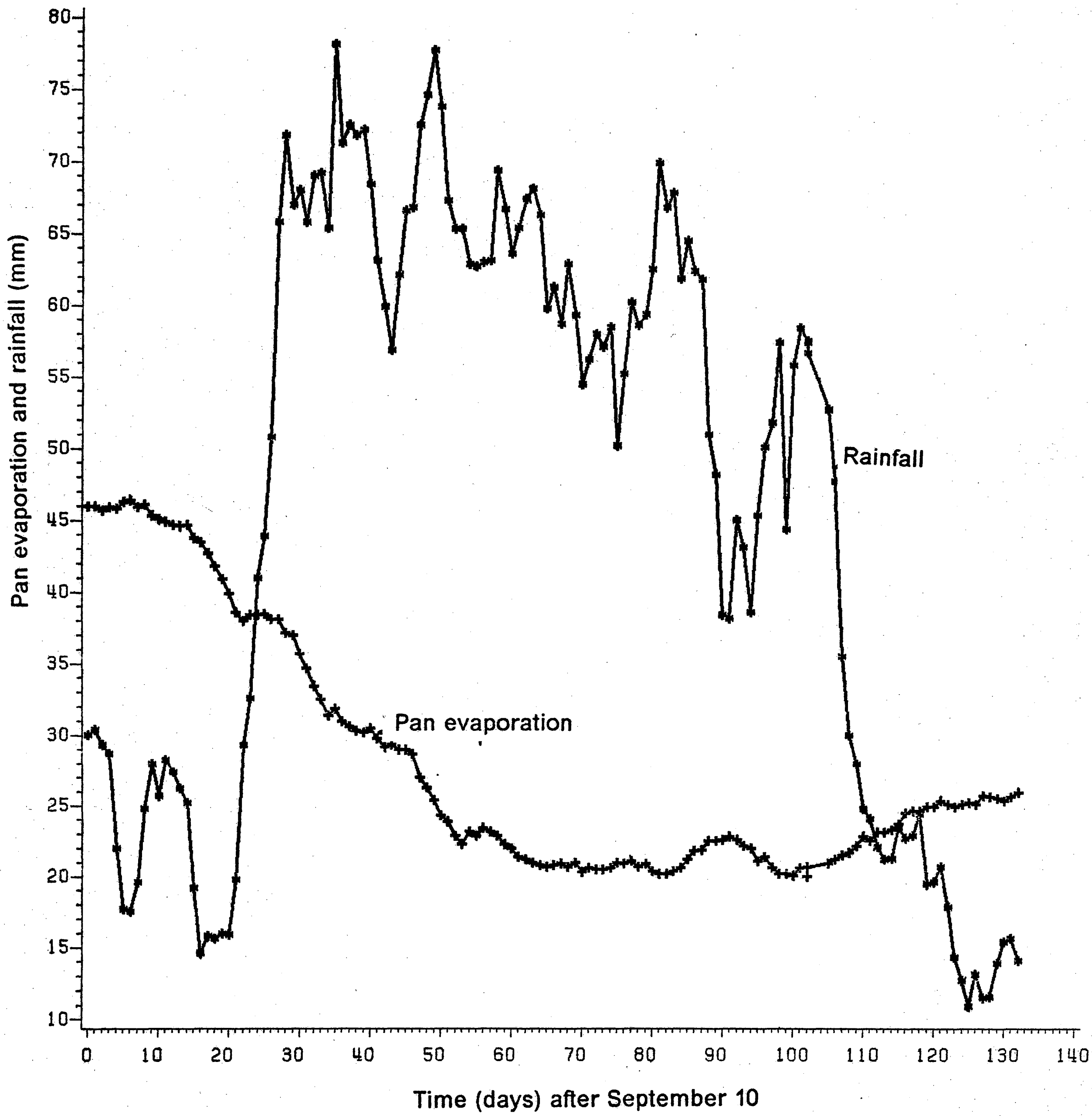


Figure 4.8. Relationship between longterm mean weekly rainfall and pan evaporation.

data without transformation were significantly different from zero and three, which eliminated the use of the normal distribution.

The values of C_s and C_k did not approximate to the required values of zero and three with the SMEMAX trasformation, thus eliminating the use of the SMEMAX transformation to describe the variation of weekly rainfall. For the power transformation, C_s' equaled zero for all sets of data, however, C_k' did not approximate to three for all sets of data. Values of C_k ranged between 1.2 to 6.8, and provided better approximations to 3 than those determined from the untransformed data and the SMEMAX transformation.

Although, values of C_s and C_k serve to indicate how close the set of data is to normal distribution, it is not a determining criteria for normality. Therefore, to test the transformed data for normality, the Shapiro-Wilk statistic, W, was computed (SAS, Users guide, 1982). For all sets of data, W computed was closer to 1, which is a requirement to accept that the data sets are normally distributed. Therefore, the power transformation was accepted to describe the variation of weekly rainfall values.

Weekly rainfall data with estimated mean (μ), standard deviation (σ_{n-1}), C_s and C_k for observed data and the corresponding values of transformed data (using power transformation) are given in Table 4.1. Notations with prime are estimates of transformed data and λ is the power of the transformation that transformed the data to normal distribution.

4.2.3.1 Comparisons of Distributions

The probability of exceedence of rainfall for the normal distribution can be calculated directly by transforming the variable x (weekly rainfall in this case) to z limits. For example for the first week beginning the 10th of September (μ = 30.04 and σ = 54.31) the probability that rainfall will be greater than 10 mm is:

$$P(x \geq 10) = P(z \geq \frac{10-\mu}{\sigma}) = P(z \geq \frac{10-30.04}{54.31}) = P(z \geq -0.369)$$

Table 4.1. Parameters estimated for weekly rainfall data.

week	μ	σ_{n-1}	C_s	C_k	λ	μ'	σ'_{n-1}	C'_s	C'_k
1	30.04	54.31	2.320	7.859	0.177	0.44	5.25	0.000	1.502
2	30.38	55.32	2.445	8.664	0.172	0.25	5.41	0.000	1.425
3	29.32	54.04	2.610	9.655	0.165	0.02	5.41	0.000	1.457
4	28.71	56.25	2.612	9.599	0.139	-0.84	5.83	0.000	1.339
5	21.98	37.98	2.254	8.196	0.131	-1.39	5.98	0.000	1.201
6	17.70	25.82	1.332	3.575	0.188	0.17	4.76	0.000	1.387
7	17.46	24.25	1.376	3.920	0.247	1.22	4.43	0.000	1.472
8	19.64	29.52	1.835	5.877	0.241	1.29	4.55	0.000	1.539
9	24.77	42.39	2.840	12.124	0.224	1.30	4.81	0.000	1.587
10	27.98	51.72	2.494	8.561	0.196	0.90	4.96	0.000	1.637
11	25.71	49.92	2.813	10.422	0.180	0.34	5.08	0.000	1.530
12	28.26	51.72	2.892	11.055	0.225	1.50	4.92	0.000	1.680
13	27.36	50.21	2.664	9.679	0.218	1.52	4.67	0.000	1.847
14	26.16	46.30	2.541	9.396	0.214	1.29	4.75	0.000	1.716
15	25.17	36.85	2.074	7.144	0.292	2.74	4.59	0.000	1.878
16	19.22	23.66	1.284	3.979	0.350	2.90	4.56	0.000	1.629
17	14.55	19.35	1.594	5.154	0.313	1.98	4.04	0.000	1.693
18	15.75	25.63	2.349	8.551	0.242	1.05	4.27	0.000	1.654
19	15.63	25.28	2.200	7.636	0.253	1.21	4.22	0.000	1.734
20	15.96	24.86	1.670	4.519	0.237	1.00	4.29	0.000	1.644
21	15.85	26.81	1.786	4.824	0.201	0.38	4.40	0.000	1.642
22	19.85	35.93	2.034	6.052	0.155	-0.62	5.20	0.000	1.421
23	29.25	43.99	1.327	3.257	0.172	0.23	5.44	0.000	1.338
24	32.58	46.36	1.250	3.137	0.226	1.71	5.15	0.000	1.475
25	41.04	66.06	1.937	6.520	0.198	1.32	5.51	0.000	1.469
26	43.89	75.41	2.723	11.327	0.224	2.38	5.15	0.000	1.764
27	50.82	80.96	2.361	8.726	0.254	3.56	5.15	0.000	1.969
28	65.75	80.89	2.104	7.988	0.377	7.48	6.61	0.000	2.296
29	71.80	81.38	1.772	6.206	0.398	8.78	6.78	0.000	2.436
30	67.01	70.88	1.346	4.241	0.439	9.64	7.46	0.000	2.283
31	68.81	70.02	1.311	4.193	0.448	10.27	7.49	0.000	2.307
32	65.78	56.35	0.451	1.886	0.634	18.27	13.37	0.000	1.753
33	69.01	58.69	0.554	2.144	0.576	15.91	10.69	0.000	1.844
34	69.19	51.84	0.532	2.451	0.668	21.89	13.50	0.000	2.175
35	65.39	58.22	1.004	3.414	0.496	12.09	7.71	0.000	2.276
36	64.12	52.32	0.636	2.423	0.590	16.05	10.29	0.000	2.073
37	71.31	64.96	1.096	3.806	0.486	12.24	7.88	0.000	2.324
38	72.50	66.99	1.525	5.411	-0.377	2.10	0.27	0.000	3.631
39	71.75	63.16	1.225	4.239	0.525	13.94	8.92	0.000	2.702
40	72.18	56.66	0.839	3.331	0.634	20.04	12.76	0.000	2.568
41	68.37	57.11	0.954	3.443	0.586	16.40	10.78	0.000	2.498
42	63.14	49.70	0.653	2.608	0.635	18.33	11.77	0.000	2.241
43	59.92	55.84	1.074	3.382	0.458	10.20	6.59	0.000	2.304
44	56.93	40.75	0.527	2.308	0.614	16.47	9.04	0.000	2.130
45	62.05	38.52	0.389	2.404	0.723	24.80	12.76	0.000	2.322
46	66.60	42.53	0.450	2.180	0.611	18.52	8.66	0.000	2.128
47	66.78	42.59	0.463	2.372	0.636	20.01	9.62	0.000	2.209
48	72.46	49.04	0.781	3.812	0.555	16.40	7.62	0.000	2.464
49	74.62	54.03	1.049	3.887	0.349	9.24	3.36	0.000	2.403
50	77.67	56.43	0.601	2.291	0.519	15.15	7.36	0.000	2.065
51	73.77	56.01	0.525	2.060	0.565	16.66	9.21	0.000	1.971
52	67.33	56.49	0.779	2.422	0.478	11.96	6.76	0.000	2.185
53	65.29	56.47	1.118	3.313	0.361	8.61	4.08	0.000	2.549
54	65.34	58.65	1.291	3.541	0.315	7.65	3.38	0.000	2.965
55	62.87	59.02	1.418	4.161	0.377	8.65	4.54	0.000	3.098
56	62.66	59.05	1.360	4.207	0.414	9.40	5.48	0.000	2.717
57	62.99	55.94	1.359	4.778	0.431	10.05	5.54	0.000	2.728
58	63.08	54.00	1.340	5.520	0.474	11.38	6.46	0.000	2.644
59	69.37	68.06	1.576	5.570	0.408	9.60	5.82	0.000	2.668
60	66.68	63.89	1.056	3.546	0.484	11.40	8.14	0.000	2.160
61	63.56	57.77	1.037	3.707	0.522	12.63	8.73	0.000	2.284
62	65.40	59.89	1.179	4.392	0.436	10.17	6.13	0.000	2.222
63	67.42	62.79	1.232	4.176	0.480	11.60	7.65	0.000	2.424
64	68.12	60.90	0.839	3.094	0.573	15.30	11.14	0.000	2.110
65	66.25	54.26	0.450	2.086	0.687	21.97	15.77	0.000	1.900
66	59.80	48.14	0.558	2.231	0.588	15.34	9.64	0.000	1.951
67	61.33	48.98	0.767	3.110	0.577	15.14	9.23	0.000	2.250

Table 4.1. Continued.

week	μ	σ_{n-1}	C_s	C_k	λ	μ'	σ'_{n-1}	C'_s	C'_k
68	58.65	49.74	0.860	2.955	0.456	10.37	5.84	0.000	2.125
69	62.91	66.00	2.070	8.085	0.379	8.41	5.10	0.000	3.096
70	59.28	63.41	3.245	15.828	0.386	8.55	4.73	0.000	4.815
71	56.00	61.85	3.696	18.746	0.353	7.73	3.95	0.000	5.395
72	56.15	61.03	3.744	19.135	0.383	8.35	4.45	0.000	5.758
73	58.03	61.49	3.489	17.562	0.354	7.92	3.94	0.000	5.070
74	57.12	62.92	3.399	16.843	0.340	7.50	3.83	0.000	4.802
75	58.52	60.14	2.900	13.683	0.252	6.23	2.61	0.000	3.443
76	50.22	39.38	0.643	2.357	0.484	10.45	5.59	0.000	1.970
77	55.19	46.45	0.727	2.385	0.428	9.33	5.08	0.000	1.906
78	60.22	56.71	0.843	2.695	0.379	8.22	5.00	0.000	1.794
79	58.63	56.70	0.873	2.733	0.342	7.32	4.39	0.000	1.813
80	59.40	55.85	1.090	3.498	0.359	7.87	4.41	0.000	2.120
81	62.54	60.61	1.426	4.970	0.428	9.61	6.05	0.000	2.610
82	69.88	76.61	1.829	5.922	0.324	7.61	4.30	0.000	3.216
83	66.81	72.59	1.801	5.893	0.323	7.48	4.15	0.000	3.337
84	67.84	79.71	1.691	4.976	0.307	6.93	4.35	0.000	2.958
85	61.90	73.93	1.994	6.563	0.237	5.68	3.13	0.000	2.778
86	64.51	75.18	1.729	5.340	0.270	6.14	3.77	0.000	2.391
87	62.38	69.69	1.697	5.581	0.364	7.69	5.33	0.000	2.606
88	61.80	61.96	1.228	3.660	0.420	9.15	6.17	0.000	2.375
89	50.98	54.85	1.397	4.324	0.376	7.20	5.12	0.000	2.418
90	48.20	51.15	1.422	4.403	0.289	5.82	3.49	0.000	2.244
91	38.39	40.30	1.433	4.407	0.372	6.25	4.35	0.000	2.480
92	38.23	41.18	1.605	5.306	0.354	5.95	4.17	0.000	2.464
93	44.95	46.19	1.478	5.399	0.425	7.66	5.67	0.000	2.327
94	43.12	45.35	1.326	4.626	0.403	6.96	5.36	0.000	2.123
95	38.59	39.68	1.220	4.290	0.445	7.21	5.95	0.000	2.005
96	45.34	49.84	1.427	5.085	0.398	6.77	5.79	0.000	1.971
97	50.07	62.49	2.139	8.070	0.328	5.94	4.79	0.000	2.454
98	51.78	61.78	2.131	8.124	0.348	6.53	4.95	0.000	2.544
99	57.44	76.22	2.501	9.434	0.293	6.01	4.16	0.000	3.172
100	44.35	46.69	1.575	5.853	0.370	6.68	4.62	0.000	2.355
101	55.80	52.81	1.065	3.839	0.438	9.24	6.06	0.000	2.141
102	58.40	53.64	0.836	2.834	0.493	11.03	7.55	0.000	2.039
103	57.40	54.93	0.961	2.921	0.433	9.24	6.07	0.000	2.220
104	57.45	60.61	1.160	3.495	0.356	7.29	4.92	0.000	2.238
105	56.69	63.34	1.292	3.814	0.343	6.84	4.91	0.000	2.356
106	52.67	65.93	1.941	6.220	0.283	5.70	3.82	0.000	3.023
107	47.68	58.61	1.831	5.715	0.279	5.45	3.58	0.000	3.144
108	35.54	49.12	2.358	8.762	0.307	4.52	4.24	0.000	2.670
109	30.01	41.76	2.087	7.305	0.319	3.66	4.82	0.000	2.018
110	27.97	32.17	1.214	4.187	0.393	4.58	5.31	0.000	1.700
111	24.78	28.81	0.825	2.371	0.348	3.48	4.90	0.000	1.474
112	24.08	27.08	0.841	2.527	0.391	3.99	5.17	0.000	1.481
113	22.06	31.06	1.583	4.996	0.257	1.83	4.56	0.000	1.563
114	21.18	31.11	1.960	7.080	0.258	1.72	4.56	0.000	1.589
115	21.33	31.24	1.990	7.338	0.257	1.72	4.58	0.000	1.580
116	23.52	33.42	1.792	5.736	0.289	2.45	4.64	0.000	1.722
117	22.72	32.69	1.567	4.438	0.257	1.80	4.67	0.000	1.565
118	22.91	31.85	1.323	3.604	0.246	1.54	4.78	0.000	1.452
119	24.41	33.40	1.315	3.894	0.254	1.86	4.75	0.000	1.509
120	19.52	29.22	2.022	7.211	0.261	1.74	4.37	0.000	1.687
121	19.57	31.76	2.665	11.097	0.253	1.85	4.14	0.000	1.936
122	20.68	31.84	2.522	10.580	0.278	2.20	4.33	0.000	1.881
123	17.77	30.18	3.071	14.087	0.252	1.60	4.12	0.000	1.931
124	14.32	22.19	2.254	8.566	0.251	1.27	3.95	0.000	1.759
125	12.74	17.54	1.513	4.376	0.286	1.45	3.89	0.000	1.655
126	10.93	16.29	1.493	4.182	0.188	-0.41	4.46	0.000	1.326
127	13.09	16.38	0.815	2.107	0.231	0.40	4.47	0.000	1.214
128	11.46	15.27	0.954	2.345	0.208	-0.01	4.37	0.000	1.284
129	11.63	18.79	2.041	6.571	0.220	0.19	4.25	0.000	1.455
130	13.85	25.42	2.556	9.007	0.196	-0.06	4.54	0.000	1.466
131	15.39	25.24	2.214	7.232	0.249	1.19	4.15	0.000	1.780
132	15.62	26.30	2.336	8.044	0.224	0.72	4.35	0.000	1.599
133	14.11	25.86	2.562	9.159	0.216	0.67	4.05	0.000	1.852

From standard normal table $P(z \geq -0.369)$ is determined to be 0.644.

For the SMEMAX and power transformations, the desired probabilities are evaluated by first transforming the variable x to y (where y is the transformed variable using the respective transformation) and y to z scale and then using standard normal tables.

For example, for the SMEMAX transformation, $P(x \geq 10)$ for the first week beginning September 10 is obtained by first transforming the variable to y scale accoding to equation 2.19a and 2.19b.

where:

$$A = \arctan\left[\frac{x_l - x_m}{x_m - x_s}\right] = \frac{225.8 - 3.0}{3.0 - 0.0} = 1.557$$

From Table B1 (Appendix B) for the week between Sept. 10 and Sept. 16, the largest value = 225.8 mm, the smallest value = 0.0 mm and the mode 3.0 mm. Substituting these values in equations 2.19a gives:

$$y = \frac{(3.0 - 0.0) + (10 - 3.0)\cot(1.557)}{2\cos(1.557)} = 114.7$$

The probability is evaluated by transforming y to z limits from the following:

$$z = \frac{y - \mu}{\sigma} = \frac{114.7 - 76.8}{71.4} = 0.531$$

Where $\mu=76.8$ and $\sigma=71.4$ are the mean and standard deviation for the transformed data. From standard normal tables $P(z \geq 0.531)$ is determined to be 0.298.

Using the power transformation, $P(x \geq 10)$ for the first week beginning September 10 is obtained by transforming the variable x to y scale using equation 2.17a as follows:

$$y = \frac{x^{\lambda} - 1}{\lambda} = \frac{10^{0.177} - 1}{0.177} = 2.843$$

The probability is evaluated by transforming y to z limits from the following

$$z = \frac{y - \mu}{\sigma} = \frac{2.843 - 0.44}{5.25} = 0.458$$

From standard normal tables $P(z \geq 0.458)$ is determined to be 0.316.

Results obtained from the normal distribution, power transformation and SMEMAX transformation are compared with probabilities determined from observations (Figures 4.8a, 4.8b, 4.8c, 4.8d). Observed probabilities were determined by summing the number of observations greater than a given value by the total number of observations. For example, for the week between Sept. 10 to Sept. 16 (Table 4.1) the number of data points greater than 10 mm is 13, ie. 13 out of 33 data points are greater than 10 mm. The observed probability is therefore, 13/33 = 0.394. Four data sets (data for weeks between Sept. 10-16, Nov. 5-11, Nov. 19-25 and Dec. 24-30) were selected at random to illustrate how the probabilities of rainfall calculated from the different distributions compare with the observed values (Figures 4.9a to 4.9d).

The power transformation was chosen to describe the distribution of weekly rainfall data, since it gave best fits with the historical data. Using the power transformation, the rainfall at different probability levels was determined. Figure 4.10 shows the variation of rainfall at different probability levels, for all weeks beginning on different days during the Maha season.

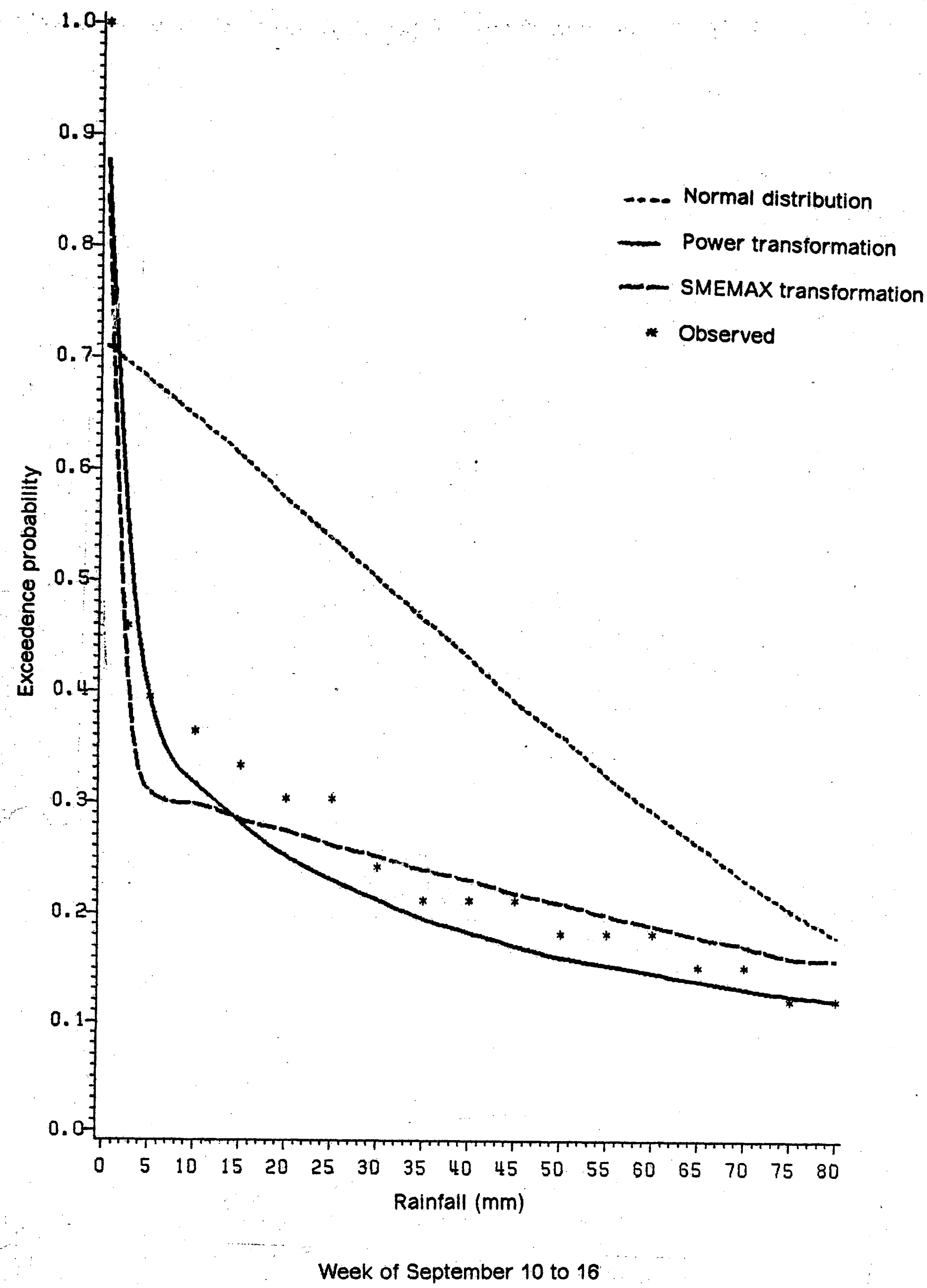


Figure 4.9a. Comparison of distributions for weekly rainfall data (eg. 1).

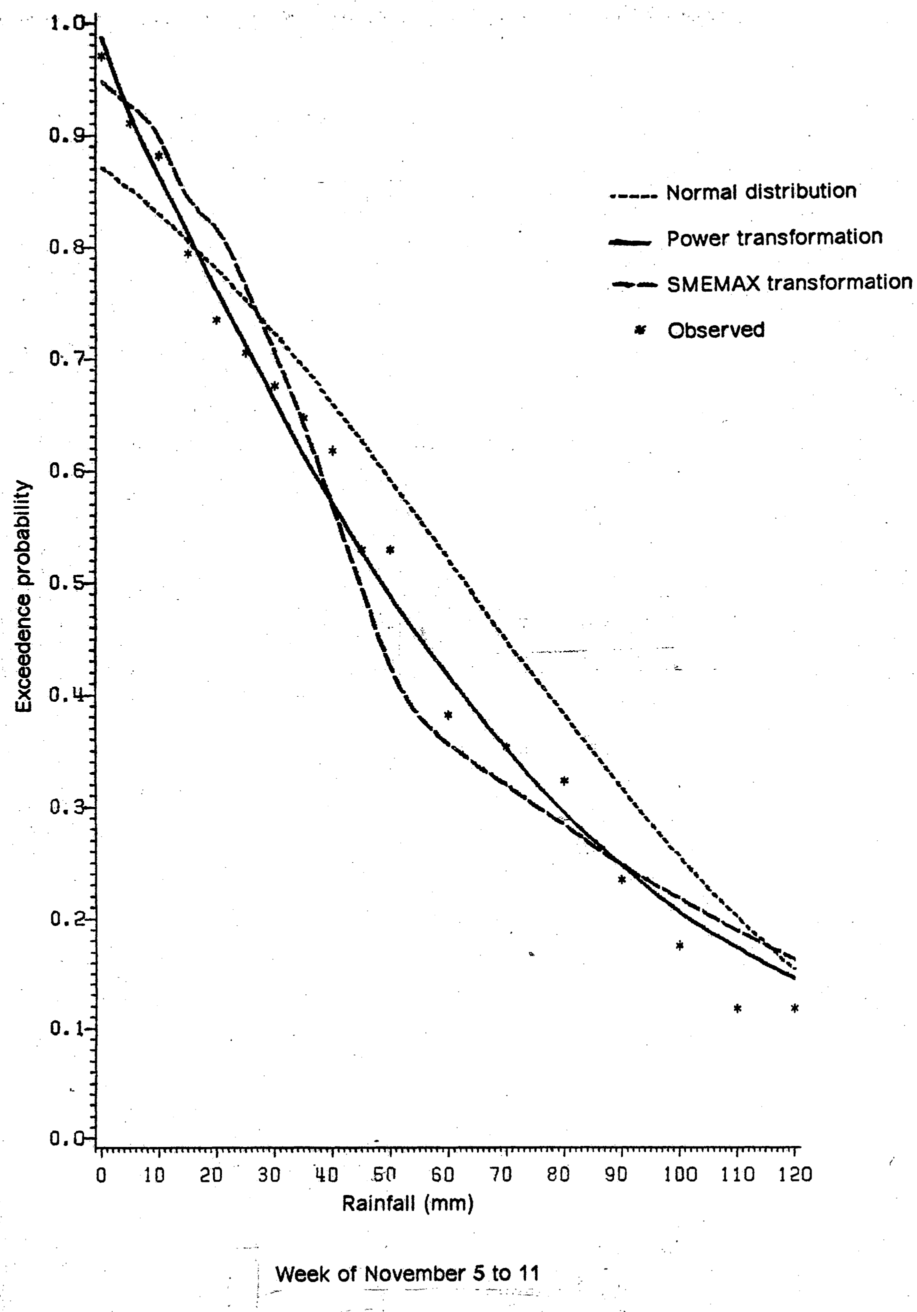
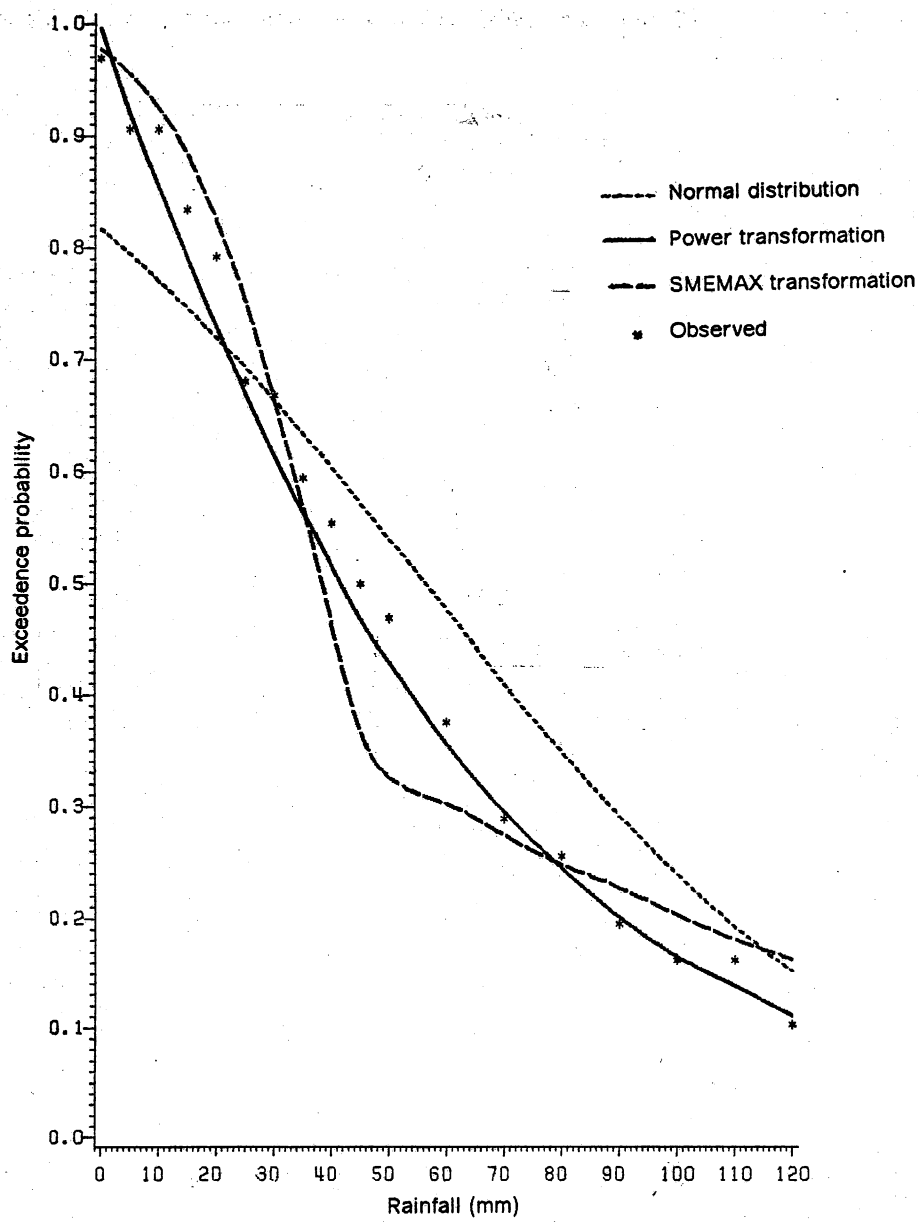


Figure 4.9b. Comparison of distributions for weekly rainfall data (eg. 2).



Week of November 19 to 25

Figure 4.9c. Comparison of distributions for weekly rainfall data (eg. 3).

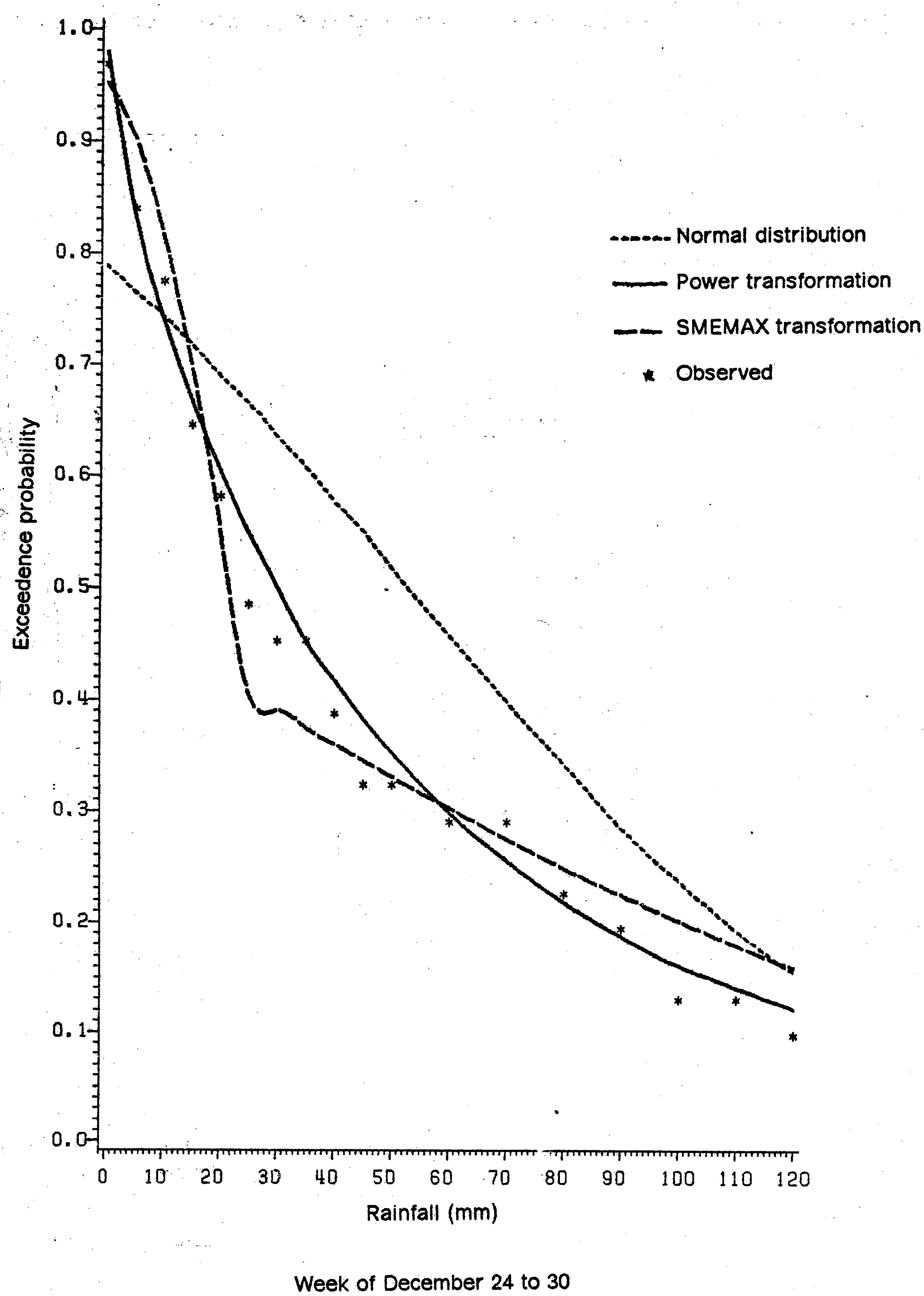


Figure 4.9d. Comparison of distributions for weekly rainfall data (eg. 4).

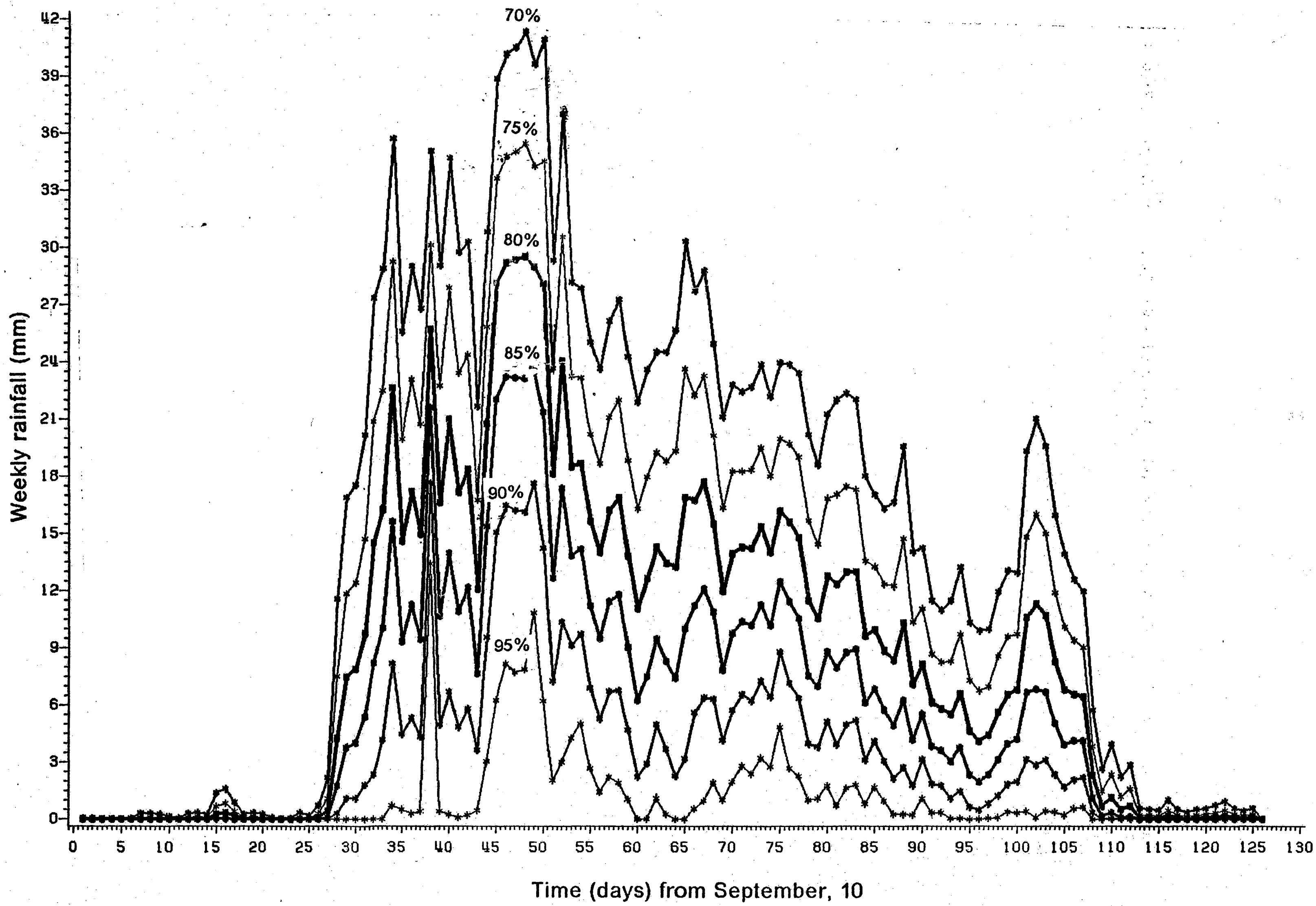


Figure 4.10. Weekly rainfall estimated at different probability levels.

4.2.4 Analysis of Weekly Pan Evaporation Data

Using the procedure used for weekly rainfall data, distributions capable of describing the weekly pan evaporation were determined. Unlike rainfall data, the weekly pan evaporation data included observed as well as generated data. Table 4.2 gives estimated mean (μ) and standard deviation (σ_{n-1}), C_s and C_k, for untransformed data and for the data transformed with the power transformation.

The variation in weekly pan evaporation data were relatively small (Table 4.2), unlike weekly rainfall data which had large standard deviations. The λ values that transformed the data are higher than those obtained for rainfall data. In order to have variability in the data (to fit the normal distribution), the data had to be raised by a high power to get the desired variability, subsequently, the mean (μ') and standard deviation (σ'_{n-1}) of the transformed data were high.

The normal distribution, power transformation and SMEMAX transformations were tested for their ability to describe the distribution of weekly evaporation values. As with rainfall data, the power transformation was best able to describe the weekly pan evaporation data. In Figures 4.11a, 4.11b, 4.10c and 4.10d, results obtained from normal distribution, power transformation and SMEMAX transformation are compared with probabilities determined from the data. Weeks of September 10 to 16, October 29 to November 4, November 26 to December 2 and January 7 to 13 were selected at random to illustrate (graphically) the ability of the distributions to describe the variation of weekly pan evaporation.

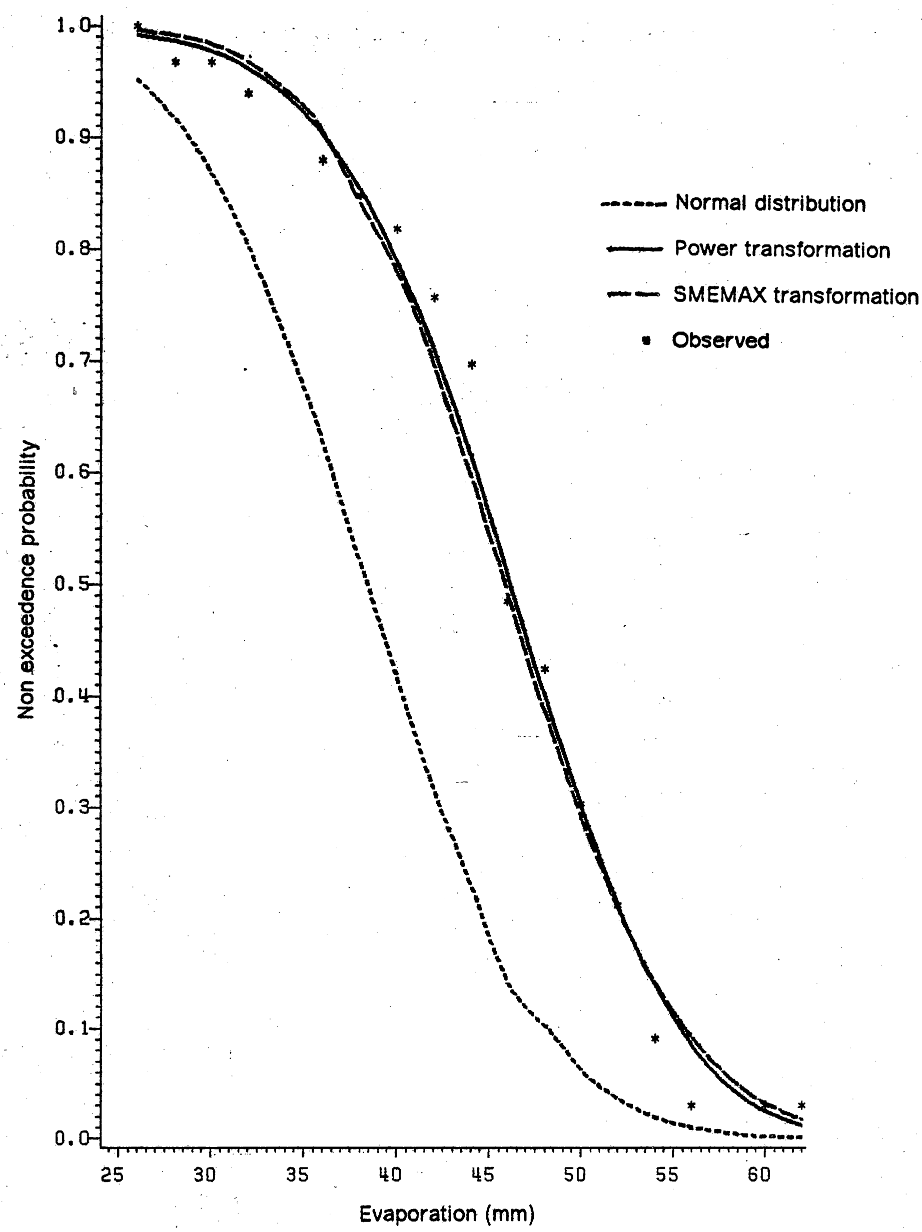
The power transformation was chosen to describe the variation of weekly pan evaporation, since it gave the best results from analysis. Using the power transformation, variation of pan evaporation at different probability for the weeks in the growing season are given in Figure 4.12.

Table 4.2. Parameters estimated for weekly pan evaporation data.

week	μ	σ_{n-1}	C_s	C_k	λ	μ'	σ'_{n-1}	C'_s	C'_k
1	45.98	8.59	-1.206	4.519	3.399	148428	71839	0.000	2.269
2	45.95	9.10	-1.205	4.843	2.796	17322	7649	0.000	2.793
3	45.70	9.54	-1.395	5.249	2.833	19581	8859	0.000	2.976
4	45.94	9.14	-1.283	5.244	2.592	8423	3496	0.000	3.422
5	45.82	8.71	-1.018	4.623	2.303	3049	1152	0.000	3.708
6	46.28	8.26	-0.855	4.008	2.319	3271	1191	0.000	3.593
7	46.37	7.70	-0.803	4.340	2.106	1581	505	0.000	4.225
8	45.86	7.57	-0.267	3.555	1.428	165.52	38.41	0.000	3.618
9	46.08	7.15	-0.133	3.296	1.251	95.96	18.64	0.000	3.362
10	45.31	6.58	0.191	2.898	0.495	11.27	0.96	0.000	2.730
11	45.07	6.75	0.030	2.629	0.916	34.62	4.91	0.000	2.626
12	44.89	6.65	0.254	2.621	0.215	5.87	0.34	0.000	2.451
13	44.73	6.63	0.312	2.778	0.076	4.39	0.20	0.000	2.472
14	44.59	6.42	0.021	2.999	0.952	37.91	5.35	0.000	3.014
15	44.70	6.48	-0.305	3.486	1.586	263.35	59.28	0.000	3.210
16	43.83	6.54	0.022	2.888	0.947	36.77	5.35	0.000	2.887
17	43.48	6.78	0.109	2.312	0.635	15.67	1.72	0.000	2.295
18	42.74	7.09	0.218	2.117	0.165	5.18	0.31	0.000	2.071
19	41.76	8.03	0.264	1.940	-0.101	3.10	0.13	0.000	1.839
20	40.92	8.85	0.318	2.158	0.093	4.41	0.31	0.000	2.149
21	39.92	9.62	0.175	1.721	0.341	7.31	0.85	0.000	1.770
22	38.55	10.60	0.211	1.704	0.287	6.38	0.79	0.000	1.768
23	37.97	10.58	0.324	1.758	-0.061	3.23	0.23	0.000	1.830
24	38.40	10.28	0.194	1.826	0.427	8.68	1.28	0.000	1.876
25	38.40	10.52	0.124	1.856	0.668	15.48	3.15	0.000	1.909
26	38.50	10.83	-0.008	1.997	1.018	39.44	11.56	0.000	1.994
27	38.08	10.53	0.134	1.924	0.671	15.49	3.20	0.000	1.980
28	38.05	10.07	0.007	2.269	0.988	35.79	9.62	0.000	2.273
29	37.22	9.48	0.100	2.175	0.790	20.65	4.45	0.000	2.230
30	37.03	9.36	0.097	2.180	0.795	20.81	4.48	0.000	2.228
31	35.70	8.68	0.362	2.175	0.164	4.81	0.44	0.000	2.333
32	34.68	8.17	0.329	2.053	0.051	3.86	0.28	0.000	2.046
33	33.42	7.52	0.328	2.619	0.334	6.62	0.73	0.000	2.467
34	32.52	7.35	0.392	2.450	0.085	4.02	0.30	0.000	2.295
35	31.35	7.70	0.422	2.510	0.177	4.70	0.45	0.000	2.488
36	31.92	8.03	0.567	2.819	-0.005	3.40	0.25	0.000	2.588
37	30.99	8.61	0.599	3.403	0.272	5.61	0.71	0.000	3.008
38	30.55	8.63	0.375	2.822	0.477	8.52	1.45	0.000	2.716
39	30.34	8.25	0.098	1.770	0.836	19.42	4.73	0.000	2.451
40	30.22	8.49	0.141	1.879	0.604	11.21	2.22	0.000	1.838
41	30.53	8.23	-0.076	1.779	1.249	57.12	19.18	0.000	1.773
42	29.83	8.45	-0.025	1.595	1.099	37.22	11.80	0.000	1.590
43	29.23	7.39	-0.152	1.912	1.445	91.92	32.73	0.000	1.922
44	29.40	7.33	0.064	2.082	0.838	19.01	4.25	0.000	2.056
45	29.01	7.08	-0.193	2.198	1.446	91.01	0.29	0.000	2.209
46	29.04	7.15	-0.267	2.192	1.628	152.06	58.09	0.000	2.166
47	28.72	6.81	0.072	2.285	0.838	18.63	3.97	0.000	2.261
48	27.00	6.52	0.362	2.543	0.280	5.37	0.61	0.000	2.421
49	26.34	8.45	-0.025	1.595	1.099	37.22	11.80	0.000	1.590
50	25.40	5.22	0.563	2.610	-0.541	1.52	0.04	0.000	2.215
51	24.32	5.31	0.653	3.219	-0.137	2.57	0.14	0.000	2.876
52	23.90	4.77	0.741	2.780	-1.131	0.86	0.01	0.000	2.316
53	22.87	4.71	1.002	3.927	-1.011	0.95	0.01	0.000	2.614
54	22.35	4.60	0.677	3.682	-0.090	2.69	0.15	0.000	3.031
55	23.18	4.85	0.733	3.571	-0.179	2.39	0.12	0.000	3.179
56	22.91	4.92	0.413	3.679	0.482	7.26	0.98	0.000	3.515
57	23.35	4.82	0.053	3.526	0.935	19.23	3.93	0.000	3.540
58	23.23	5.10	-0.132	3.732	1.144	31.18	7.98	0.000	3.725
59	22.89	5.18	0.070	3.729	0.927	18.52	4.13	0.000	3.731
60	22.30	5.43	0.757	4.989	0.390	5.98	0.81	0.000	4.538
61	21.96	5.39	1.042	5.149	-0.024	2.95	0.22	0.000	3.938
62	21.43	5.18	-0.113	3.226	1.132	27.63	7.73	0.000	3.141
63	21.16	5.43	0.045	2.563	0.929	17.24	4.38	0.000	2.581
64	21.01	5.66	0.423	3.159	0.447	6.41	1.05	0.000	2.898
65	20.78	5.67	0.979	4.316	-0.218	2.20	0.14	0.000	2.933
66	20.72	5.45	0.959	4.525	-0.080	2.66	0.20	0.000	3.287
67	20.79	5.14	0.926	5.351	0.121	3.63	0.35	0.000	3.728

Table 4.2. Continued.

week	μ	σ_{n-1}	C_s	C_k	λ	μ'	σ'_{n-1}	C'_s	C'_k
68	20.89	5.15	0.570	3.838	0.322	5.11	0.66	0.000	3.250
69	20.68	4.87	0.117	3.343	0.860	14.51	3.20	0.000	3.332
70	21.01	5.03	0.224	3.138	0.710	10.76	2.09	0.000	3.143
71	20.32	4.95	0.403	3.038	0.372	5.50	0.75	0.000	2.742
72	20.60	5.52	0.070	2.248	0.861	14.47	3.63	0.000	2.238
73	20.50	5.41	0.020	2.464	0.966	18.09	4.88	0.000	2.459
74	20.53	5.48	-0.054	2.485	1.092	24.02	7.22	0.000	2.526
75	20.60	5.66	0.836	5.065	0.337	5.12	0.83	0.000	3.646
76	21.02	5.95	1.071	4.496	-0.428	1.69	0.07	0.000	2.602
77	20.89	5.48	1.188	5.764	-0.121	2.52	0.18	0.000	3.630
78	21.06	5.63	1.019	5.217	-0.085	2.66	0.20	0.000	3.082
79	20.68	5.66	1.185	6.091	-0.089	2.63	0.20	0.000	3.388
80	20.87	6.26	0.768	4.434	0.253	4.51	0.64	0.000	3.164
81	20.42	5.89	0.971	5.622	0.266	4.56	0.64	0.000	3.963
82	20.22	6.19	0.613	3.598	0.203	4.10	0.50	0.000	2.750
83	20.22	5.75	1.029	5.578	0.144	3.71	0.43	0.000	3.636
84	20.43	5.41	1.057	5.867	0.075	3.35	0.33	0.000	3.589
85	20.62	5.35	0.965	5.448	0.087	3.42	0.33	0.000	3.470
86	21.24	5.13	0.727	4.009	-0.050	2.81	0.20	0.000	2.730
87	21.75	5.19	0.338	3.342	0.555	8.09	1.32	0.000	3.123
88	21.86	5.79	0.282	2.739	0.556	8.10	1.48	0.000	2.590
89	22.51	5.61	0.175	2.800	0.734	11.96	2.47	0.000	2.755
90	22.53	5.59	0.094	2.813	0.859	15.69	3.62	0.000	2.787
91	22.57	5.59	0.299	2.877	0.548	8.16	1.37	0.000	2.797
92	22.83	5.39	0.527	3.241	0.230	4.54	0.48	0.000	3.035
93	22.57	5.32	0.273	3.549	0.681	10.73	1.98	0.000	3.415
94	22.23	4.55	0.401	4.724	0.599	8.97	1.32	0.000	4.223
95	21.99	4.30	0.653	5.479	0.361	5.65	0.60	0.000	4.343
96	21.12	4.93	0.408	4.284	0.587	8.44	1.41	0.000	3.782
97	21.35	5.05	0.382	3.749	0.553	7.95	1.29	0.000	3.380
98	20.55	4.77	0.545	3.391	0.290	4.79	0.56	0.000	3.380
99	20.16	4.46	0.256	2.774	0.586	8.16	1.29	0.000	2.919
100	20.16	3.92	0.056	3.415	0.922	16.17	3.10	0.000	3.415
101	20.12	3.99	0.094	2.850	0.820	13.04	2.33	0.000	2.770
102	20.62	4.22	-0.281	2.392	1.674	96.28	31.80	0.000	2.480
103	20.67	4.49	-0.127	1.827	1.479	59.90	18.98	0.000	1.828
104	19.99	4.56	-0.297	2.162	1.802	126.50	49.06	0.000	2.035
105	20.68	4.47	-0.234	2.290	1.572	75.25	24.86	0.000	2.318
106	20.88	4.04	-0.226	3.087	1.375	47.16	12.47	0.000	2.896
107	21.17	4.12	0.108	2.437	0.746	11.68	1.90	0.000	2.461
108	21.49	4.53	0.427	2.793	0.079	3.44	0.27	0.000	2.455
109	21.72	4.80	0.201	3.706	0.764	12.38	2.33	0.000	3.573
110	22.16	5.29	0.025	3.573	0.972	19.84	4.84	0.000	3.549
111	22.75	4.97	0.061	3.937	0.937	18.85	4.08	0.000	3.915
112	22.54	5.58	-0.205	3.653	1.207	35.04	10.52	0.000	3.773
113	23.10	5.96	-0.281	3.443	1.289	44.19	14.52	0.000	3.298
114	23.10	6.11	-0.395	3.654	1.372	54.45	19.12	0.000	3.361
115	23.28	6.12	-0.717	4.201	1.606	100.25	38.73	0.000	3.721
116	23.70	6.23	-0.711	3.708	1.757	154.23	63.85	0.000	3.247
117	24.46	5.92	-0.737	3.746	1.877	224.99	91.24	0.000	3.105
118	24.61	5.64	-0.590	3.879	1.630	116.08	40.62	0.000	3.809
119	24.56	5.29	-0.244	3.702	1.278	46.46	12.74	0.000	3.747
120	24.91	5.06	-0.206	3.642	1.258	44.87	11.48	0.000	3.796
121	24.92	5.18	0.107	3.123	0.834	16.27	3.04	0.000	3.067
122	25.28	5.11	0.210	3.247	0.686	11.85	1.86	0.000	3.218
123	25.12	5.11	0.506	3.719	0.307	5.47	0.55	0.000	3.430
124	24.87	5.28	0.489	3.454	0.243	4.83	0.46	0.000	2.990
125	25.07	5.23	0.746	4.206	-0.035	3.03	0.18	0.000	3.193
126	25.15	5.14	1.063	5.038	-0.402	1.80	0.05	0.000	3.351
127	25.05	5.60	0.891	4.488	-0.128	2.62	0.14	0.000	3.318
128	25.73	5.57	0.461	3.767	0.367	6.20	0.71	0.000	3.166
129	25.57	5.21	0.572	3.370	-0.103	2.74	0.15	0.000	2.585
130	25.54	5.17	0.253	3.221	0.588	9.67	1.36	0.000	3.016
131	25.33	5.51	-0.006	3.018	1.010	24.91	5.68	0.000	3.023
132	25.62	6.18	-0.246	3.218	1.312	52.66	16.15	0.000	3.269
133	25.92	6.52	-0.360	2.909	1.517	93.55	34.10	0.000	2.713



Week of September 10 to 16

Figure 4.11a. Comparison of distributions for weekly pan evaporation data (eg. 1).

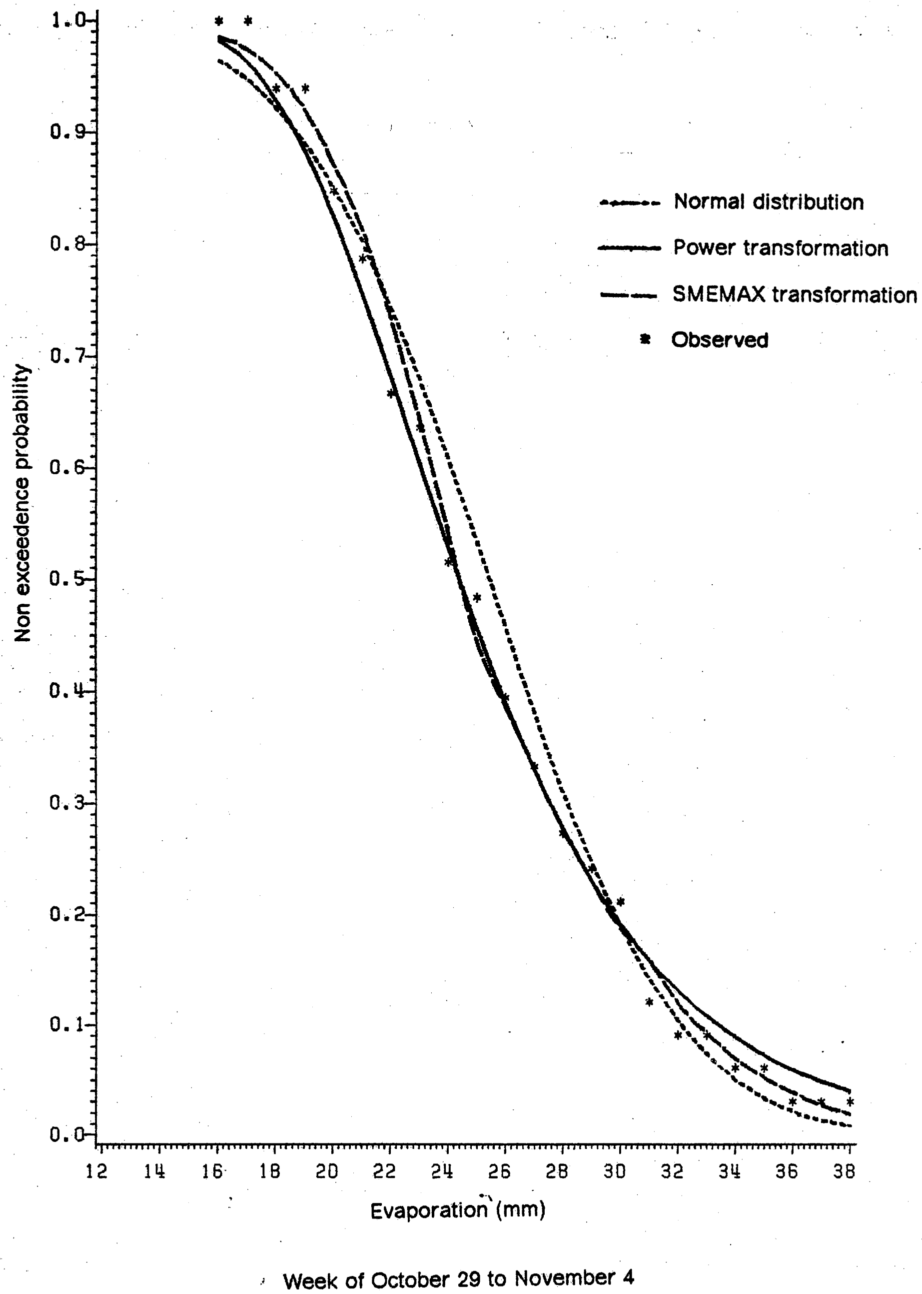
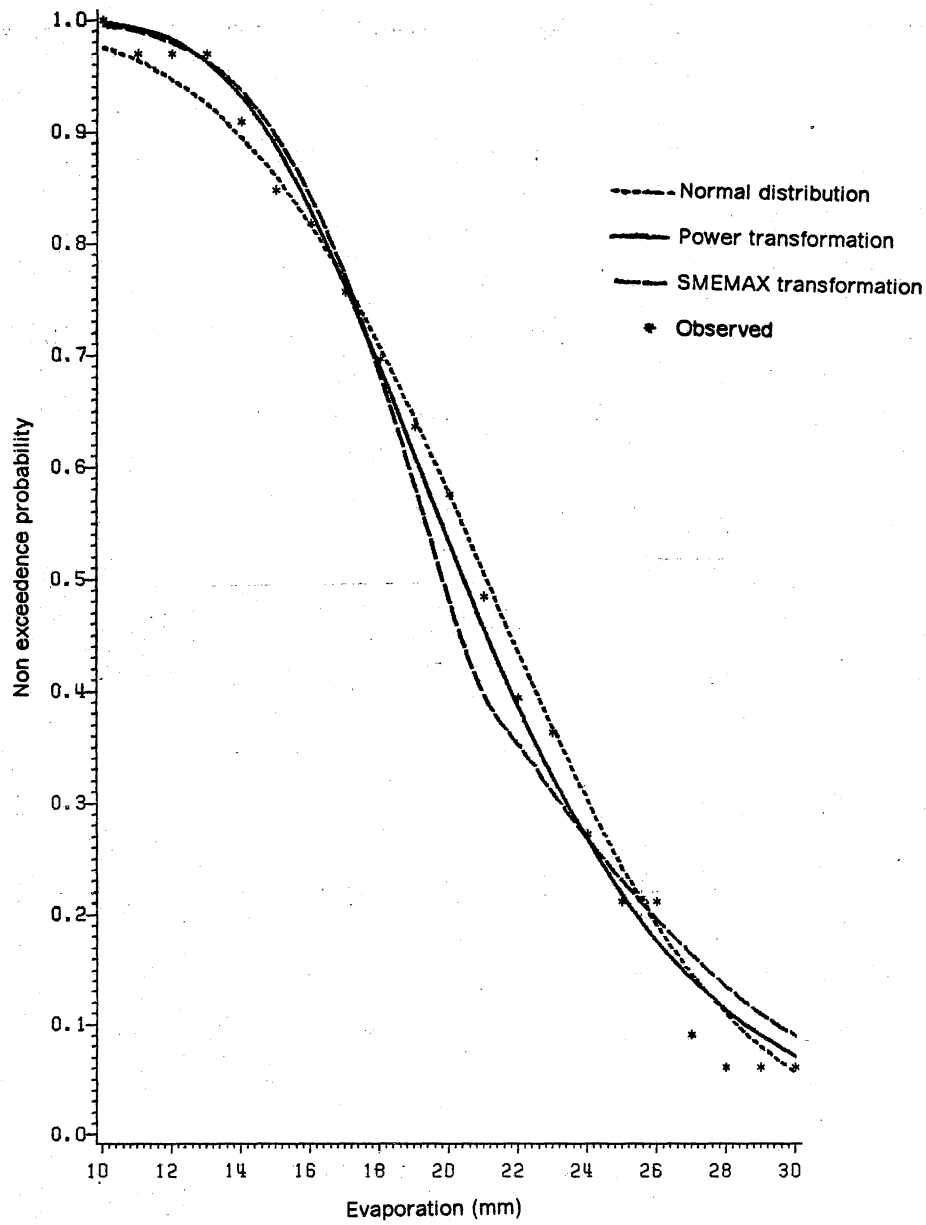
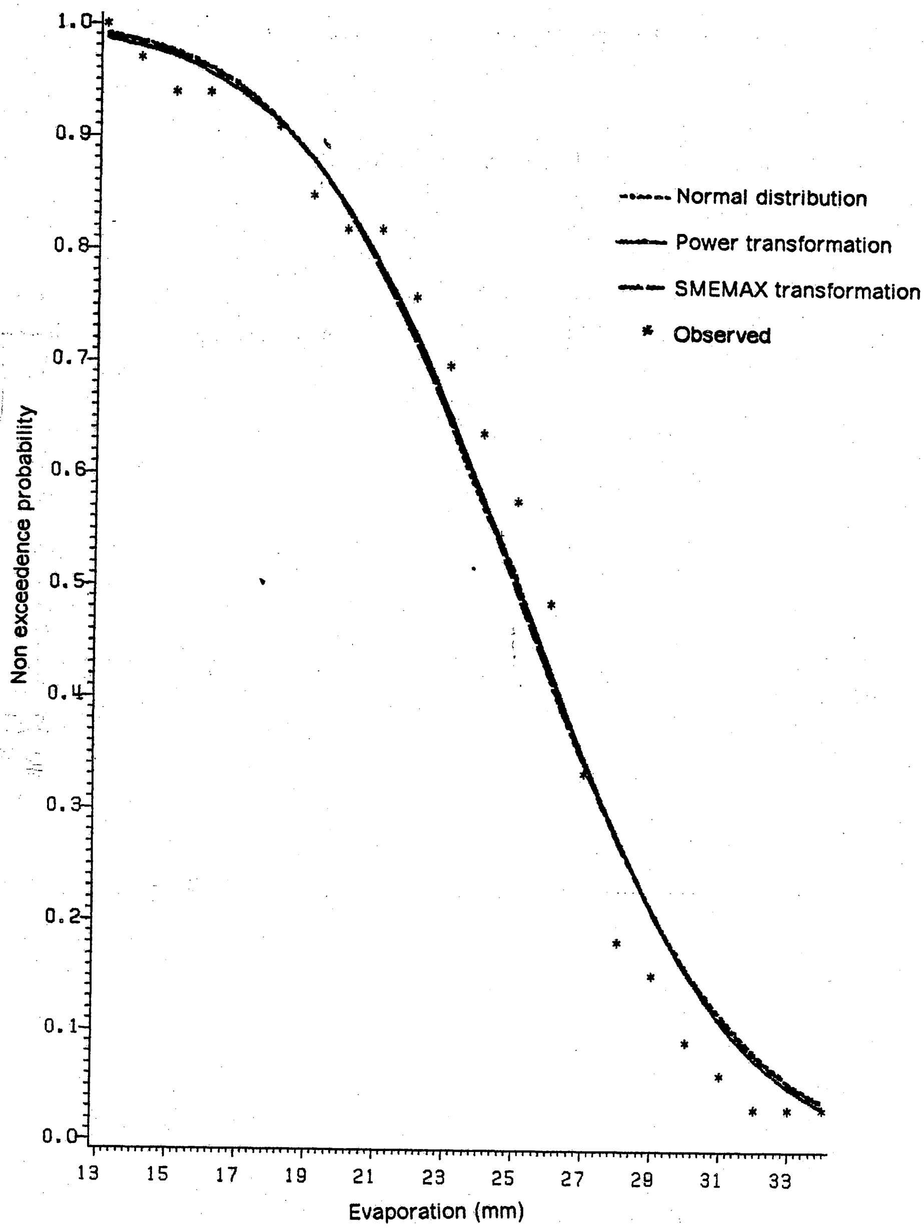


Figure 4.11b. Comparison of distributions for weekly pan evaporation data (eg. 2).



Week of November 26 to December 2

Figure 4.11c. Comparison of distributions for weekly pan evaporation data (eg. 3).



Week of January 7 to 13

Figure 4.11d. Comparison of distributions for weekly pan evaporation data (eg. 4).

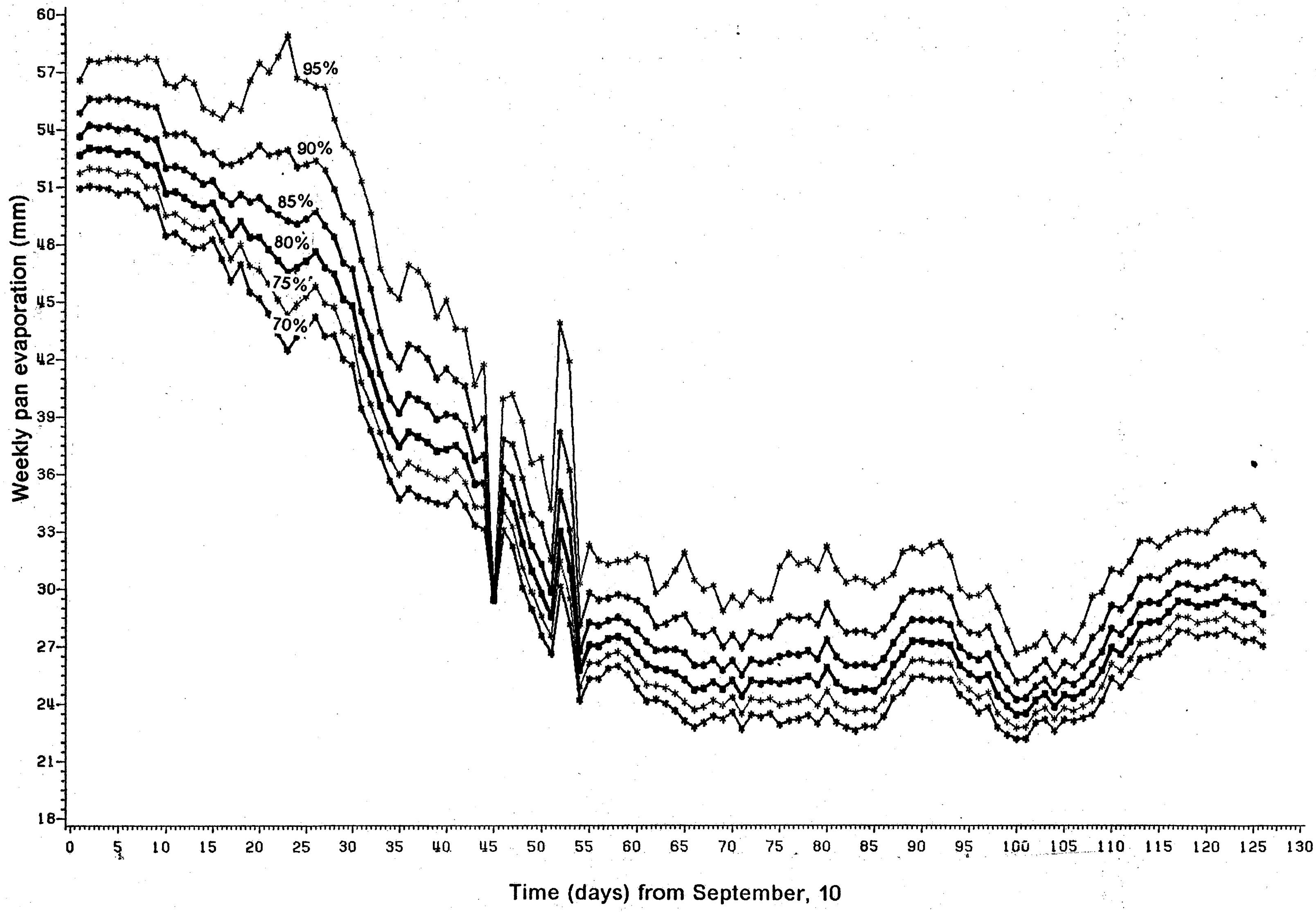


Figure 4.12. Weekly pan evaporation estimated at different probability levels.

4.2.5 Estimating Irrigation Requirements

Figure 4.9 gives the probability that rainfall will be greater than the values given on the vertical axis, for all weeks in the wet season. Figure 4.12 gives the probability at which EV will be less than the values on the vertical axis. From figures 4.10 and 4.12, RF and EV can be determined for any given week at a desired probability level. Figures 4.13a, 4.13b, 4.13c, 4.13d, 4.13e and 4.13f were prepared from Figures 4.10 and 4.12 and give estimates of (k • EV - RF) at different probability levels for values of k=1.0 k=1.1 k=1.2 k=1.3 for the different growth stages of the rice plant. Estimates of (k • EV - RF) from Figures 4.13a to 4.13a can be used in the water balance equation (3.7) to determine irrigation requirements at the desired probability levels.

The desirable probability at which the irrigation system is to be operated must be decided by the management of the irrigation system. The chosen probability will be the probability that irrigation requirement (IR) will be greater than or equal to IR determined from equation 3.7.

To illustrate the steps involved in determining irrigation requirement, the week beginning October 31 is used as an example. To determine irrigation requirements using the water balance equation, estimates of (k • EV - RF) have to be first determined Since estimates of (k • EV - RF) have been computed for all weeks beginning September 10, the number of days to October 31 from September 10 has to be determined (52 days in this case) in order to use Figure 4.13 to estimate the appropriate values of (k • EV - RF). Assuming that on October 31, the rice plants are at the beginning of its reproductive growth stage, and the value of k for this period is 1.2 (discussed in Section 2.3 of Chapter 2). If the system is assumed to be operated at probability greater than 81%, from Figure 4.13b, the value of k • EV - RF is 37 mm.

For the reproductive growth period, the minimum required water level (SMIN) is 50 mm (Table 3.1). Assuming the paddy fields had an initial water depth (SIN) of 25 mm, and assuming 3 mm/day of seepage and percolation losses (PERC), the irrigation requirement is 92 mm/week. For the 1st of November the k • EV - RF is 34 mm and the corresponding irrigation requirement is 90 mm assuming SMIN, SIN and PERC remain constant. Similarly for the 2nd of November, k • EV - RF is 24 mm and the irrigation requirement is 80 mm assuming all other factors are constant.

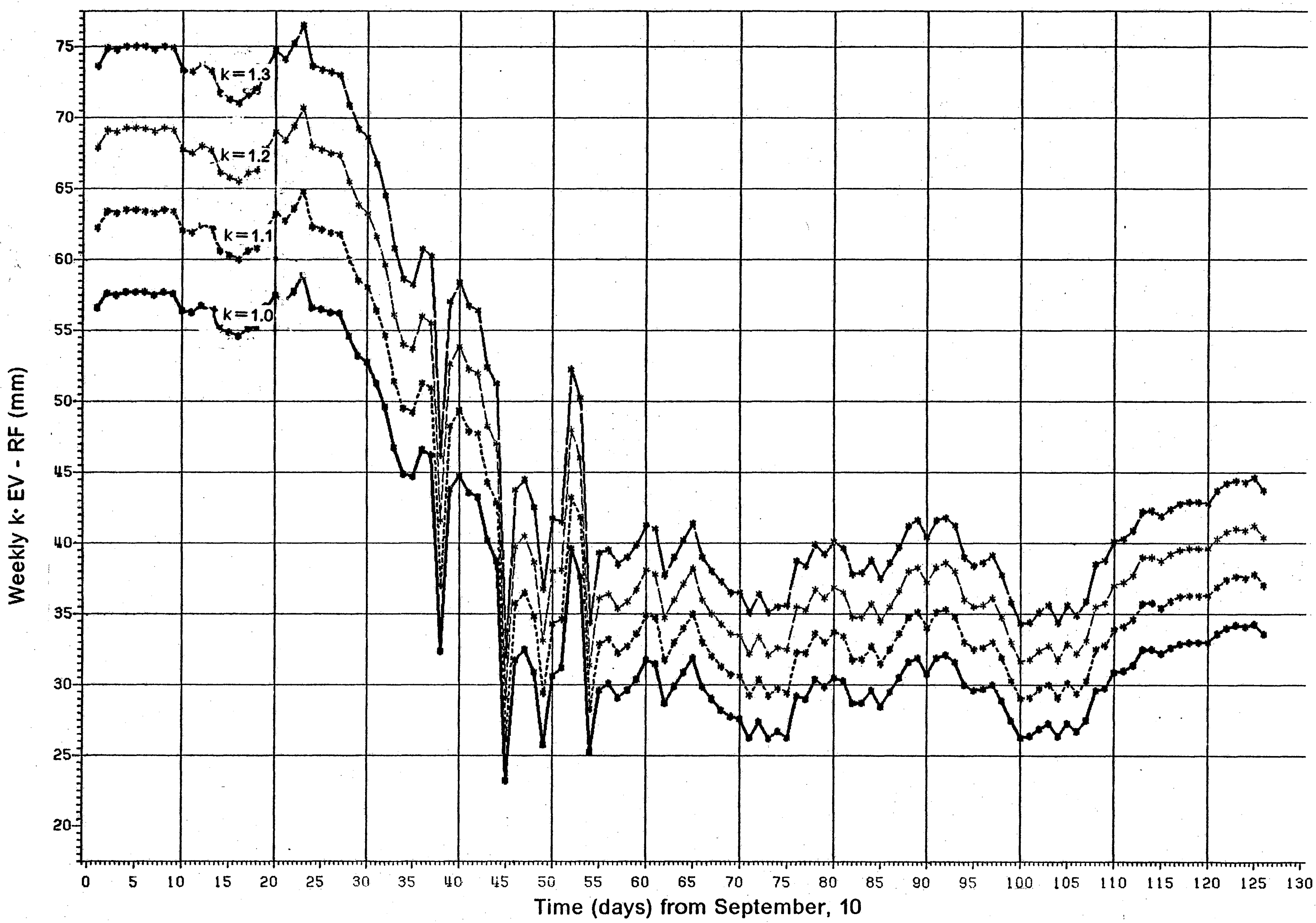


Figure 4.13a. Weekly k · EV - RF estimated at probability greater than 90%.

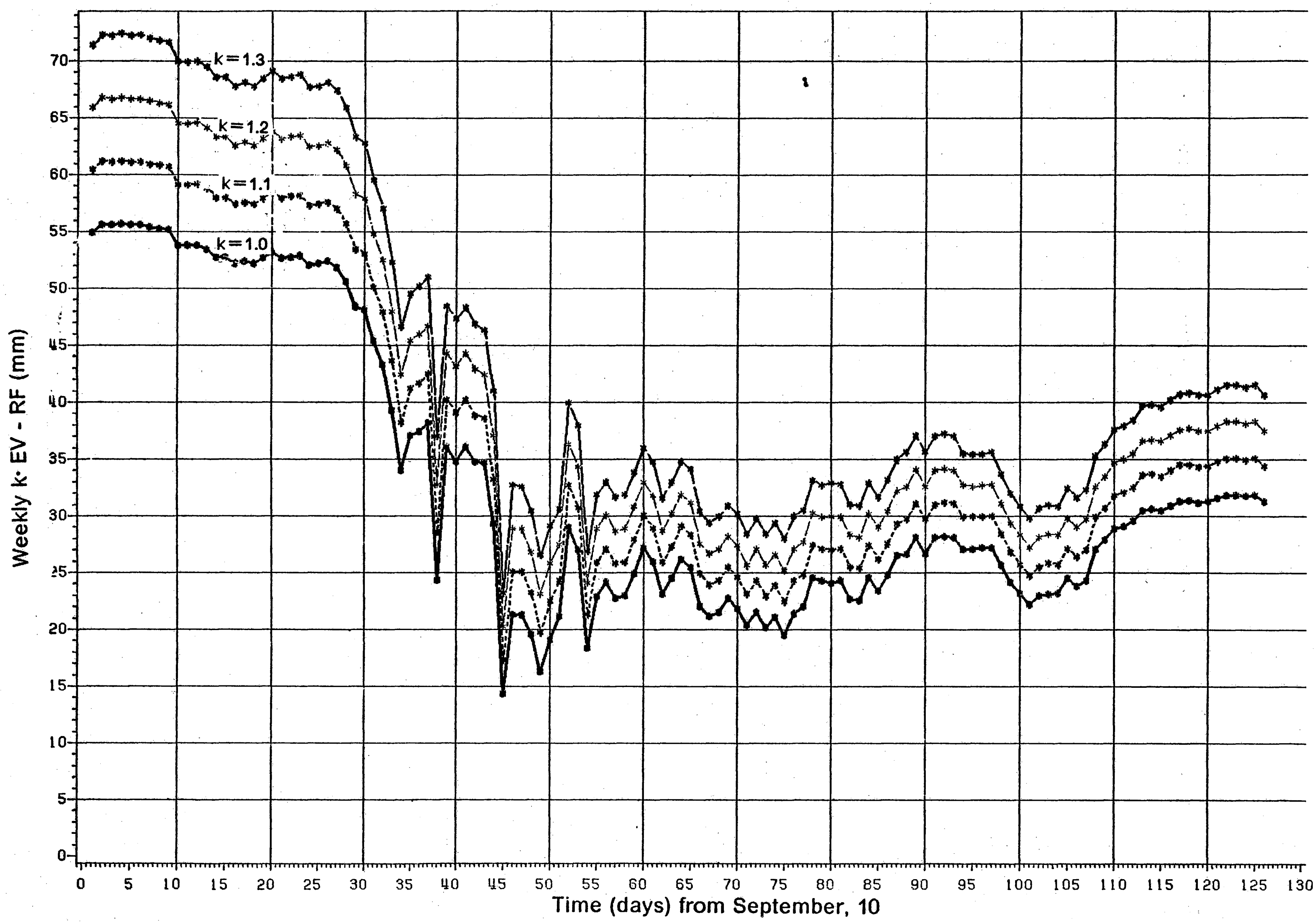


Figure 4.13b. Weekly k · EV - RF estimated at probability greater than 81%.

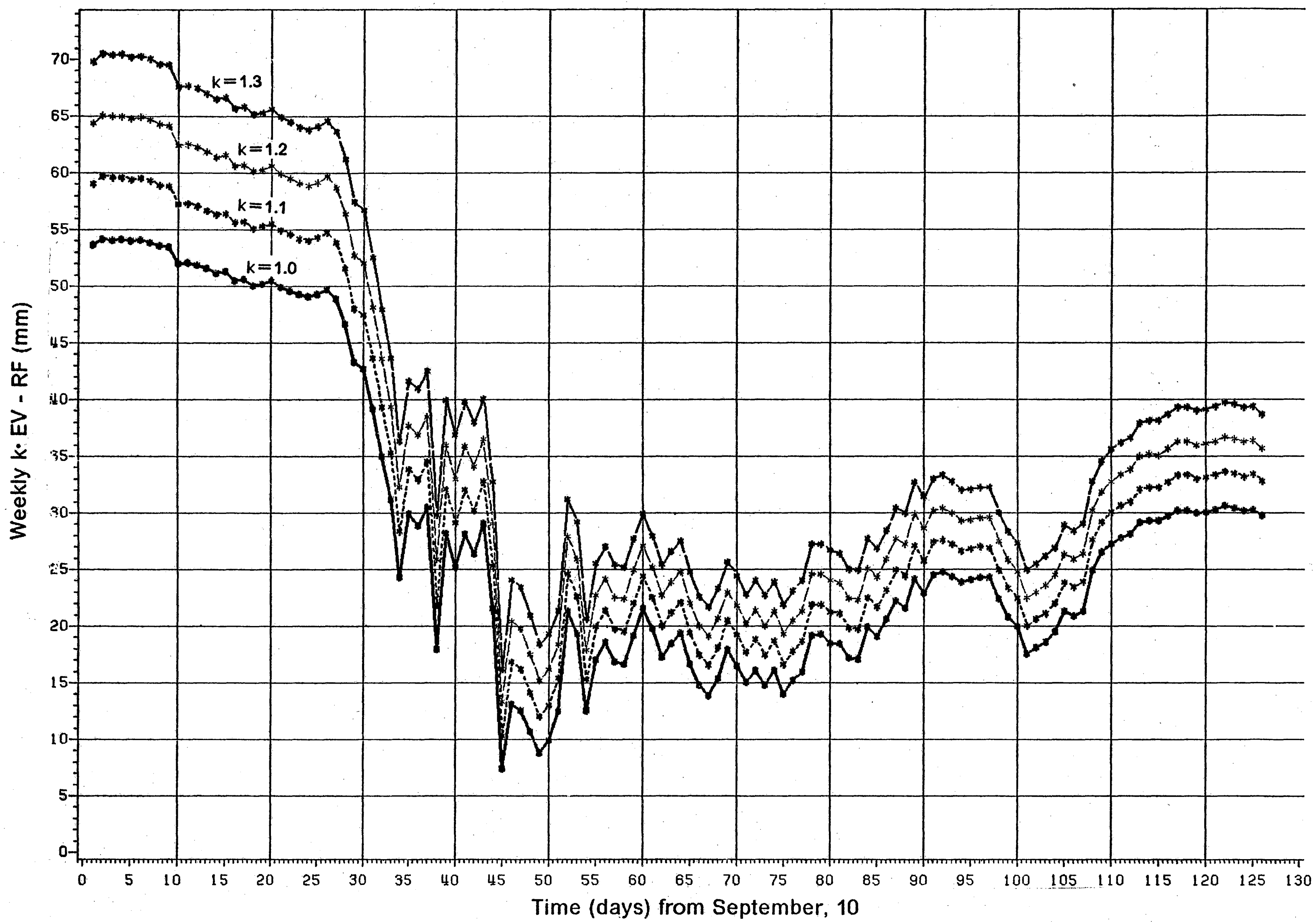


Figure 4.13c. Weekly k · EV - RF estimated at probability greater than 72%.

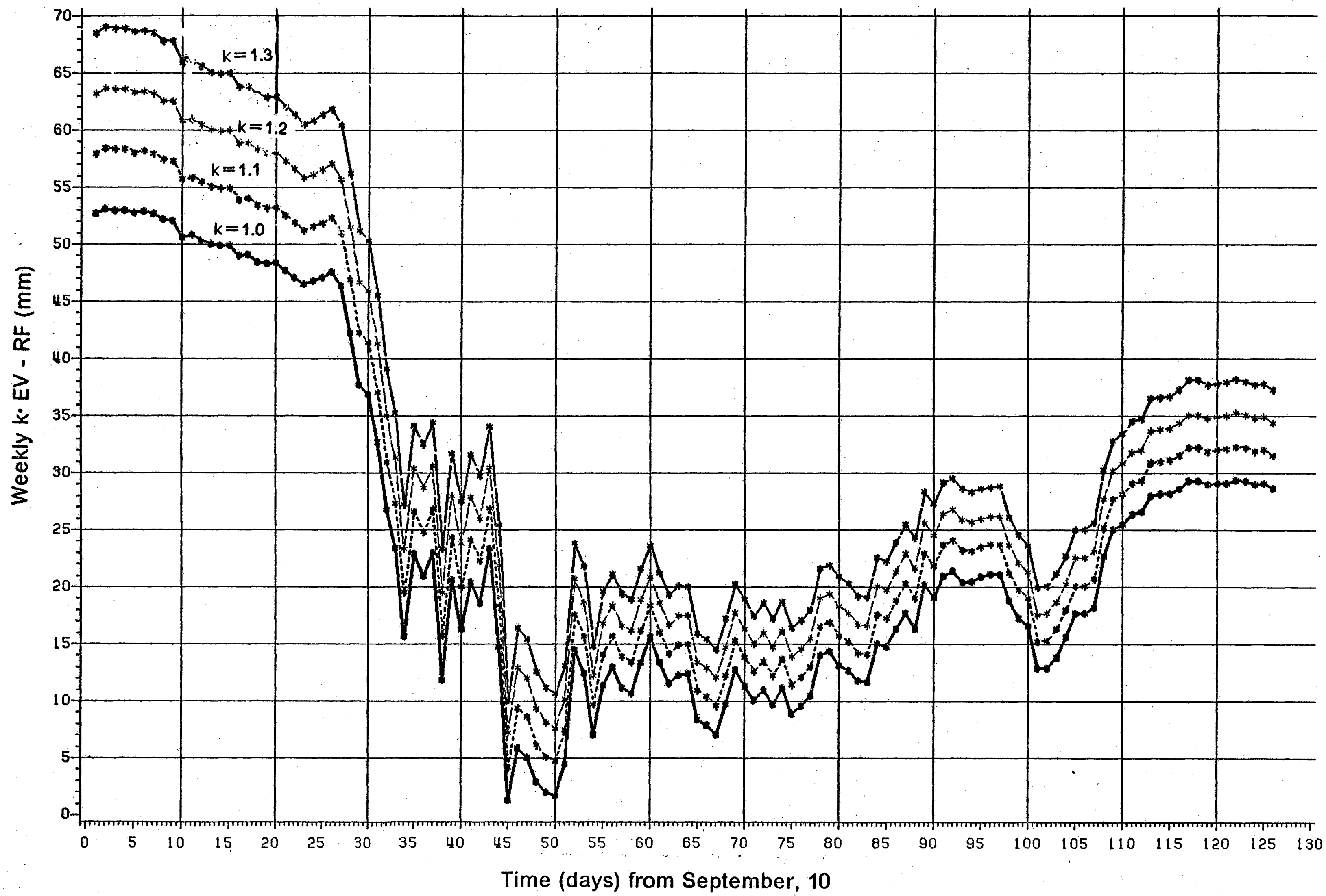


Figure 4.13d. Weekly k · EV - RF estimated at probability greater than 64%.

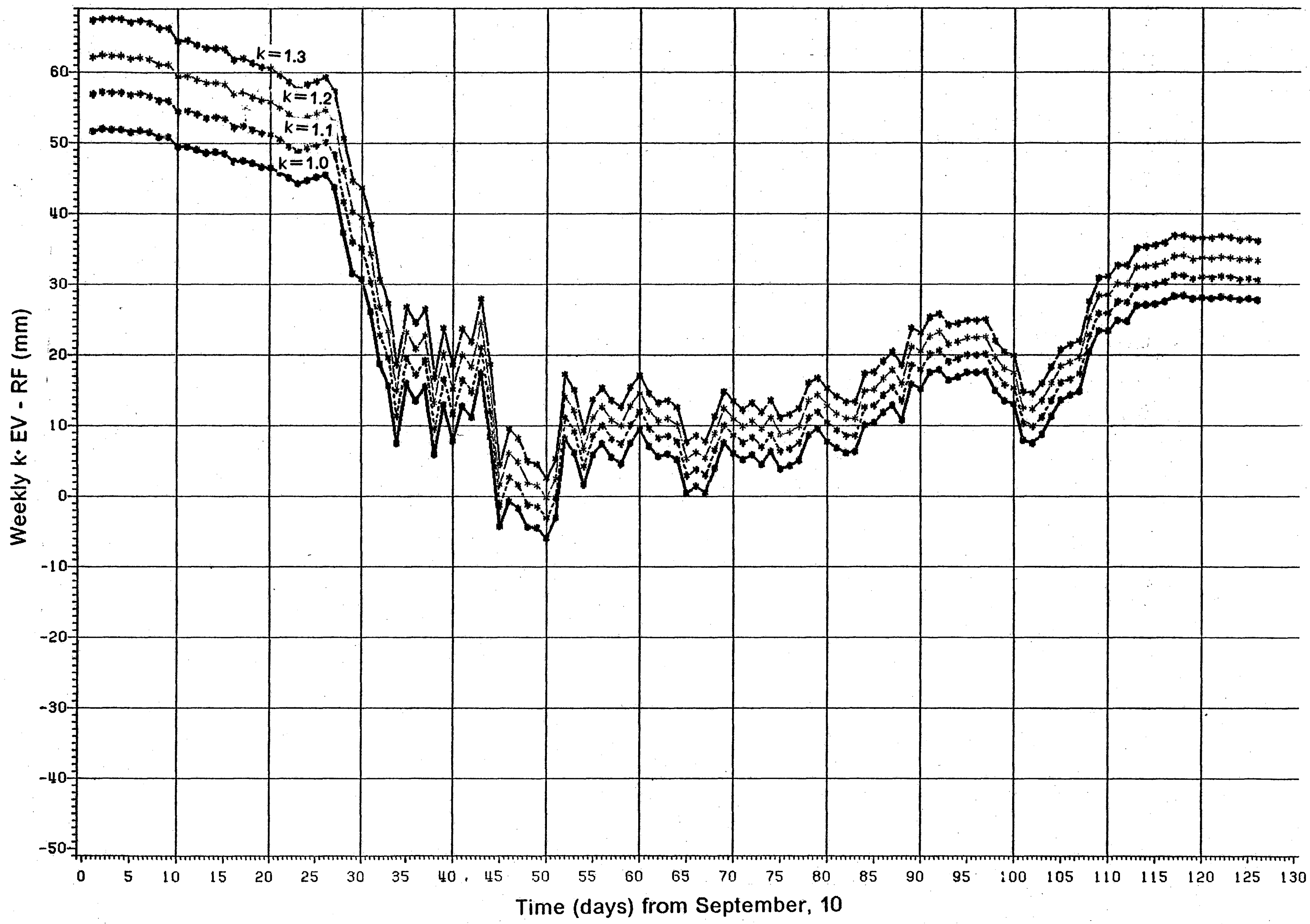


Figure 4.13e. Weekly k · EV - RF estimated at probability greater than 56%.

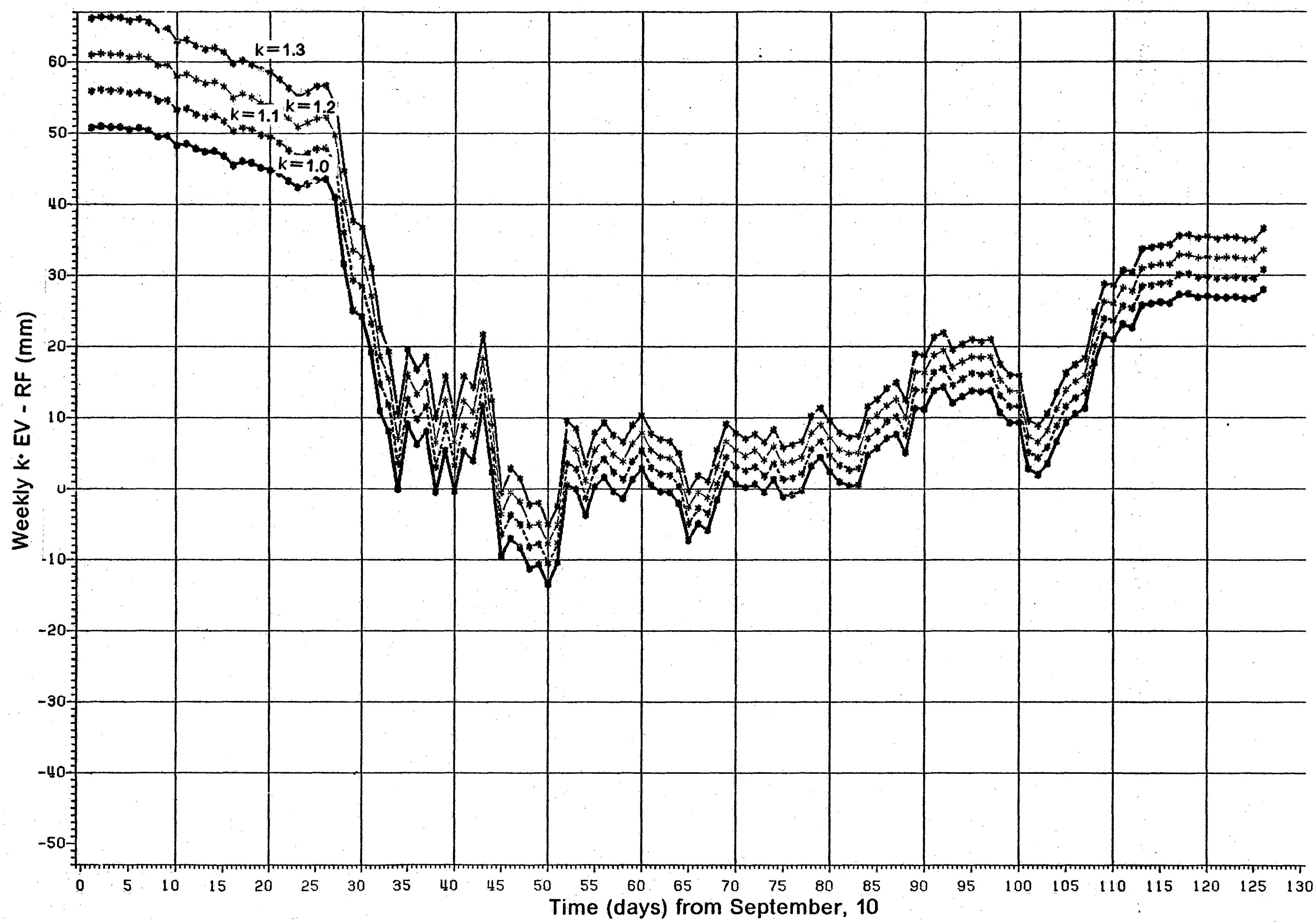


Figure 4.13f. Weekly k · EV - RF estimated at probability greater than 49%.

4.3 *Canal Conveyance Model Application*

In a typical irrigation system, usually there is a reservoir with a diversion dam or a similar control structure at the upstream end of the main canal. In the Kalawewa irrigation scheme, the left bank main canal and the right bank main canals carry water from the Kalawewa reservoir to the D-channels. To conserve water in the reservoir, only the required quantity of water should be released to the main canals commensurate with the irrigation requirements of the D-channels.

Computer models of water distribution systems are frequently used to solve design and operation problems. The EXTRAN hydraulic flow routing model is used herein to simulate flows in the left bank main canal to determine the optimal canal operations. For demonstration purposes, a segment of the left bank main canal was chosen, with the head gate at the Kalawewa reservoir as the upstream boundary and the Mulanatuwa tank as the downstream boundary (Figure 4.14).

4.3.1 Data Input for Flow Simulation

Nodes and canal reaches were identified to describe the physical layout of the distribution system. Canal reaches are the means of conveyance and nodes are the beginning and ending points of each canal reach. Nodes are specified at points where flow leaves the main canal (i.e. location of turnout structures to D-channels). The canal is composed of 16 reaches with 15 turnout structures of the orifice type. The orifice openings can be adjusted via vertical movable gates.

All nodes are numbered but are not required to be in any prescribed sequence. The nodes here are numbered with four digit numbers associating the number of the D-channel and the number of the block. For example, block 301 (Figure 4.14) has 6 D-channels and the

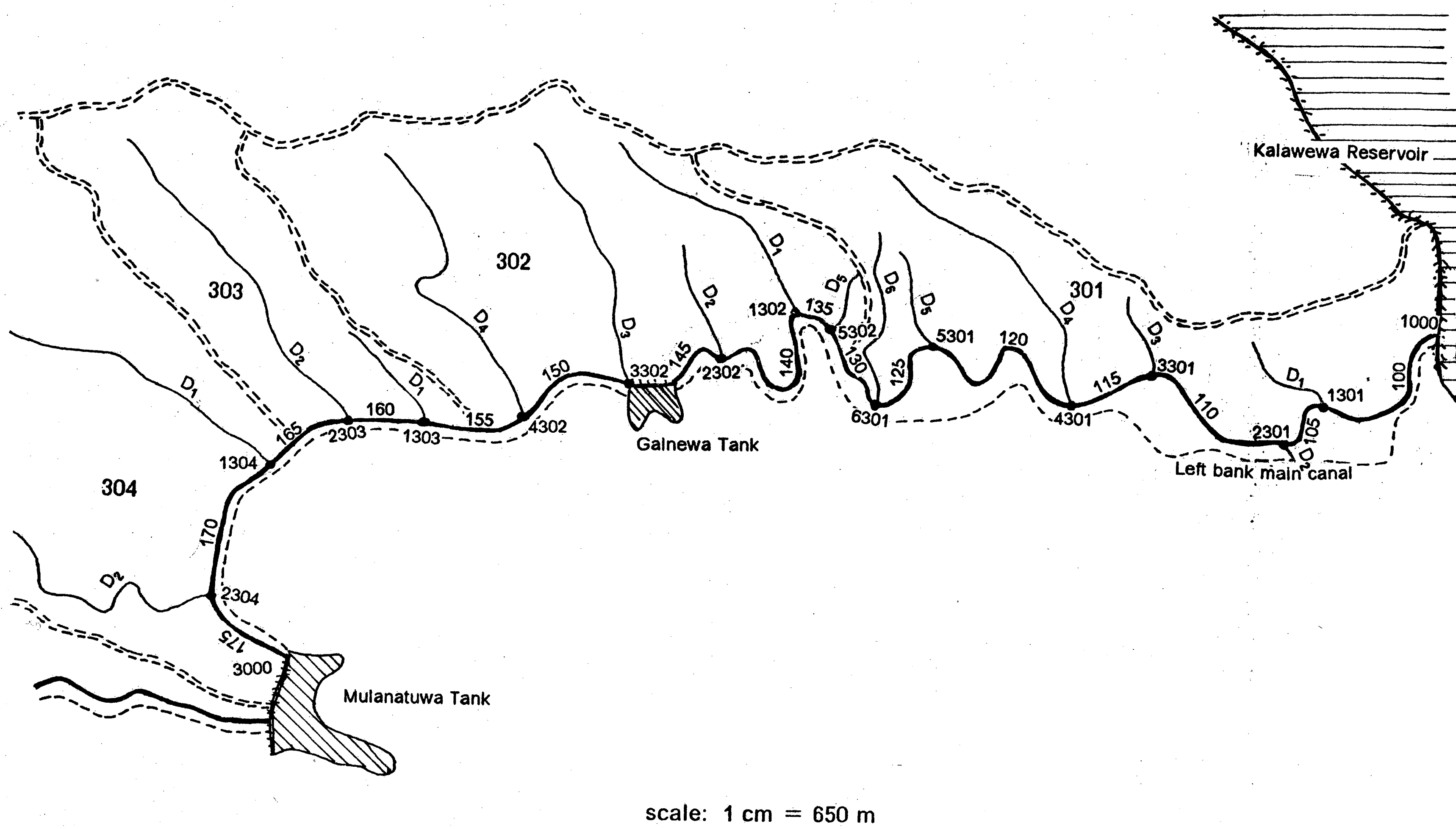


Figure 4.14. Map showing segment of the left bank main canal.

node at D-channel 1 is numbered 1301. The node at D-channel 2 in in block 302 for example, is numbered 2302, etc. The upstream end (head gate) and downstream end (Mulanatuwa tank) were assigned node numbers 1000 and 3000, respectively. These two nodes do not have D-channels associated with them. Node 1000 is the only inflow point and node 3000 is assumed to be a free outflow point beyond which water is fed to the smaller regulating reservoirs supplied by the Kalawewa reservoir. To distinguish between canal reaches and node points, canal reaches are assigned 3 digit numbers in ascending order, moving from the source towards the various reaches. Figure 4.14 shows the classification of nodes and canal reach notations for the left bank main canal of the Kalawewa irrigation scheme.

A positive elevation above a datum is required for all nodes. Table 4.4 gives the distance between node points, elevations at nodes and numbers assigned to nodes and canal reaches. Canal sections are trapezoidal with bottom width 3.05 m (10 ft) and side slopes 1 : 1.5. Mannings roughness coefficient was assumed to be 0.1 for the canal in the main system. The slope of each canal reach is calculated by the model, from the elevation of the nodes at each end of the canal and the canal length.

When simulating flow through side orifices, the node at which the side orifice is located and the node to which it discharges must be specified. EXTRAN however, allows side flow orifices to discharge only into another node within the network. This poses a problem for simulating water flow in irrigation canals, where water from the main or branch canal flows into D-channels (located along the main canal) via side orifices or side flow weirs. To overcome this limitation in the water flow simulation of the left bank main canal of the Kalawewa irrigation system, it was assumed that all side flow orifices discharged into node 3000, in setting up the input data to run EXTRAN.

The above assumption does not cause any computational errors with regard to the flows in the main canal or to the flow across the side flow orifices into the D-channel. However, this will produce an error in the continuity balance in the computer program output, which the program computes and prints out at the end of the simulation. The continuity balance in EXTRAN is computed as the total volume of inflow into node 1000, minus the volume of outflow

Table 4.4. Lengths of canals and elevation of nodes for the left bank main canal.

	Node	Elevation in m	Canal reach	Length in m
Head gate	1000	12.00 (39.72)		
			100	717 (2354)
	1301	11.87 (38.94)		
			105	412 (1351)
	2301	11.75 (38.54)		
			110	1458 (4781)
	3301	11.25 (36.92)		
			115	475 (1559)
	4301	11.10 (36.41)		
			120	602 (1975)
	5301	10.90 (35.75)		
			125	1900 (6236)
	6301	10.25 (33.64)		
			130	1679 (5509)
	5302	9.71 (31.87)		
			135	412 (1351)
	1302	9.35 (31.43)		
			140	689 (2262)
	2302	9.35 (30.68)		
			145	634 (2079)
Galnewa tank	3302	9.14 (30.00)		
			150	1173 (3850)
	6302	8.74 (28.69)		
			155	800 (2625)
	1303	8.48 (27.83)		
			160	760 (2495)
	2303	8.23 (27.00)		
			165	855 (2806)
	1304	7.95 (26.08)		
			170	1362 (4469)
	2304	7.50 (24.60)		
			175	1077 (3534)
Mulanatuwa tank	3000	7.14 (23.44)		

values in brackets are in ft to be used in EXTRAN from node 3000 less the change in storage in the system. It does not account for the volume discharging through the side orifices. The program assigns internal canals (fictitious) connecting the side orifices to node 3000. These canals are not specified in the input data. The flow through these canals are not taken into account in the water balance calculations, thus resulting in a large continuity imbalance (Appendix D).

The Galnewa tank (Figure 4.14), estimated to have a surface area of 196,710 m^2 (2,117,369 ft^2), is located at node 3302. The size of this tank is relatively small with compared to the other tanks in the area which act as regulating reservoirs. Therefore, the Galnewa tank is assumed to act as an intermediate storage tank. The bottom of the reservoir is assumed to coincide with the bottom of the canal reaches connecting it. If the tank is empty at the beginning of a simulation, water will flow into the tank to fill its storage before any water can enter the downstream canal. When the tank is full, since water cannot flow into it any way, the existence of the tank is neglected for simulation purposes.

4.3.2 Estimating Required Flows in Canals

The amount of water to be diverted from the Kalawewa reservoir into the left bank main canal, depends on the amount of water required in the D-channels each day. The required water flow in each D-channel was estimated based on the water needs in the F-channels associated with a particular D-channel and knowing the area to be cultivated under each F-channel. Using the water balance equation (eq. 3.7) the irrigation requirements and the flow in the F-channels were determined. Then the flow required in the D-channels was determined by summing the requirements of the F-channels associated with each D-channel.

In D-channel 3 of block 302 there are 10 turnout areas. Each turnout area consists of 14 to 16 farms of one ha each. It can be assumed that on the average, the total area under D-channel 3 in block 302 is 150 ha. Water is supplied to the 10 turnout areas simultaneously (Alwis *et al*, 1983). For the sample calculations of section 4.2.5, the irrigation requirement estimated for October 23 is 92 mm. Assuming that the initial water depth in all the fields is the same, that all rice plants are of the same age and that the percolation losses are constant, then the required flow in D-channel 3 in block 302 will be equal to the irrigation requirement (92 mm/week) times the total area served by D-channel 3 (150 ha). Allowing for canal losses of 15% in F-channels and 6% in D-channels, the amount of water which must be diverted into D-channel 3 from the left bank main canal is 4.73 x 10^4 m^3/day or 0.55 m^3/s (19.4 ft^3/s).

The irrigation requirements calculated for the weeks beginning November 1 and 2 are 90 mm and 80 mm, respectively. The corresponding amounts of water that must be diverted into D-channel 3 are 0.54 m^3/s (19.1 ft^3/s) and 0.48 m^3/s (16.9 ft^3/s), respectively. These values correspond to a reduction in flow of 2% and 13% from the original discharge of 0.55 m^3/s (19.4 ft^3/s) required on October 31. Therefore, the headgate at the Kalawewa reservoir must be regulated such that the water released into the main canal each day reflects the daily change in demand in the D-channels, and to maintain the flow required for the downstream smaller reservoirs simultaneously. The demands in the downstream reservoirs are set by the areas cultivated under each reservoir.

4.3.3 Flow Simulation in Main Canal

In the absence of detailed information on the area cultivated under each D-channel, it is assumed that the water duty of all D-channels are equal. i.e. the discharge from all the side outlet orifices into the D-channels is the same. To estimate the gate settings of each orifice (orifice opening) required for equal discharge through all orifices, 0.093 m^2 (1 ft^2) of orifice opening was used as an initial approximation. An inflow of 5.66 m^3/s (200 ft^3/s) is used for the initial simulation because this value is within the present operating range of the system (Alwis *et al* 1983). With the present operating system in the Kalawewa irrigation system, water is allowed to flow to D-channels 3-4 days a week with alternate turnout structures open at a time. Figure 4.15a shows the discharge versus time when side orifices at nodes 1301, 3301, 5301, 5302, 2302, 4302, 2303, and 2304 have 0.093 m² (1 ft²), opening and all other orifices closed. Similarly, Figure 4.15b shows the discharge versus time when side orifices at nodes 2301, 4301, 6301, 1302, 3302, 1303 and 1304 have 0.093 m² (1 ft²) openings.

As one would expect, the steady state discharge through the orifices decreased gradually towards the downstream end of the main canal when the orifice openings of the turnout structures were uniform (Figures 4.15a and 4.15b). In order to achieve equal discharges through all the orifices, the orifice openings were adjusted proportionately with the aid of Figures 4.15a and 4.15b. The simulation was repeated with orifice openings of 0.084, 0.085, 0.095, 0.096, 0.099, 0.108, 0.116 and 0.123 m² (i.e. 0.90, 0.92, 1.02, 1.03, 1.07, 1.16, 1.25 and 1.32 ft²) at nodes 1301, 3301, 5301, 5302, 2302, 4302, 2303 and 2304, respectively (Figure 4.16a). The simulation was also carried out for the alternative schedule, where orifices at nodes 2301, 4301, 6301, 1302, 3302, 1303 and 1304 were open 0.084, 0.085, 0.089, 0.095, 0.110, 0.108 and 0.113 m² (i.e. 0.90, 0.92, 0.96, 1.02, 1.08, 1.16 and 1.22 ft²), respectively, and all other orifices were closed (Figure 4.16b).

As shown in Figures 4.16a and 4.16b a near constant flow is maintained through the side outlet orifices into the D-channels, by adjusting the orifice openings. If, however, the demands vary for the different D-channels, the turnout structures (orifice openings) can be adjusted and the flow simulations repeated until the required flow through each orifice is obtained. Determining required orifice opening is a trial and error method, i.e. for each set up of orifice openings the simulations have to be repeated until the required flow is obtained.

The forgoing flow simulations are for the main canal assuming the canal was dry initially. However, according to the present operation system water is allowed to flow in the main canal continuously, although it may not flow at full capacity at all times. It is, therefore, necessary to determine how the discharges through the different orifices will vary when the inflow at the head gate is changed.

There is a time lag of about 15 hours from the time water is first released to the main system at the head gate and the time it takes for the water to flow into the D-channel at node 3302 located downstream of the Galnewa tank. Further, it takes more than 108 hours for the

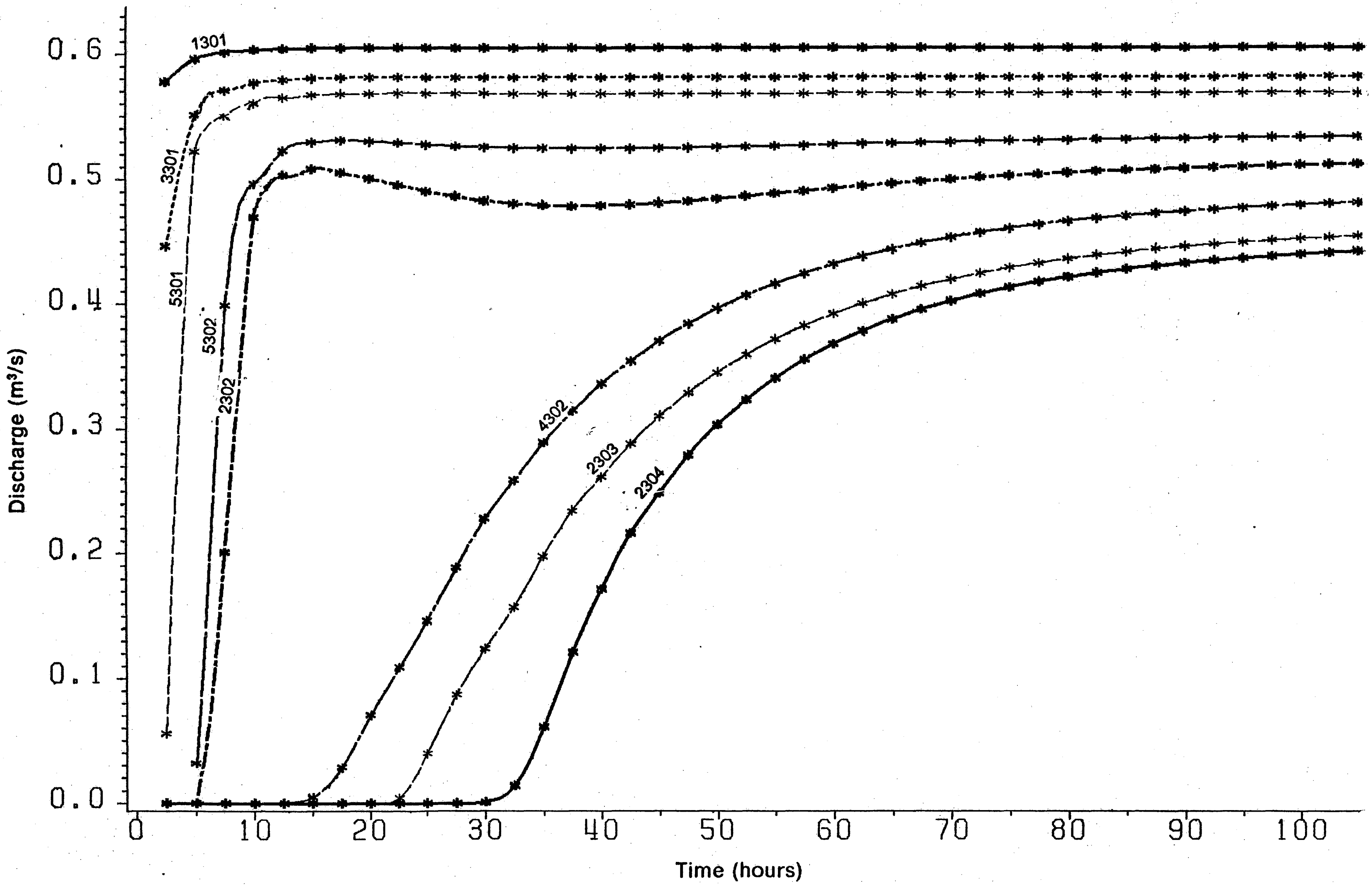


Figure 4.15a. Flow into turnouts when alternate turnouts are open (1301, 3301, 5301, 5302, 2302 4302, 2303 and 2304 open).

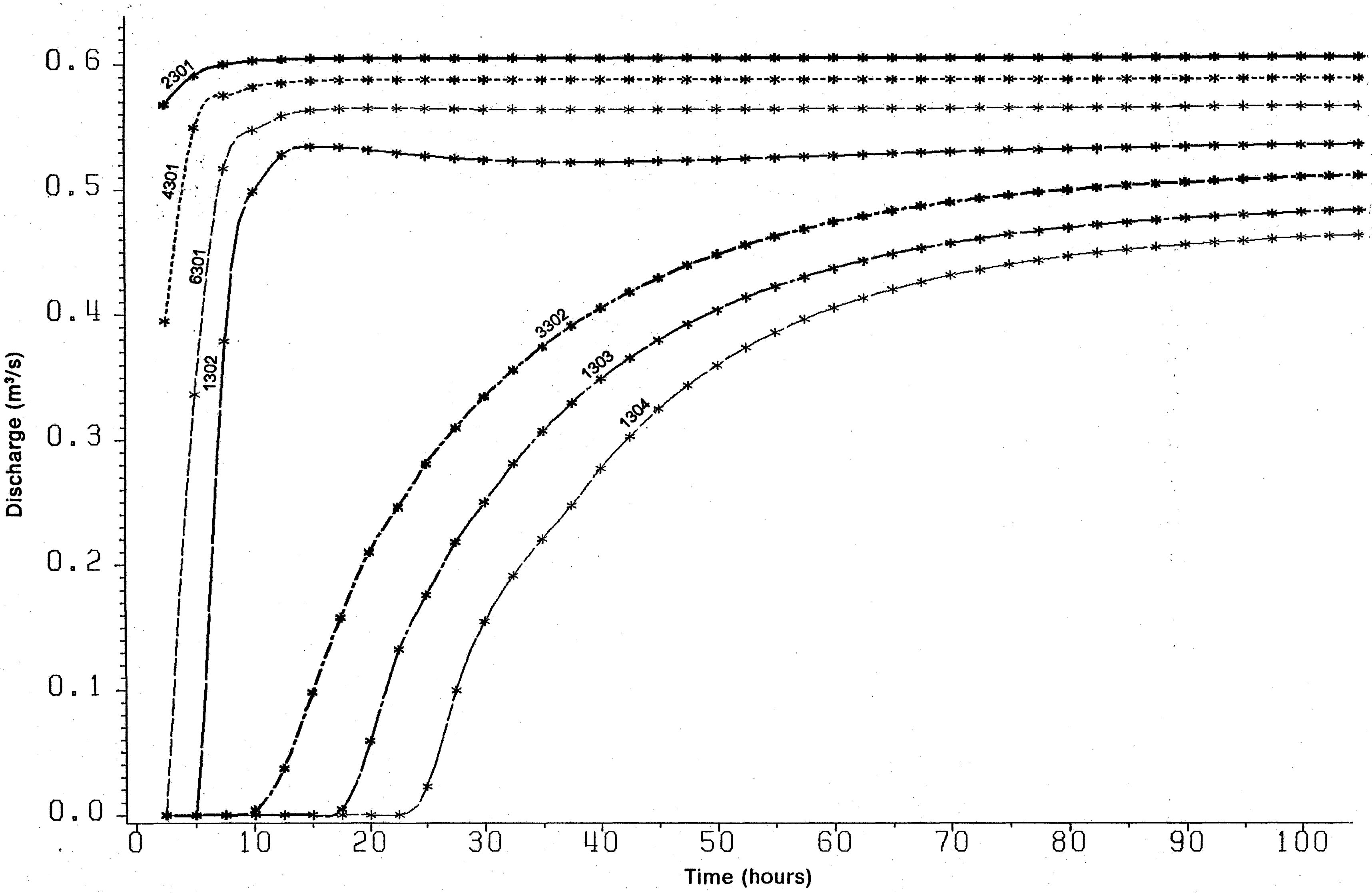


Figure 4.15b. Flow into turnouts when alternate turnouts are open (2301, 4301, 6301 1302, 3302, 1303 and 1304 open).

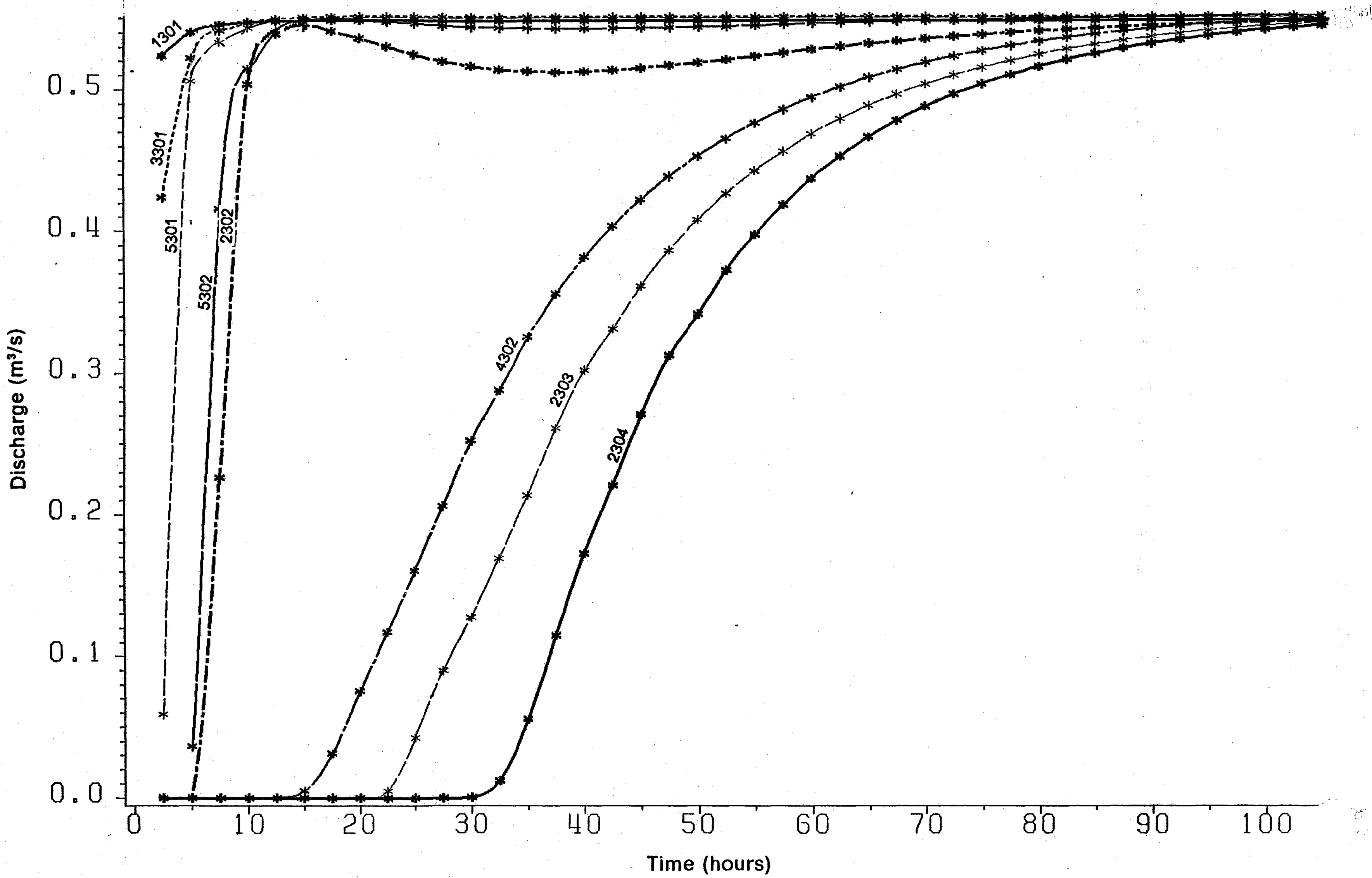


Figure 4.16a. Flow through turnouts when gates are adjusted for equal flow (1301, 3301, 5301, 5302, 2302 4302, 2303 and 2304 open).

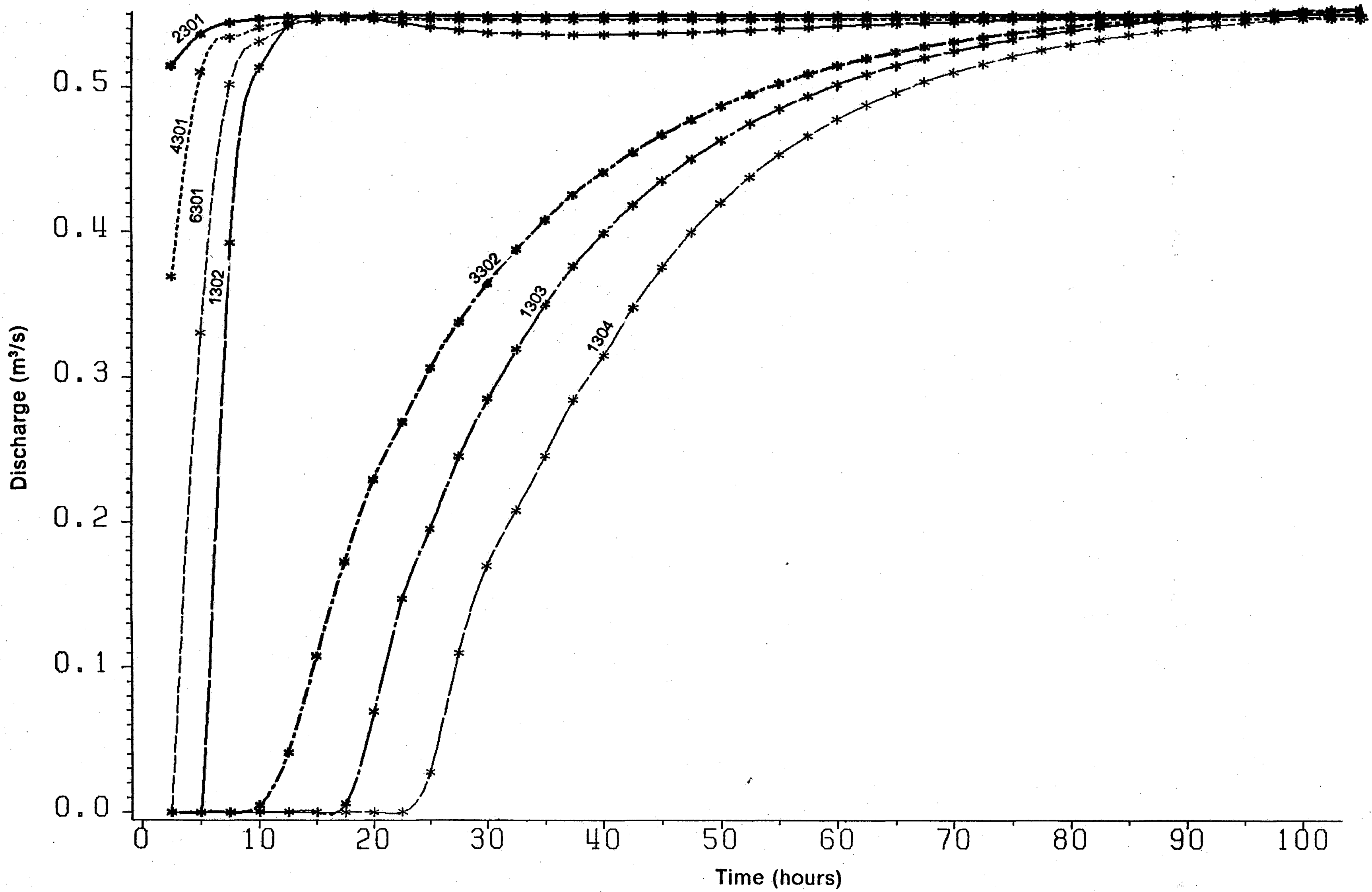


Figure 4.16b. Flow through turnouts when gates are adjusted for equal flow (2301, 4301, 6301 1302, 3302, 1303 and 1304 open).

flow in the canal reaches downstream of Galnewa tank to achieve steady state conditions. This is because the Galnewa tank is assumed a storage at node 3302. Water flows into the Galnewa tank to fill its storage before flowing downstream of it. It would be more appropriate therefore, to assume the Galnewa tank to act as a regulating reservoir fed by the Kalawewa reservoir and that the flow into the D-channels between the Galnewa and Mulanatuwa tanks is controlled by the Galnewa tank. With this assumption, the canal reaches upstream of node 3302 can be considered separately and the flow into the turnouts upstream of node 3302 to be regulated by the Kalawewa reservoir.

Flow simulation was done for the system between the head gate at the Kalawewa reservoir and the Galnewa tank, with 10 canal reaches and 11 nodes. According to the irrigation requirements estimated in section 4.2.5, the water demand in each turnout will vary each day. For illustration purposes, it is assumed that the demand in each turnout area is decreased by 0.057 m^3/s (2 ft^3/s) each day for a period of 4 days. If the demand in the downstream reservoirs remained unchanged, the amount of water released from the head gate should be reduced by 0.283 m^3/s (10 ft^3/s) each day to be commensurate with demands at the turnouts. The inflow from the head gate is therefore adjusted every 24 hours (= 1 day) so that the initial flow of 5.66 m^3/s (200 ft^3/s) is decreased to 5.83, 5.10, 4.81 and 4.53 m^3/s. The flow through the turnouts at 1301, 3301, 5301, 5302 and 2301 when all other turnouts are shut is shown in Figure 4.17a. Similarly Figure 4.17b shows the flows through the turnout for the alternate schedule when the turnouts at 2301, 4301, 6301 and 1302 are open.

Table 4.5 gives the flow across the turnout structures when the discharge at the head gate was decreased by 0.283 m^3/s (10 ft^3/s) each day from the initial discharge of 5.66 m^3/s (200 ft^3/s) and the flow in the canal reach (145) to the downstream regulating reservoirs. The initial discharges through the orifices are not equal (Table 4.5) but the values are very close to the required flow of 0.55 m^3/s (19.4 ft^3/s) which is the demand for October 31. The orifice opening can be adjusted further if desired and the flow simulation can be repeated until the exact flows are attained. When the flow in the head gate was decreased by 0.283 m^3/s (10 ft^3/s), the decrease in flow at the turnouts are neither equal to 0.057 m^3/s (2 ft^3/s) nor uniform. The de-

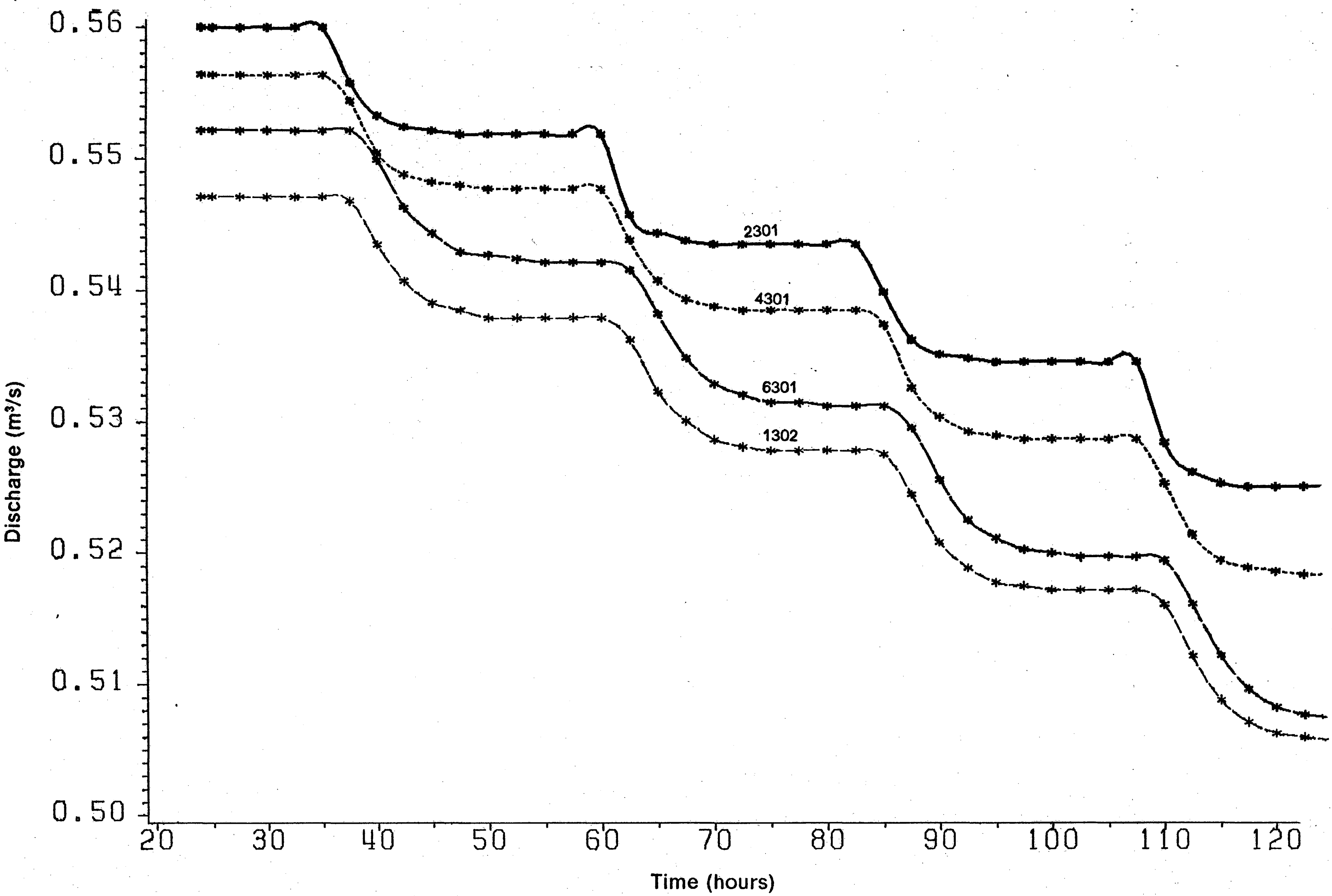


Figure 4.17b. Flow through turnouts for variable inflow at head gate (2301, 4301, 6301 and 1302 open).

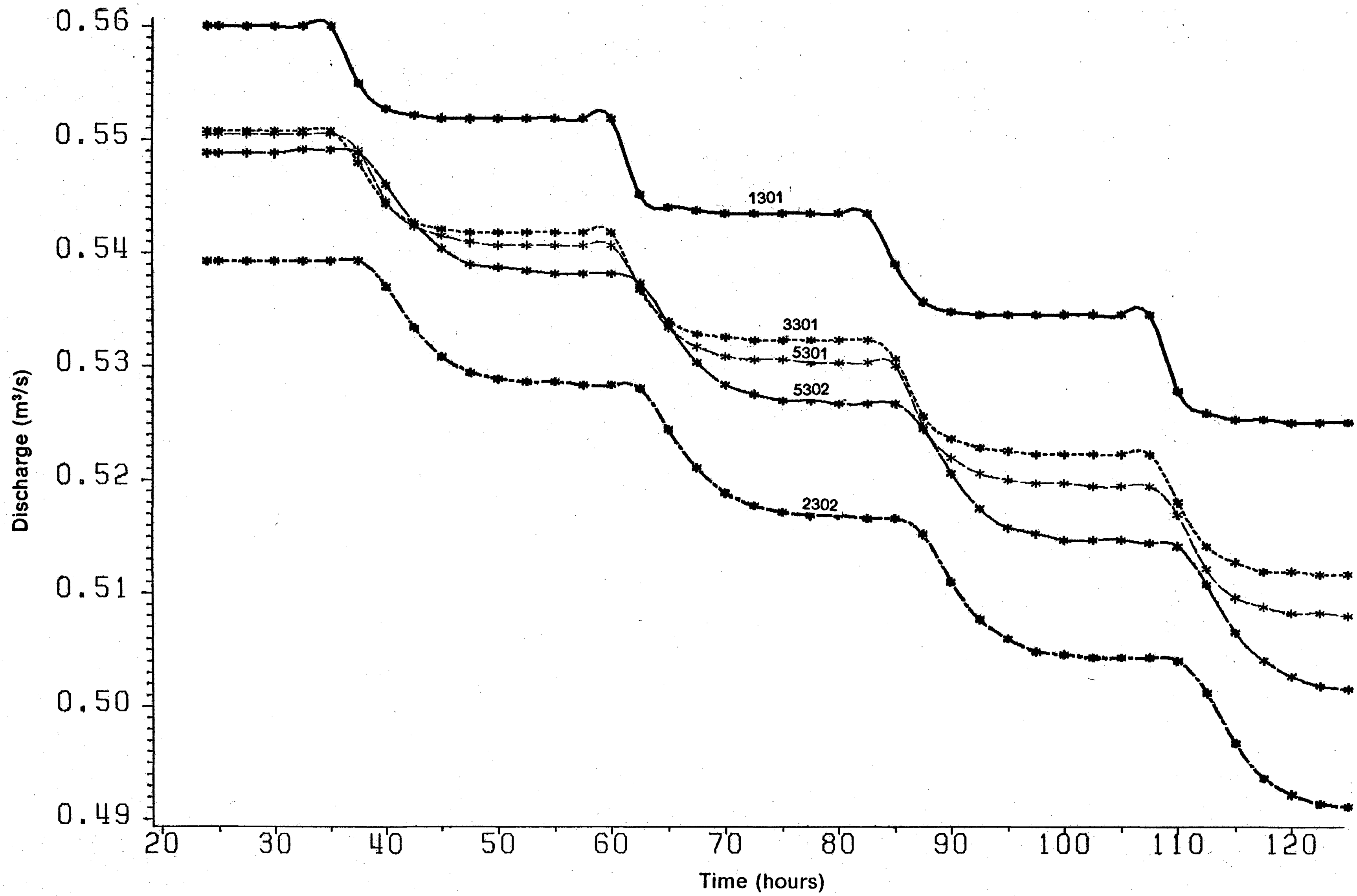


Figure 4.17a. Flow through turnouts for variable inflow at head gate (1301, 3301, 5301, 5302, and 2302 open).

crease in flow was less than 0.057 m^3/s in all turnouts but the amount of decrease was higher at the downstream turnouts. In order for the flow in each of the orifices to decrease uniformly, the orifice openings must be decreased proportionately.

As one would expect, the flow through the orifices does not decrease in proportion to the change in inflow at the headgate. This is because the flow into the turnout is not directly proportional to the flow in the main canal, instead the relationship is non-linear. Further, since water is fed into the alternate turnout structures simultaneously from the main canal, the flow through each turnout is related to the flow into the turnouts upstream of it. Therefore, in order to adjust the flow into D-channels to the required flow, the flow simulation has to be repeated with the adjusted orifice openings until the required flows are attained. If for example a 1% decrease in discharge is desired at the turnouts, the flow in the headgate has to be decreased to correspond to the decrease in demand while maintaining the required flow to the downstream reservoirs. i.e. the flow in canal reach 145 has to meet the downstream demands. In Table 4.5 it is seen however, that the flow in canal 145 decreases more than the percentage decrease at the turnouts. In order to maintain a constant flow downstream therefore, the inflow at the headgate has to be increased and the gate settings (orifice openings) adjusted to divert only the required flows into the D-channels.

When the alternate orifices starting with second orifice are open, water is fed only to 4 D-channels as opposed to the other where 5 orifices are open simultaneously. Therefore, the flow in the head gate has to be decreased to supply water into 4 turnout areas, instead of 5 turnout areas, and the gate settings adjusted to pass the required flows while maintaining the demands in the downstream reservoirs.

Table 4.5. Flow in D-channels for varying inflow at headgate.

Turnouts at nodes 1301, 3301, 5301, 5302 and 3302 open.

	Head gate discharge in m³/s				
	5.663 (200)	5.380 (190)	5.097 (180)	4.184 (170)	4.531 (160)
1301	0.566 (20.00)	0.558 (19.71)	0.550 (19.41)	0.541 (19.09)	0.531 (18.75)
3301	0.555 (19.61)	0.548 (19.35)	0.538 (19.01)	0.528 (18.65)	0.517 (18..27)
5301	0.557 (19.66)	0.547 (19.31)	0.536 (18.94)	0.528 (18.55)	0.514 (18.14)
5302	0.544 (19.20)	0.554 (19.22)	0.533 (18.81)	0.520 (18.38)	0.507 (17.91)
3302	0.545 (19.26)	0.534 (18.87)	0.522 (18.45)	0.510 (18.01)	0.496 (17.53)
Flow in 145	2.887 (101.97)	2.650 (93.57)	2.418 (85.40)	2.190 (77.34)	1.967 (69.47)

Turnouts at nodes 2301, 4301, 6301 and 2302 open.

	Head gate discharge in m³/s				
	5.663 (200)	5.380 (190)	5.097 (180)	4.184 (170)	4.531 (160)
2301	0.566 (20.00)	0.558 (19.71)	0.550 (19.41)	0.541 (19.09)	0.531 (18.75)
4301	0.563 (19.87)	0.554 (19.56)	0.547 (19.23)	0.535 (18.88)	0.524 (18.51)
6301	0.553 (19.54)	0.544 (19.21)	0.534 (18.85)	0.523 (18.47)	0.511 (18.06)
1302	0.558 (19.72)	0.548 (19.36)	0.537 (18.97)	0.526 (18.56)	0.513 (18.11)
Flow in 145	3.422 (120.84)	3.177 (112.19)	2.933 (103.57)	2.691 (95.03)	2.453 (86.64)

values in brackets are discharge in ft³/s.

chapter 5

Results and Discussion

5.1 *On Farm Water Management*

5.1.1 Analysis of Daily Pan Evaporation Data

The water balance given in equation 3.7 was used to determine irrigation requirement. Equation 3.7 consists of stochastic components EV and RF and deterministic components SMIN, SIN (S_{i-1}) and PERC. Because equation 3.7 consisted of stochastic components, weekly IR were estimated at different probability levels. To estimate weekly IR values for all weeks coinciding with the wet season, it was necessary to analyze weekly EV and RF to describe their variations and to estimate their values at different probability levels. Historical records of daily RF data were available for Maha Iluppallama (near Kalawewa irrigation scheme) for the years between 1952 to 1985. However, there were gaps of missing data in the available records of daily pan evaporation at Maha Iluppallama.

In some years daily evaporation observations were recorded with an evaporimeter and therefore, it was necessary to correlate pan evaporation records to evaporimeter records. For 1964 and 1965, both pan evaporation and evaporimeter records were available and therefore, it was possible to use regression analysis to relate pan evaporation observations to evaporimeter observations.

A quadratic relationship between pan evaporation and evaporimeter records was obtained (Figure 4.6), with $r^2 = 0.751$. The relationship between the two variables are given in equation 4.1. Equation 4.1 was used to estimate pan evaporation values for the days for which only evaporimeter readings were available.

Evaporation observations were not recorded when the evaporation pan overflowed owing to heavy rainfall on some days. An attempt was made to fill such gaps in daily observations by relating daily RF to daily EV observations, since one could expect EV to be inversely related to RF but satisfactory relationships were not found (Figure 4.7). Among other factors evaporation is a function of humidity. With rainfall, humidity will be high and therefore, theoretically evaporation should be low. An inverse relationship between rainfall and evaporation was not observed probably due to errors in observation. Although daily rainfall was not correlated with daily evaporation, long term mean weekly RF and EV, when plotted against time, showed an inverse relationship between the two variables (Figure 4.8).

Continuous records of daily evaporation values were required for the analysis, and it was therefore necessary to generate daily evaporation values to fill gaps of missing data using Monte Carlo simulation. To use Monte Carlo simulation, it was necessary to identify the distributions that best fit the available daily EV data for all months in the wet season with each month considered separately. The normal distribution was able to describe the daily evaporation data for all months and equations 4.2a to 4.2f were used to generate daily evaporation data. It is to be noted that the highest daily mean EV (6.581 mm) was observed for November and the lowest value was observed for February (3.052 mm). The lowest standard deviation for EV was observed for February (1.334 mm) and the highest standard deviation was observed for December (2.083 mm). This is probably due to the very low rainfall occurring in February and the evaporation records are not interrupted by rainfall. On the other hand, owing to heavy rainfall in December, evaporation observations were probably interrupted, and the readings may be in error to some extent.

Monte Carlo simulation was used successfully to generate daily EV data, to fill gaps in the data. Using Monte Carlo simulation, daily EV data were generated for the years for which only rainfall was available (Table A2, Appendix A).

After filling gaps in daily EV records, weekly EV values were determined for all weeks beginning each day after September 10, for the 34 years of record (years 1952 to 1985, Table B2, Appendix B).

5.1.2 Analysis of Weekly Rainfall and Pan Evaporation Data

Weekly RF and EV data were transformed with the power and SMEMAX transformations and tested for normality. The C_s and C_k after each transformation, were used to determine the best transformation for normality. For the untransformed data, the C_s and C_k values were not close to the desired values of 0 and 3, respectively, indicating that the raw data were not normally distributed. With the SMEMAX transformation, the values of C_s and C_k determined were much closer to 0 and 3, respectively, than those obtained from the untransformed data. The power transformation gave the best approximations of C_s and C_k. With the power transformation, C_s values were determined to be 0 for all sets of data (Tables 4.1 and 4.2), indicating symmetric distributions about the mean value. The C_k values, although not equal 3, were much better than those determined for the untransformed data and the SMEMAX transformation. Further, the Shapiro Wilk test used to verify that the transformed data (with power transformation) sets were normally distributed showed that the transformed data was normal.

The λ values of the power transformation (equation 2.15a) determined for weekly rainfall data ranged from a minimum value of 0.131 for week 5 (week of September 14 to 20) to a maximum value of 0.723 for week 45 (week of October 24 to 30), with a low variability between values (Table 4.1). The coefficient of variation of the λ values was 0.2, which indicated that a mean value of λ could have been substituted in place of different λ for each data set. Using a mean value of λ would simplify calculations considerably, however, this should be verified further by testing the transformed data (with the new value of λ) for normality.

The standard deviations (σ_{n-1}) of weekly rainfall data without transformations were greater than their mean (μ) values (Table 4.1), indicating a high variability in weekly rainfall. Weekly pan evaporation data, however,had mean values (μ) much greater than its standard deviations (σ_{n-1}), indicating small variability in weekly EV data. Therefore, mean EV values could be used for each week instead of determining weekly EV values at different probability levels. This would greatly simplify calculations by eliminating the necessity to identify a distribution to describe its variation. Using mean values will cause estimated weekly EV to be less than their actual value about 50% of the time, thus underestimating the amount of irrigation required about 50% of the time, and overestimating it about 50% of the time. However, since the variability of EV was small, EV values will be underestimated or overestimated by only a very small amount. The main advantage associated with assuming a mean value of EV is that it would result in much simpler calculations for determining IR from equation 3.7, because RF will be the only random component. Further, long term records of daily EV are not frequently available for irrigation schemes in Southeast Asia, and the only reliable data are rainfall. Therefore, with only available long term rainfall data, the proposed method of estimating irrigation requirements can still be applied.

Unlike λ values obtained for weekly RF data, the λ values obtained for weekly evaporation had high variability for the different weeks. The variation of weekly EV (Figure 4.12) at different probability had also high variation (eg. week 52 in Figure 4.12) at different probability levels and low variations for certain other weeks (eg. week 45 in Figure 4.12). The λ value and the ratio μ'/σ'_{n-1} influence the variation of EV at different probability.

Differentiating the untransformed variable, EV, with respect to the transformed variable, EV′, in the equation for power transformation (equation 2.15a) gives:

$$\frac{dEV}{dEV'} = EV^{-\lambda+1} \qquad [5.1]$$

From equation 5.1, the difference in EV corresponding to a difference in the transformed value EV' is influenced by the exponent $-\lambda + 1$. When λ value is low the exponent $-\lambda + 1$ will be high and the difference of EV with respect to a difference in EV' will be large. Similarly, when λ is high, the exponent $-\lambda + 1$ will be low and the difference of EV with respect to a difference in EV' will be small. The variability of EV' at different probability will depend on the ratio of μ'/σ'_{n-1}. This is because for the standard normal distribution, EV' at different probability levels are computed as follows:

$$P(EV' \leq a) = P(z \leq \frac{a-\mu}{\sigma'_{n-1}}) = P_z \qquad [5.2]$$

where, P_z is the desired probability for which EV' will be less than or equal to the value a. From the standard normal tables, values of z corresponding to $P_z = 0.95, 0.90, 0.85, 0.80, 0.75$ and 0.70 are 1.65, 1.28, 1.04, 0.85, 0.78 and 0.52, respectively. The EV' values at different probability are estimated by substituting the values of z in the following equation:

$$a \geq \mu' + \sigma'_{n-1} z \qquad [5.3]$$

From equation 5.3, it is seen that when σ'_{n-1} is very small compared to μ', the values of EV' at different probability will have small variations. Similarly when σ'_{n-1} is not too small with compared to μ' the variations of EV' will not be small. Therefore, the ratio of μ'/σ'_{n-1} will determine the amount of variation in EV' values at different probability levels.

For the week beginning October 24, corresponding to week 45 in Figure 4.12, $\mu'=91.01$ and $\sigma'_{n-1}=0.21$ (Table 4.2), thus $\mu'/\sigma'_{n-1}=314$. Substituting these values in equation 5.3 shows very low variation of EV' at different probability. Moreover, substituting $\lambda = 1.446$ (from Table 4.2) in equation 5.1 gives:

$$\frac{dEV}{dEV'} = EV^{-0.441} \qquad [5.4]$$

It is seen from the above expression that the variation of EV to variations in EV′ is small. Therefore, a large ratio of μ'/σ'_{n-1} and a large value of λ compound to give very small variations of EV at different probability levels (Figure 4.12).

On the other hand, the week beginning October 31, corresponding to week 52 in Figure 4.12, shows high variations of EV at different probability levels. For week 52, $\mu'=0.86$ and $\sigma'_{n-1}=0.01$, thus $\mu'/\sigma'_{n-1}=86$. Since μ'/σ'_{n-1} is comparatively small, the variability of EV′ at different probability levels is high. Further, substituting λ=-1.131 (Table 4.1) in equation 5.1 gives:

$$\frac{dEV}{dEV'} = EV^{2.131} \qquad [5.5]$$

This shows a high variability of EV with respect to EV′. Therefore, for week 52, a small ratio of μ'/σ'_{n-1} and a small λ value compound to give high variability of EV at different probability levels, as seen in Figure 4.12.

For all other weeks, when λ is high its affect is compensated by small ratios of μ'/σ'_{n-1} or when λ value is low its affect is compensated by a high ratio of μ'/σ'_{n-1}. Thus causing moderate variations of EV at different probability levels. Large variations in EV at different probability levels cause comparable variations in irrigation requirement estimates at different probability levels.

Comparing the variations of weekly RF (Figure 4.10) and EV (Figure 4.12) with those of (k • EV) - RF (Figures 13a to 13f), it was shown that the shapes of (k • EV - RF) were governed mainly by the shape of weekly EV values (Figure 4.12). The effect was more pronounced at high probability levels and gradually decreased at lower probability levels, because RF was low and EV was high at high probability levels, resulting in high irrigation requirement estimates.

In the present method of determining (k • EV - RF), the variables EV and RF were analyzed separately to determine its variations. However, values of (k • EV - RF) at different probability levels can also be determined by analyzing the variable (k • EV - RF) and determining its variation. Since the variable (k • EV - RF) is composed of two random variables EV and RF, the variable (k • EV - RF) will have properties different to the variables EV and RF. Therefore, values of (k • EV - RF) will have values different from those estimated by the present method in which EV and RF were analyzed separately.

5.1.3 Potential Water Savings

As discussed previously, irrigation requirement based on probability levels gives an indication of the chance that irrigation will be inadequate to meet crop water needs. When operated at low probability levels, the amount of water saved can be significant. However, a compromise must be made which balances the risk of crop damage due to inadequate water supply that may result from operating the system at low probability levels and potential water savings which may be obtained.

To illustrate potential water savings at different probability levels, consider for example the week beginning October 31 (same example used in section 4.2.5 in Chapter 4). For the first week of the reproductive growth stage, k=1.2, the (k • EV - RF) values are determined from Figures 4.13a to 4.13f, and the corresponding irrigation requirements assuming SMIN=50 mm, SIN=25 mm and PERC=3 mm/d, are given as.

	Irrigation requirement per week					
Probability	90%	81%	72%	64%	56%	49%
(k • EV - RF) (mm)	48	37	28	21	14	6
IR (mm)	94	83	74	67	60	52
volume (m^3/ha)	940	830	740	670	600	520

For the Kalawewa irrigation scheme, each farm turnout area consists of approximately 15 one ha fields. Therefore, the irrigation requirement (m^3/ha) multiplied by 15 will give the corresponding irrigation water that must be diverted to each farm turnout area from the D-channel.

It should be noted that the IR values calculated above referred to the first week of reproductive growth stage for which, SMIN=50 mm (Table 3.1). Theoretically SIN $\geq$ $SMIN_{i-1}$, if adequate irrigation had been provided so that water levels did not fall below SMIN. i.e. water level at the beginning of a given week would have been greater than or equal to the minimum required water level for the previous week. Therefore, for the week under consideration, SIN was greater than 25 mm.

If the actual (k • EV - RF) value the previous week fell below the estimated value given in Figures 4.13a to 4.13f, then SIN for the week beginning October 31 would have been greater than SMIN for the previous week (25 mm), i.e. SIN for a given week would have been governed by the amount of rainfall in the previous week. SIN was assumed to be equal for all fields because rainfall and evaporation were the same in all fields. If SIN=50 mm for the week beginning October 31, then the IR values would have been 25 mm less than those determined above.

From the values provided, it is seen that 22% more water is needed when the system is operated at 90% probability than when it is operated at 72%. Although, this is the case for the week beginning October 31, the difference in potential water savings for other weeks in the wet season may not be as high because as seen from Figure 4.13a to 4.13f, towards the middle of the wet season estimated (k • EV - RF) values at different probability levels tend to have high variations.

At present the Kalawewa irrigation scheme supplies 63 mm/week of irrigation water throughout the entire growing season. This value assumes a constant 3 mm/day of percolation losses and 6 mm/day of evapotranspiration losses and ignores rainfall. Farmers in the study area generally, fill water to spillway height whenever water is available. Consequently, considerable water is lost to drainage when it rains because the fields are already at or near their maximum storage level. If the farmers fill water to the spillway height of 150 mm (SMAX=150 mm), according to present practice, 125 mm of water (assuming SIN of 25 mm) is needed for the week beginning October 31. These values are obviously in excess of the amount of irrigation water that is actually needed, because rainfall has not been accounted.

The potential savings using the proposed model, when compared with the existing practice for each turnout (TO) of 15 ha of paddy fields are given below:

	Irrigation water requirement (m^3)						
probability level	90%	81%	72%	64%	56%	49%	present practice
per ha	940	830	740	670	600	520	1,250
per TO of 15 ha	14,100	12,450	11,100	10,050	9,000	7,800	18,750
per D-channel of 10 TO	141,000	124,500	111,000	100,500	90,000	78,000	187,500
potential water savings/D-channel	46,500	63,000	76,500	87,000	97,500	109,500	

From the above values it is seen that even when the system is operated at high probability level (90%), there is a potential saving of about 25% or 46,000 m^3 in each D-channel for the week beginning October 31. This means that up to 25% more area could be farmed with the water saved if it is managed correctly.

The values computed above, assume all paddy crops are at the same growth stage. However, in practice all farmers do not start cultivating on the same day and the paddy varieties cultivated are not the same. Since for different crop growth stages SMIN and SMAX are not the same, the irrigation required for all fields in a single turnout will not be the same. Therefore, determining irrigation requirement for a single turnout with paddy at different growth stages and different varieties will be more complex.

5.2 Distribution System Management

Flows were simulated for 5.66 m^3/s (200 ft^3/s) at the head gate with orifices 1301, 3301, 5301, 5302 and 3302 opened at one time and for alternate orifices 2301, 4301, 6301, and 1302 opened during another trial. In each case the orifice openings were adjusted so that ≅ 0.547 m^3/s (flow required for the week beginning October 31) discharged through each turnout. For illustration purposes, it was assumed that demand the following day was 0.057 m^3/s (2 ft^3/s) less in each of the 5 turnouts. When the demand in each turnout decreased by 0.057 m^3/s, the flow at the head gate had to be decreased by 0.283 m^3/s (10 ft^3 /s) to be commensurate with the decrease in demand.

As shown in Table 4.5, when the flow at the head gate was decreased by 0.283 m^3/s, the flows through the turnouts decreased by varying amounts, and the flow reductions were much less than the desired reduction of 0.057 m^3/s. Thus, causing an excess flow into the turnouts. The amount of water flowing in channel reach 145 to the reservoirs downstream decreased from 2.887 to 2.650 m^3/s, because flow through the turnout structures (orifices) was not linearly proportional to the flow in the main canal. Flow through the orifices is governed by the following equations, for the trapezoidal channel with side slopes 1 : 1.5 (Alwis *et al.*, 1983):

$$Q_o = C_o A \sqrt{2gh} \qquad [5.6]$$

$$Q_m = \frac{1}{n}\left[\frac{h(b + 1.5h)}{b + 2\sqrt{2.25h}}\right]^{2/3} S_f^{1/2} \qquad [5.7]$$

where: Q_o = flow through orifice in m^3/s,

A = area of orifice in m^2,

C_o = coefficient of discharge through orifice,

h = head above the orifice (water depth in main canal in m),

Q_m = flow in the main canal in m^3/s,

n = Manning's roughness coefficient,

S_f = friction slope in the main canal (canal bottom slope for uniform flow).

The water depth (h) in the main canal is a function of flow (Q_m), when all other terms in equation 5.7 remains constant. But Q_m in the main canal is dependent on the amount of flow drawn at the turnout structures upstream of it. Since the flow through a turnout (Q_o) is related to the water head in the main canal (eq. 5.6), Q_o will depend on the flow drawn at the turnout structures upstream of it. Moreover, the demand in each turnout will vary each day and consequently will affect the flow through the turnouts downstream of it.

In order to supply only the desired amount of water into each turnout, while maintaining the required flow to downstream reservoirs, the flow at the head gate and the gate settings at each turnout should be adjusted simultaneously. The amount by which the gate opening has to be increased or decreased to pass a desired flow, at steady state conditions, will be governed by equations 5.6 and 5.7. In order to estimate gate opening (A) for a specific discharge through the turnout (Q_o), equations 5.6 and 5.7 have to be solved numerically, since a direct solution cannot be determined.

The above example is for the Kalawewa left bank main canal, assuming there are no structures that cause backwater effects. But in reality there are check structures across the canal immediately downstream of the turnout structures. Check structures are sometimes weirs constructed across the canal to head up the water level to a fixed height. With a check structure of this form, the water level near the turnout structures are fairly constant and only slightly higher than the height of the weir. The turnout opening (A) can therefore, be calculated using equation 5.6 for the required flow (Q_o), by substituting for h, which is fixed by the height of the weir. However, if weirs are provided only at a few turnout structures, the flow through other turnouts will be affected by the backwater effects caused by the weirs. The head near such orifices will vary with the flow in the main canal and equation 5.7 will no longer be valid. Flow simulation using computer models will be specially useful for these systems, since it will be difficult to determine h otherwise.

Check structures sometimes take the form of radial gates in which the water flows through the opening at the bottom of the gate (orifice type). This type of check structures also heads up the water upstream of it. However, unlike the weir type check structures, the water levels upstream will not be constant and instead will vary depending on the gate opening and the flow in the canal. Here again equation 5.7 will not be valid since the flow in the canal will be non uniform. Therefore flow simulation must be done to determine water depths in the canal and consequently the flow through the turnouts.

By simulating the flow using EXTRAN, the required gate settings at the turnout structures can be estimated in advance, so that only the required quantity of water flows through the turnouts. In the absence of a flow simulation model, the flow through the turnouts must be regulated using flow measuring structures (if available) and the amount released to each turnout will be determined by the ditch rider. If more water than the required quantity is released at a single turnout, the flow through downstream turnouts will be affected subsequently, causing a breakdown in system operation.

It should be noted that according to Figures 4.18a and 4.18b, there is a time lag from the time when the flow is decreased at the head gate and the time it takes for the flow at the turnouts to attain steady state. At the beginning of each day, the flow at the turnouts will be smaller (or greater depending on the case) than the actual demand, and will gradually attain steady state to commensurate with the demand. Since a steady flow of water will be required in each D-channel throughout the day, the above effect will cause problems in the distribution of water to the farm turnouts within the the D-channels. Further, its effect increases as distance to the turnout from the regulating reservoirs increases. Therefore, in order to operate the system effectively, it would be most appropriate to have small storage reservoirs at the upstream end of each D-channel and the water into the D-channels could be regulated from these storage reservoirs each day.

The proposed construction of small reservoirs, whether or not economically feasible, was shown to be effective in a pilot project on 147 ha served by D-channel 1 in block 404. With use of the reservoirs, the system could be operated as a demand irrigation system, which was shown to provide adequate and equitable water supply, superior to that of the conventional irrigation controlled by the government organizations (Merriam and Davids, 1986).

chapter 6

Summary and Conclusion

6.1 Summary

The objective of this research was to develop a water management system to improve water use efficiencies in irrigated paddy in Southeast Asia. In order to achieve the above objective a method to determine irrigation requirements taking into account probable rainfall and evaporation was developed.

The water balance equation given in equation 3.5 was used to determine weekly irrigation requirements during the wet season. Emphasis was focused on the wet season because it was known to have low irrigation efficiencies and there was considerable potential to save water.

The stochastic components of the water balance equation included weekly ET and RF. Crop evapotranspiration (ET) was related to EV by the relationship:

$$ET = k \cdot EV$$

where, k is a coefficient varying between 1.0 to 1.3, depending on the stage of growth of the crop. All other terms in the water balance equation could be determined from field measurements. In order to determine weekly irrigation requirements using the water balance equation, it was necessary to predict the values of EV and RF that could occur each week. To predict values of EV and RF, it was necessary to analyze weekly EV and RF, to determined their variation with time, during the growing season.

Having noted the varied stochastic nature of the RF and EV data, attempts were made to apply different transformations to normalize these variates. This resulted in a unique distribution which enabled the simple properties of the normal distribution to be used to advantage to determine the probabilities of weekly RF and EV.

To demonstrate the application of the irrigation scheduling method, records of daily EV and RF observed at the Maha Iluppallama research station, near the Kalawewa irrigation scheme in Sri Lanka were used. Daily RF and EV records were used to estimate weekly RF and EV.

Weekly RF and weekly EV data for all weeks after September 10 were analyzed to determine the distribution that best fit the data. One hundred and thirty three data sets of weekly RF and weekly EV were analyzed. The C_s and C_k values of the untransformed and transformed data with the SMEMAX and power transformation were used to determine the best transformation satisfying the normality condition. The power transformation was found to best transform weekly RF and weekly EV data to satisfy the normality condition.

It was shown that the coefficient of variation of weekly EV data were $\cong 0.2$. Therefore using a mean value of EV in place of EV values at different probability levels, detail analysis of weekly could have been avoided. This simplification will not impair the accuracy of estimated irrigation requirement values.

From the distributions of weekly EV and RF, thus established, (k · EV - RF) values were estimated at different probability levels for each week coinciding with the wet season. These values were then used in the water balance equation to determine irrigation requirement.

When the irrigation requirement was estimated, taking into account possible rainfall, the potential for saving a significant amount of water was demonstrated. In order to achieve the potential water savings, it was necessary to manage the irrigation distribution system so that only the required amount of water was released from the reservoir to the main canal each day.

For demonstration purposes, flow in the upper most reach of the left bank main canal of the Kalawewa irrigation scheme was simulated for discharges varying every 24 hours. The flow in the turnouts was simulated and the gate settings at the turnouts required to supply only the desired quantity of water into each turnout were estimated.

It was observed that there was considerable time lag between the time when flow at the head gate was changed and the time that the effect was observed at the turnout structure. The flow across the turnouts changed gradually and before attaining steady state causing variable flow into the turnouts each day. This time lag was due to the long distances between the regulating reservoir and the turnout structures. With the present method of system operation it was not possible to regulate the flow in the reservoir to achieve water savings while supplying the demands in each turnout.

6.2 Conclusions

1. An irrigation scheduling method that accounts for rainfall and crop evapotranspiration at different probability levels was developed. Irrigation water requirements estimated using the model showed significant water savings over the present method of irrigation application in the Kalawewa irrigation scheme.

2. The crop growing season was divided into weekly periods to estimate irrigation requirements on a weekly basis. The present method of estimating weekly irrigation require-

ment by analyzing weekly RF and EV can be applied to irrigation schemes where rotational irrigation is practiced with irrigation interval of one week. If rotation is practiced every 3 days, however, analysis have to be based on 3 day intervals. It is to be noted that when the irrigation interval is small, the accuracy of predicting rainfall variability will decrease. On the other hand when the irrigation interval is large the accuracy of predicting rainfall variability will be high. However, rotational intervals greater than 7 days are not commonly encountered.

3. To manage the irrigation system to reflect the changing demands in the fields it is necessary to measure the initial water level in the fields at the beginning of each day. This information must be provided to persons responsible for scheduling the release of water at the headgate, and the required amount of water can thus be released to the distributary channels. When the demand in the different farm turnouts are different, water should be distributed to the farm turnouts to commensurate with the demands.

   Since water distribution within a farm turnout is done on a rotational basis, with only two farmers irrigating simultaneously in a single day, it will be necessary to measure initial water depths of only those fields to be irrigated that day. For the Kalawewa irrigation scheme, each farm consists of 1 ha. i.e. 2 ha of paddy is irrigated each day. However, if the two farms have different initial water depths and if the growth stages of the crops in the two farms are different, then different proportions of water have to be shared among the two farmers. Therefore, the farm turnouts have to be adjusted by the operations staff so that the water is distributed proportionately to meet the demands of the individual farms. If the water were shared equally between the two farms, one farm would be under-irrigated while the other will be over-irrigated. This means that the distribution and regulation of water from the headgate to the farm turnouts should be under the control of the operations staff.

4. The EXTRAN hydraulic flow routing model was shown to be a valuable tool for determining required gate settings at the turnouts so that water could be distributed to the D-channels to meet demands. The flow released at the head gate to the main canal will have to be regulated each day to suit demands in the D-channels. The flow into the D-channels will depend on the water level in the main canal which is a function of the flow in the main canal. The flow in the various canal reaches will depend on the discharge into the turnouts upstream. Since the flow into the D-channels vary each day, the flow in the canal reaches will also vary each day. Conventional calculations involved in determining flows and water depths in the various canal reaches and determining gate settings are cumbersome. Therefore, a canal flow routing model such as EXTRAN is indispensable for managing flows in an irrigation canal.

5. From flow simulation, it was observed that owing to large distances between the reservoir and turnouts there was appreciable time lag after discharge from the reservoir was changed before the responses were observed at the turnouts. When the demand in each D-channel for each day has been estimated, it will be necessary to supply the estimated amount of water each day at a constant rate. However, the model showed that it was difficult to supply the required flow at a constant rate each day because of the time lag. Therefore, it was proposed that a regulating reservoir be located near each turnout structure to compensate for the time lag effects.

   Day to day management of the irrigation system requires the estimation of water depths in the main canal and the desired gate settings for the variable flows each day. Therefore, a steady state hydraulic flow routing model will be sufficient to aid in the regulation of irrigation water. However, for design purposes since it is necessary to determine the time lags between the time at which water is released at the head gate and the time it takes for the flow to reach the further turnouts, EXTRAN flow routing model or a comparable flow routing model will be required.

chapter 7

Recommendations

1. The irrigation scheduling model presented here is semi-stochastic in nature and consisted of both deterministic and a stochastic components. The stochastic component was formed from the two stochastically variable parameters, rainfall and pan evaporation, which were analyzed to determine the variation in irrigation requirement.

   At the beginning and end of the wet season rainfall is highly variable, and there are often periods with no rainfall. Therefore, it is recommended that the use of a mixed distribution with a point distribution be used to represent zero rainfall and another distribution to represent non zero rainfall. To apply the mixed distribution, however, there should be a sufficient number of non zero data points. For the data analyzed in this dissertation, there were 34 years of data points of which about half were equal to zero during each weekly period. Since a minimum of at least 30 data points is desirable to fit a distribution, there were not sufficient data points to fit a distribution for the remaining non zero data points.

2. The variability of weekly pan evaporation was very low compared to the variation of weekly rainfall data. Therefore, using mean values for weekly pan evaporation will not

cause appreciable errors in the estimated irrigation requirement values. This approximation will greatly decrease the volume of calculations involved in determining distributions to describe its variations. Assuming mean values of weekly EV will result in a single random variable in the water balance equation.

3. The established (k • EV - RF) values describe the variation in irrigation water requirement, and it can be considered a time series with a trend component and a stochastic component. If the trend component can be identified by removing the random noise, a gradual variation in (k • EV - RF) for each day in the wet season can be identified, thus a gradual variation of the irrigation requirement values with time. This should be considered in future work.

4. Future work also should involve analyzing the variable (k • EV - RF) to determine its variations and estimate values of (k • EV - RF) at different probability levels. Since the variable (k • EV - RF) is composed of the the variables EV and RF which have different properties, the random variable (k • EV - RF) will have properties that are different to both EV and RF.

5. In the water balance equation presented in this dissertation, effects of ground water contribution have been neglected, owing to lack of available information. Since after heavy rainfall the groundwater depths can be high, groundwater can make an appreciable contribution to the water balance. Therefore, neglecting the effect of groundwater may overestimate the irrigation required. In future studies, the groundwater contribution should be incorporated into the model if deemed significant. If groundwater depths are known, using the graphs of Doorenbos and Pruitt (Doorebos and Pruitt, 1977) groundwater contributions could be estimated. Further, if depth of rainfall can be related to the rate of rise in the groundwater depth, a relationship between rainfall and groundwater depth can be established. Thereby, groundwater contribution can be incorporated into the water balance using the graphs of Doorenbos and Pruitt.

6. Flow simulation was done to aid in the management of the distribution system in order to determine the required gate settings at the turnout structures to pass the required flows, and to determine the response at the turnout structures to variations in flow at the head gate. It was observed from flow simulation that when distance between the regulating reservoir and the turnout structure was large, there is considerable time lag for the effects of change in flow at the upstream end to be felt at the turnout structure. Thus, causing a variable flow in the D-channels from which water is supplied to the farm turnouts. A steady flow in the D-channel each day is however, essential for equitable discharge into the farm turnouts. Therefore, in order to minimize the effect of uneven distribution of water, and to provide a more efficient water distribution system it is recommended that small storage reservoirs be constructed at the upstream end of D-channels from which water can be regulated into the D-channels each day.

Bibliography

Aldabagh, A.S., N. Rasheed and M.V. Ramamoorthy. 1982. Dry days analysis for planning supplemental irrigation schemes. Transactions of the ASAE 25(1):150-153,159.

Alwis, J., L. Nelson, H. Gamage, R.A. Nandasena, R.E. Griffin, K.Yoo, A. Ekanayake, M. Haider, L. Wickramasinghe, L. Dunn, M.A.W. Bandaranayake, J.M. Reddy and W.R. Laitos. 1983. System H of Mahaweli development project, Sri Lanka: 1982 Diagnostic Analysis. WMS Report No. 16, Colorado State University, Fort Collins, Colorado.

Baier, W.G., W. Robertson and M.F. Clarke. 1969. A climatological analysis of irrigation requirements in the lower Fraser Valley. B.C. Publication 1318, Canada Department of Agriculture, Ottawa.

Bethlahmy, N. 1977. Flood Analysis by SMEMAX transformation. Proc. Am. Soc. Civ. Eng., J. Hydr. Div. 103(HY1):69-78.

Blaney, H.F. and W.D. Criddle. 1952. Determining water requirements in irrigated areas from climatological and irrigation data. Soil Conservation Service, USDA SCS-TP-96. February.

Bolton, F.R. and H.G. Zandstra. 1981. A soil moisture-based yield model of wetland rainfed rice. Paper no. 62. International Rice Research Institute. Los Banos, Phillipines.

Box, G.E.P. and D.R. Cox. 1964. An analysis of Transformation. Journal of the Royal Statistical Society. B26:211-252.

Burman, R.D., L.O. Pochop, M.A. Kostrzewski and C.D. Yonts. 1982. Statistical and numerical representation of irrigation water requirements. Transactions of the ASAE 25(1):165-168.

Chander, Subash, S.K. Spolia, and Arun Kumar. 1978. Flood frequency analysis by Power Transformation. Proc. Am. Soc. Civ. Eng., J. Hydr. Div. 104(HY11):1495-1504.

Chapman, A.L. and W.R. Kininmonth. 1971. A water balance model for rain-grown, lowland rice in Northern Australia. Agricultural Meteorology. Elsevier Publishing Company. Amsterdam, The Netherlands. 65-82.

Chaudry, M.S. and R.G. Pandey. 1969. New water management practices in rice. Indian Farming 19(1):23-24.

Chiang, C.Y. and P.B. Bedient. 1986. PIBS model for surcharged pipe flow. Proc. Am. Soc. Civ. Eng., J. Irrig. Drain. Div. 112(IR3):181-192.

Chow, Lee. 1965. Rice irrigation. Proc. Am. Soc. Civ. Eng., J. Irrig. Drain. Div. 91(IR3):35-49.

Chow, Ven Te. 1955. Integrating the equation of gradually varied flow. Proc. Am. Soc. Civ. Eng., J. Hydr. Div. 81(HY11):831-832.

Davis, D.W. and J.J. De Vries. 1977. Development of a computer model for an area control center of the California Aqueduct. Technical Memorandum No. 23, California Department of Water Resources.

De Datta, S.K., E.T. Alvarez and S.C. Modgal. 1973. Water management practices in flooded tropical rice. pp. 1 - 18. *In* Water management in Philippine irrigation systems: Research and Operations. International Rice Research Institute, Los Banos, Philippines.

De Datta, S.K. 1981. Principles and Practices of Rice Production. John Wiley-Sons. New York.

Doorenbos, J. and W.O. Pruitt. 1977. Guidlines for predicting crop water requirements. FAO Irrigation and Drainage paper No. 24. FAO, Rome, Italy.

Gupta, R.K. and H.S. Chauhan. 1986. Stochastic modeling of irrigation requirements. Proc. Am. Soc. Civ. Eng., J. Irrig. Drain. Div. 112(IR1):65-78.

Haan, C.T. 1977. Statistical Methods in Hydrology. The Iowa State Press. Ames, Iowa.

Hamilton, D.L. and J.J. De Vries. 1986. Computer simulation of canal operation. Proc. Am. Soc. Civ. Eng., J. Irrig. Drain. Div. 112(IR3):264-273.

Henderson, F.M. 1966. Open channel flow. McMillan Company, New York, N.Y. 269-273.

Hershfield, D.M. 1960. Effective rainfall and irrigation requirements. Proc. Am. Soc. Civ. Eng., J. Irrig. Drain. Div. 90(IR2):33-47.

Johnson, B.L.C. 1981. South Asia: Selective studies of the essential geography of India, Pakistan, Bangladesh, Sri Lanka and Nepal. Heinemann Educational Books. London. 179-205.

Kampen, J. 1970. Water losses and water balance studies in lowland rice irrigation. Ph.D. thesis, Cornell University. Ithaca, NY.

Kassem, A.M. and P.E. Wisner. 1980. Validity of the WRE transport model. IMPSWM Congress Report No. 12.

Khanjani, M.J. and J.R. Busch. 1980. Optimal irrigation distribution systems with internal storage. Transactions of the ASAE 26(3):743-747.

Krug, P. 1971. Irrigation agronomy in Monsoon Asia. FAO, Rome. 31-45.

Lenka, D., B. Bhol, C. Panda and A. Misra. 1971. Water management for tall an dwarf indica varieties of rice in the wet season. IRC Newsletter 20(4):16-19.

Levine, G. and T. Wickham. 1977. Some critical issues in irrigation planning for Southeast Asia. Paper presented at the seminar on Water Resources problems in developing countries, University of Minnesota, July.

Matsushima, S. 1962. Some experiments on soil water plant relationship in rice. Bull. 112, Div. Agric., Min. Agric. Coop. Kuala Lumpur, Malaysia.

McCormick, T.C. 1984. Frequency analysis of low flows: Application to Viriginia streams. Thesis submitted for Master of Science degree, Viginia Poytechnic Institute and State University. Blacksburg, VA.

Merriam, J.L. and G.G. Davids. 1986. Demand irrigation schedule project: Sri Lanka. Proc. Am. Soc. Civ. Eng., J. Irrig. Drain. Div. 112(IR3):185-202.

Moorman, F.R. and van Beeman. 1978. Rice: Soil, Water, Land. International Rice Research Institute. Los Banos. Philippines.

Penmann, H.L. 1948. Natural evaporation from open water, bare soil and grass. Proc. Roy. Soc. 193:120-145.

Phien, H.N. 1983. A mathematical model for the assessment of rainfed irrigation. International Journal for Development Technology. 1:129-140.

Pierce, L.T. 1960. A practical method of determining evapotranspiration from temperature and rainfall. Transaction of the ASAE 3(1):77-81.

Prasad, R. 1970. Numerical method of computing flow profiles. Proc. Am. Soc. Civ. Eng., Hydr. Div. 96(HY1):75-87.

Pruitt, W.O. and M.C. Jensen. 1955. Determining when to irrigate. Agricultural Engineering. 36:389-393.

Pruitt, W.O., S. von Oettingen and D.L. Morgan. 1972. Central California evapotranspiration frequencies. Proc. Am. Soc. Civ. Eng., Irrig. Drain. Div. 98(IR1):177-184.

Roesner, L.A., R.B. Shubinski, R.J. Chernik. 1981. Computer program documentation for EXTRAN prepared for the University of Frlorida.

Roesner, L.A., R.B. Shubinski, J.A. Aldrich. 1983. Stormwater management model user's manual version III. Addendum I EXTRAN. Municipal Environmental Research Laboratory. Cincinnati, Ohio.

Rojiani, K.B., B.B. Ross, F.E. Woeste and V.O. Shanholtz. 1982. A probabilistic model for assessment of plant water availability. Transactions of the ASAE 25(6):1576-1580, 1588.

Salter, P.J. and J.E. Goode. 1967. Crop responses to water at different stages of growth. J. Lonken Ltd., Poole, Dorset, Great Britain.

SAS. 1982. SAS user's guide. SAS Institute Inc., Cary, North Carolina.

Sen, L.N. and T. Wickham. 1977. Determination of effective rainfall for lowland rice. Paper presented at the IRRI Saturday seminar. Dept. of Irrigation and Water management, International Rice Research Institute, Los Banos, Laguna, Philippines.

Smith, K.V.H. 1973. Computer programming for flow over side weirs. Proc. Am. Soc. Civ. Eng., Hydr. Div. 99(HY3):495-506.

Stewart, J.I., R.M. Hagan and W.O. Pruitt. 1974. Functions to predict optimal irrigation programs. Proc. Am. Soc. Civ. Eng., Irrig. Drain. Div. 100(IR2):179-199.

Thornthwaite, C.W. 1948. An approach toward a rational classification of climate. The Geographical Review. 38:55-94.

Trava, J., D.F. Heermann and J.W. Labadie. 1977. Optimal on-farm allocation of irrigation water. Transactions of the ASAE 20(1):85-88.

Valera, A. and T.H. Wickham. 1978. A field study on water use and duration of land preparation for lowland rice. Paper presented at the IRRI Saturday seminar. Dept. of Irrigation and Water management, International Rice Research Institute, Los Banos, Laguna, Philippines.

van Bavel, C.H.M. and T.V. Wilson. 1952. Evapotranspiration estimates as criteria for determining time of irrigation. Agricultural Engineering. 33(7):417-418.

van Bavel, C.H.M. 1953. A drought criterion and its application in evaluating drought incidence and occurrence. Agron. J. 45:167-171.

Wickham, T.H. and L.N. Sen. 1978. Water management for lowland rice: water requirement and yield response. Soils and Rice. International Rice Research Institute, Los Banos, Laguna, Philippines.

Wickham, T.H. and A. Valera. 1978. Practices and accountability of better water management. *In* Irrigation policy and management in Southeast Asia, International Rice Research Institute, Los Banos, Laguna, Philippines.

Wiser, E.H. 1969. Irrigation planning using climatological data. Proc. Am. Soc. Civ. Eng., Irrig. Drain. Div. 91(IR4):1-11.

Yamada, N. 1965. Some problems of irrigation and drainage in rice culture. IRC Newsletter. 14(2):13-28.

Yonts, C.D. Burman, R.D. Eding and D.A. Anderson. 1979. Climatic probability of irrigation requirements. ASAE Paper No. 79-4039. ASAE, St. Joseph, MI 49085.

Zandstra, H.G. 1980. Effect of soil moisture and texture on the growth of upland crops after wetland rice. pp. 42 - 54. *In* Cropping systems research in Asia. International Rice Research Institute. Los Banos, Philippines.

Zandstra, H.G., D.E. Samarita and A.N. Pontipedra. 1982. Growing season analysis for rainfed wetland rice. Paper No. 73. International Rice Research Institute. Los Banos, Philippines.

Appendix A

Daily Rainfall and Pan Evporation Data For Maha Iluppallama

Table A1. Daily rainfall data for Maha Illuppallama

Year 1952

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1											3.8	0.0
2											4.3	0.0
3											0.0	0.8
4											0.0	0.3
5											0.0	7.4
6											0.5	7.9
7											3.3	7.4
8											0.0	3.6
9											0.0	27.4
10											0.0	0.0
11											0.0	4.3
12											0.0	0.0
13											0.0	4.6
14											0.0	0.5
15											0.0	3.0
16											18.3	0.0
17											5.8	0.0
18											5.6	0.0
19											8.9	2.3
20											0.0	0.0
21											20.8	3.6
22											0.3	1.5
23											3.6	0.0
24											0.0	3.8
25											0.0	3.3
26											0.0	4.3
27											0.0	13.2
28											0.0	0.0
29											0.5	0.0
30											2.5	0.0
31											1.3	

Year 1953

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3.3	0.0	0.0	0.0	0.0	0.0	2.3	1.0	0.0	0.0	0.0	0.0
2	0.0	0.0	15.7	15.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
3	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.8	14.0	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.8	11.4	0.0	0.0	7.1	0.0	0.0	1.5	0.0	0.0
6	0.0	0.0	0.0	8.9	0.0	0.0	12.7	17.3	0.0	0.8	0.0	0.0
7	2.8	0.0	0.0	5.6	0.0	0.0	1.8	15.5	0.0	7.1	0.0	0.0
8	0.8	0.0	0.0	41.4	0.0	0.0	2.3	0.0	0.0	38.4	0.0	0.0
9	1.5	0.0	0.0	2.5	0.0	0.0	0.0	0.5	25.4	6.1	0.0	0.3
10	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	19.1	27.2	0.0	6.9
11	0.0	0.3	0.0	30.0	0.0	0.0	0.0	0.0	30.2	0.0	0.0	0.0
12	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	3.6	140.0	3.8	1.8
13	0.0	0.0	1.8	3.8	0.0	0.0	0.0	0.0	0.0	16.8	12.5	27.9
14	0.3	0.0	3.8	0.0	0.0	0.0	0.3	0.0	0.0	18.0	1.5	1.5
15	6.4	0.0	4.3	0.0	0.0	0.0	3.8	0.3	0.0	1.5	14.2	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	58.4	1.8
17	7.1	0.0	0.0	6.9	0.0	0.0	8.9	0.0	0.0	0.3	38.1	0.0
18	2.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1	7.6	0.5
19	12.0	1.0	0.0	5.1	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.8
20	1.0	3.6	4.6	3.0	0.0	0.0	0.3	0.0	0.0	7.4	0.0	12.4
21	12.4	7.1	0.0	2.3	0.0	0.5	0.0	0.0	0.3	7.6	0.0	0.0
22	20.8	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0
23	11.4	0.5	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.3	4.8	1.3
24	2.8	1.2	0.0	1.0	0.0	0.0	0.3	0.0	0.0	0.0	38.1	43.2
25	0.0	0.0	0.0	10.9	0.0	0.0	0.0	0.8	0.0	35.8	0.8	73.9
26	0.0	0.0	0.0	0.0	0.0	0.0	30.0	0.0	0.0	0.5	7.9	35.3
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.4	0.3	0.0	3.0	1.8
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.1	0.0
29	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	80.0	0.0	6.4
31	0.0		0.0		0.0		3.8	22.1		0.0		17.0

Table A1. continued.

Year 1954 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.5	0.0	18.3	12.0	0.0	0.0	0.0	0.0	0.0	0.0	86.1
2	1.5	0.0	0.0	1.5	12.2	0.0	0.0	0.0	0.0	0.3	0.0	9.7
3	25.9	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	13.5
4	0.5	0.0	0.0	4.1	1.5	0.0	7.6	0.0	0.0	0.0	0.0	32.8
5	6.1	0.0	0.0	7.6	0.0	0.0	11.2	0.0	0.0	0.0	3.0	12.4
6	0.0	0.0	0.0	4.8	0.0	0.0	5.1	0.8	0.0	0.0	55.4	3.6
7	12.7	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	35.1
8	8.9	0.0	0.0	0.8	0.0	0.3	0.0	0.0	0.0	0.0	0.0	33.5
9	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.6
10	0.0	0.5	0.0	6.1	0.0	0.3	0.0	0.0	0.0	0.0	0.0	7.1
11	24.9	1.0	5.1	41.9	0.0	0.0	0.0	26.4	0.0	3.3	0.0	0.0
12	1.8	0.0	3.0	0.0	0.0	0.5	0.0	0.0	0.0	3.8	0.0	0.3
13	0.0	0.0	27.2	6.1	0.0	0.0	0.0	0.0	0.0	14.2	0.5	1.8
14	0.0	0.0	7.6	0.0	0.0	0.0	0.0	0.0	0.0	102.1	1.3	3.0
15	0.0	0.0	8.4	0.0	0.0	0.0	0.0	0.0	0.0	13.7	7.1	0.0
16	0.8	0.0	17.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	2.5	36.6
17	0.5	0.0	11.2	0.0	0.0	0.0	0.0	0.0	0.0	0.8	52.6	0.0
18	0.0	0.0	5.6	0.0	0.0	0.0	0.0	0.0	0.0	6.4	22.6	0.0
19	0.0	0.0	1.8	22.4	0.0	0.0	0.0	4.8	0.0	21.6	7.4	32.0
20	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	25.7	2.8	8.9
21	0.0	0.0	24.4	53.3	0.0	0.0	0.0	0.0	0.0	5.1	98.3	4.1
22	1.0	0.0	23.1	27.9	8.4	0.0	0.0	0.0	0.0	4.6	2.3	0.0
23	1.5	0.0	9.7	0.5	9.9	0.0	0.0	0.0	0.0	5.6	1.3	34.8
24	0.0	0.0	0.0	0.0	0.0	0.0	32.3	0.0	0.0	1.0	0.0	17.8
25	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.3
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	17.3
27	0.0	3.0	11.7	1.0	0.0	0.0	0.0	10.7	0.0	0.0	0.0	1.8
28	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.2	10.4	0.0
29	0.0		0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0		0.0	40.9	0.0	0.0	0.0	0.0	0.0	5.3	5.6	0.0
31	0.0		44.7		0.0		0.0	0.0		0.0		1.3

Year 1955 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	14.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.2	13.5
3	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	5.1
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0
6	32.0	0.0	0.0	3.0	9.6	0.0	0.0	5.8	0.0	0.0	0.0	0.0
7	16.2	16.0	0.0	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
8	0.0	3.8	0.0	0.0	0.0	0.0	0.0	11.2	12.2	0.0	0.0	13.5
9	1.0	13.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.1	0.0	0.0
10	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	79.2	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.1	91.2	0.0	2.5	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	55.4	0.0	0.0	0.0
16	0.5	0.0	0.0	1.8	70.1	0.0	0.0	0.0	0.0	1.0	0.0	0.0
17	8.9	0.0	0.0	19.1	4.8	0.3	0.3	7.9	12.4	0.0	0.0	0.0
18	0.0	0.0	0.8	5.3	10.7	0.8	0.0	3.0	10.4	5.1	56.6	0.0
19	3.3	0.0	0.0	17.3	13.7	0.0	0.0	0.0	0.0	52.3	24.9	0.0
20	21.6	0.0	0.5	84.8	7.1	0.0	0.0	0.0	0.0	1.5	13.7	0.0
21	5.1	0.0	0.0	13.2	4.6	0.0	0.0	0.0	0.0	6.6	0.0	0.5
22	11.1	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	60.7	0.0	0.0	4.1	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0
24	0.0	0.0	0.8	11.7	0.0	0.0	0.0	0.0	15.2	0.0	11.7	5.1
25	9.7	0.0	35.6	0.0	0.0	0.0	0.0	0.0	19.6	0.0	0.0	5.6
26	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.7	0.0	0.0	3.0
27	7.1	0.0	3.6	10.1	1.3	0.0	0.0	0.0	0.0	3.8	0.0	0.0
28	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	12.4	0.8	4.8	0.0
29	0.0		0.0	0.0	1.3	0.0	0.0	0.0	0.0	36.6	30.5	0.0
30	0.5		18.8	0.0	0.0	0.0	0.0	0.0	0.0	4.1	5.1	0.0
31	0.0		0.0		0.0		0.0	0.0		76.7		0.0

Table A1. continued.

Year 1956 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0
2	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	1.3	8.9	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	4.6	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	4.1
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.9
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	1.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	1.0	0.0
9	13.0	0.0	0.0	10.4	0.0	0.0	0.0	0.0	0.0	0.0	6.6	0.8
10	19.8	0.0	4.6	9.1	0.0	0.0	0.0	5.6	0.0	17.0	34.8	0.5
11	12.2	0.0	3.8	2.3	0.0	0.0	0.0	0.0	0.0	13.7	56.9	0.0
12	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.7	2.0	0.0
13	0.0	0.0	0.0	1.0	0.0	54.6	0.0	0.0	0.0	0.0	10.9	0.0
14	0.0	0.0	86.9	0.0	0.0	0.0	0.0	0.0	0.0	9.9	1.3	0.0
15	0.0	0.0	0.0	2.3	0.0	0.0	1.5	0.0	0.0	0.0	0.8	0.0
16	0.0	0.0	0.0	0.0	0.0	32.8	0.0	0.0	0.0	0.0	6.1	0.5
17	0.0	0.0	0.8	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.5	5.8
18	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	16.8	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	8.6	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
22	0.0	0.0	0.0	0.0	0.0	10.9	0.0	0.0	0.3	0.0	0.0	6.9
23	0.0	0.0	26.9	0.0	0.0	1.0	0.0	0.0	0.0	27.4	10.7	0.8
24	2.0	4.6	0.0	0.0	0.5	0.0	0.0	0.0	0.0	5.6	0.0	20.3
25	0.0	3.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.3	58.4
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.6	4.1	15.0
27	0.0	0.0	0.0	4.3	0.0	0.0	3.6	0.0	0.0	5.3	0.0	0.0
28	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	5.8
29	0.0	0.0	0.0	4.0	0.0	0.0	0.0	1.0	0.0	2.0	3.0	0.0
30	0.0		0.0	5.8	0.0	0.3	0.0	0.0	8.4	1.5	0.0	0.0
31	0.0		0.0		0.0		0.0	0.0		2.3		0.0

Year 1957 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	14.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6
2	0.0	0.0	0.0	0.0	7.1	8.9	0.0	3.0	0.0	0.0	13.7	1.8
3	0.0	3.3	0.0	0.0	0.0	14.0	0.0	0.0	0.0	0.0	7.1	0.8
4	1.3	0.0	0.0	23.6	38.6	0.5	0.0	0.0	0.0	0.0	137.2	34.5
5	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	6.6	0.5
6	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	20.8	50.3
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.1	0.0
8	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
9	0.5	0.0	0.0	19.8	0.0	0.3	0.0	0.0	0.0	0.0	2.0	4.3
10	17.0	0.0	0.0	0.0	9.6	0.0	0.0	0.0	1.5	0.0	7.6	34.9
11	5.1	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.3	4.8	33.8
12	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	13.7	0.0	71.6
13	0.0	11.4	0.0	4.6	5.1	0.0	0.0	0.0	0.0	0.0	6.6	0.0
14	0.0	13.0	10.4	5.3	3.6	0.3	0.0	0.0	0.0	0.0	21.3	0.0
15	0.5	20.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.5
16	13.5	17.5	0.0	3.6	69.1	0.0	0.0	0.0	0.0	0.0	6.1	7.1
17	13.2	15.5	0.0	0.0	14.5	0.3	0.0	0.0	0.0	7.6	14.5	88.4
18	1.3	0.3	0.0	0.3	3.3	0.0	0.0	0.0	0.0	34.0	42.9	20.6
19	0.0	0.0	0.0	27.9	0.0	0.0	0.0	0.0	0.0	9.7	10.2	30.0
20	0.0	0.0	0.0	21.3	0.5	0.0	0.0	0.0	0.0	68.1	9.4	55.1
21	0.0	0.0	0.0	21.8	1.3	0.3	0.0	0.0	0.0	7.6	7.1	83.6
22	0.0	0.0	0.0	5.1	2.8	0.0	0.0	0.0	0.0	103.9	19.8	1.0
23	0.0	0.0	0.0	32.5	1.3	0.0	0.0	0.0	0.0	0.0	7.1	72.9
24	0.0	0.0	0.0	39.1	0.8	0.0	2.0	0.0	0.0	7.1	0.3	204.7
25	0.0	1.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	45.0	217.2
26	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	3.3	2.0	22.4
27	0.0	0.0	0.0	0.3	0.8	0.0	0.0	0.0	0.0	39.9	4.1	9.1
28	0.0	0.0	0.0	0.0	205.5	0.0	0.0	0.0	0.5	9.1	9.1	8.6
29	8.9		0.0	0.0	1.3	0.0	0.0	0.0	0.0	5.6	33.5	14.0
30	4.3		0.0	27.9	0.0	0.0	0.0	0.0	36.3	9.1	0.8	0.8
31	1.3		0.0		0.0		0.0	0.0		0.0		0.0

Table A1. continued.

Year 1958 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2.8	15.5	0.0	0.0	20.3	0.0	1.5	0.0	0.0	0.0	26.9	0.5
2	0.0	0.0	0.0	0.0	0.3	0.0	0.3	38.4	0.0	0.0	18.3	0.0
3	7.1	0.0	0.0	0.0	25.6	0.0	0.0	0.0	0.0	0.0	13.2	10.7
4	0.0	0.0	0.0	99.6	20.8	0.0	0.0	2.8	0.0	4.6	0.0	0.0
5	5.3	0.0	0.0	3.8	29.7	0.0	0.0	13.2	0.0	6.9	0.0	0.8
6	1.0	0.0	0.0	3.8	1.3	0.0	0.0	0.3	0.0	3.3	0.0	0.0
7	0.5	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	29.5	0.0	0.0
8	1.3	0.0	0.0	0.0	0.0	0.0	0.0	6.6	0.0	17.5	0.0	0.0
9	0.8	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
10	0.0	0.0	5.6	26.7	0.0	0.0	1.8	0.0	0.0	0.0	1.5	0.0
11	0.0	0.0	9.4	3.0	0.0	0.0	0.0	0.0	0.0	0.0	14.5	1.8
12	0.0	0.0	12.7	12.7	0.0	0.0	0.0	0.0	0.0	0.8	2.5	0.0
13	0.0	0.0	0.0	10.2	20.1	0.0	0.0	0.0	0.0	46.2	1.5	0.0
14	0.0	0.0	58.7	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.3	0.0
15	0.0	0.0	3.8	0.0	1.3	0.0	0.0	0.0	0.0	2.8	15.5	1.5
16	0.0	0.0	0.0	0.0	0.0	4.1	0.0	0.0	0.0	8.6	0.0	0.5
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.6	0.0
19	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.8	0.0	0.0	13.2	0.0
20	0.0	0.0	0.0	1.3	0.3	0.0	0.0	0.5	0.0	0.0	9.7	0.0
21	0.0	0.0	0.0	0.0	0.3	0.0	0.0	1.3	0.0	0.0	9.7	0.0
22	0.0	0.0	8.9	57.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	21.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.4
24	0.0	0.0	5.3	0.0	1.3	0.0	0.0	0.0	0.0	0.0	2.0	15.0
25	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	33.5	23.6
26	3.8	0.8	0.0	7.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8
27	89.2	0.0	10.9	2.3	0.0	2.0	0.0	0.0	0.0	2.3	0.0	0.0
28	18.0	0.0	0.0	18.0	0.0	0.0	0.0	0.0	0.0	5.1	0.0	0.0
29	45.0		0.0	17.3	0.0	0.0	0.0	0.5	0.0	24.1	1.0	0.0
30	10.9		0.0	0.0	0.0	1.0	1.3	0.0	0.0	18.9	0.0	0.0
31	7.9		0.0		0.0		0.0	1.0		43.2		0.0

Year 1959 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	0.0	26.4	51.6	0.0	0.0	0.0	0.0	0.0	0.0	17.5
2	0.0	34.3	0.0	0.0	51.1	1.0	0.0	0.0	0.0	0.0	1.5	0.3
3	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
4	0.0	0.5	0.0	0.3	2.0	0.0	0.0	0.0	0.0	0.0	37.8	0.0
5	0.0	0.0	0.0	5.8	0.5	0.0	0.0	0.0	0.0	0.0	1.3	0.0
6	0.0	0.0	0.0	4.1	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	31.8	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.3
8	0.0	0.0	0.0	2.0	0.0	0.8	0.0	0.0	0.0	0.0	23.4	0.0
9	11.4	0.0	0.0	5.3	1.5	10.4	0.0	0.0	0.0	0.0	50.3	3.8
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.4	18.0
11	0.0	0.0	0.0	1.3	3.8	0.0	0.0	0.0	0.0	0.0	0.0	10.9
12	0.0	0.0	0.0	0.0	12.2	0.0	0.5	0.0	0.0	0.0	8.4	51.1
13	10.2	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.5	5.6
14	15.7	0.0	0.0	0.0	13.0	0.3	0.0	0.0	0.0	0.0	4.8	3.0
15	8.1	0.0	0.0	34.8	27.9	2.3	0.0	0.0	0.0	0.0	1.8	0.0
16	24.4	0.0	0.0	32.8	1.8	0.0	0.3	0.0	18.0	10.4	9.7	0.0
17	0.0	0.0	0.0	0.0	0.0	6.1	0.0	0.0	29.2	2.5	0.0	19.6
18	0.0	0.0	0.0	19.8	0.0	6.4	1.0	0.0	33.0	0.0	17.5	0.5
19	0.0	8.4	0.0	0.0	21.1	4.1	4.1	0.0	0.0	38.4	0.0	2.3
20	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	14.7	17.5	10.2
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	23.4	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	8.1	26.9	0.0
23	0.0	0.0	16.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	20.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	7.6	8.1	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.3	0.5	12.2
26	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.8	0.5	28.4	0.0
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.0	2.8
28	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	29.5	6.6	5.8
29	0.5		0.0	6.6	3.3	1.3	0.0	0.0	0.0	0.0	49.0	0.0
30	0.0		9.4	0.0	0.0	2.0	0.0	0.0	0.0	13.7	47.2	0.8
31	0.0		12.7		0.0		0.0	0.0		1.8		0.0

Table A1. continued.

Year 1960 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	5.6	0.0	0.0	0.3	19.1	0.0	1.3	0.0	0.0	0.0	16.8	
2	23.6	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	20.6	
3	4.6	0.0	0.0	98.3	0.8	0.0	0.0	0.0	0.0	0.0	24.9	
4	0.0	0.0	0.0	14.2	3.6	0.0	0.0	0.0	0.0	0.0	0.0	
5	0.0	0.0	0.0	1.8	0.0	0.0	1.8	0.0	0.0	0.0	72.9	
6	0.0	0.0	0.0	0.0	0.0	0.0	14.7	0.0	0.0	0.0	0.8	
7	1.3	0.0	0.0	18.0	0.0	0.0	0.0	0.0	0.0	0.0	57.4	
8	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	20.8	
9	2.3	0.0	0.0	17.5	0.0	0.0	0.8	0.0	0.0	0.0	18.5	
10	3.0	7.4	10.9	0.0	0.0	0.0	3.8	0.0	0.0	0.0	1.0	
11	0.0	0.0	0.0	0.0	0.0	0.0	92.7	0.0	0.0	0.0	4.1	
12	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	68.8	0.0	3.8	
13	1.8	0.0	0.0	27.7	40.1	0.0	0.0	0.0	0.0	47.5	6.6	
14	0.0	0.0	0.0	98.0	3.0	0.0	0.0	0.0	0.0	0.0	7.4	
15	0.0	0.0	0.0	25.4	0.5	0.0	20.3	0.0	0.0	0.0	14.7	
16	0.0	0.0	0.0	0.0	0.0	7.6	11.2	0.0	0.0	0.0	73.2	
17	0.0	0.0	0.0	0.0	17.0	0.0	48.3	0.0	0.0	0.0	0.5	
18	0.0	0.0	0.0	0.0	0.0	0.0	5.8	0.0	0.0	0.0	0.0	
19	0.0	14.2	0.0	65.8	0.3	0.0	12.2	0.0	0.0	7.9	0.0	
20	45.2	14.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.5	0.0	
21	0.8	16.8	0.0	0.5	0.3	0.0	0.0	1.5	0.0	0.0	5.3	
22	31.0	39.0	0.0	22.4	0.0	1.0	0.0	0.0	0.0	0.0	4.3	
23	0.8	5.3	0.0	0.0	0.3	0.0	0.3	0.0	0.0	0.0	38.6	
24	9.1	14.5	0.0	6.6	0.0	0.0	0.0	0.0	0.0	6.1	1.0	
25	0.0	24.4	1.5	0.0	0.8	0.0	0.0	0.0	0.0	68.6	0.0	
26	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	
27	0.0	0.0	0.0	7.9	0.0	0.0	0.0	0.0	0.0	1.0	0.0	
28	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.9	0.0	
29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.8	
30	2.0		4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.5	
31	1.5		4.3		0.0		0.0	0.0		19.1		

Year 1961 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1		0.0	0.0	0.0	0.5	0.0	1.0	1.5	0.0	0.0	0.3	9.4
2		0.0	0.0	3.0	3.8	0.0	0.3	0.0	0.0	0.0	4.6	73.2
3		0.0	0.0	13.5	0.0	0.0	0.0	13.2	0.0	0.0	2.0	0.5
4		0.0	0.0	2.0	5.8	0.5	0.0	0.0	0.0	0.0	0.0	7.1
5		0.0	0.0	14.7	21.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6		0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	80.0
7		0.0	0.0	0.0	0.0	11.7	0.0	0.0	0.0	0.0	67.3	2.3
8		0.0	0.0	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0
9		0.0	7.1	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.5
10		0.0	0.0	0.0	0.0	0.0	0.0	0.8	7.9	0.0	17.8	0.0
11		0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	20.3
12		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	13.7
13		0.0	0.0	10.4	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0
14		0.0	0.0	0.0	7.6	0.0	0.0	1.8	0.0	2.8	3.8	1.8
15		42.7	0.0	0.0	0.0	0.0	0.0	2.0	0.0	15.7	1.8	4.3
16		27.9	0.5	0.0	2.3	0.0	0.0	0.0	0.0	0.0	3.3	0.0
17		7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.4	0.0
18		8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0
19		0.3	0.0	0.0	1.3	0.0	0.0	0.0	0.0	15.7	4.3	0.0
20		0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	3.8	0.0	0.0
21		1.8	0.0	0.0	0.5	0.0	22.9	0.0	0.0	0.8	1.8	0.0
22		21.8	5.8	0.0	6.9	0.0	0.0	0.0	0.0	61.7	1.0	0.0
23		7.1	3.8	0.0	4.3	0.0	0.0	0.0	0.0	36.3	39.6	0.0
24		0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.3	0.5	0.0
25		0.0	0.0	2.5	0.0	0.0	0.0	0.3	0.0	0.0	3.3	0.0
26		0.0	13.2	22.9	0.0	19.8	0.0	0.0	0.0	43.7	6.3	0.0
27		0.0	5.8	15.0	0.0	17.5	0.0	0.0	0.0	1.8	0.0	0.0
28		0.0	0.0	2.5	1.0	18.3	0.3	0.0	0.0	37.3	8.4	0.3
29			0.0	0.0	3.0	4.3	0.0	0.0	0.0	3.0	5.3	5.6
30			8.1	117.3	0.3	0.0	0.0	0.0	0.0	1.3	22.1	45.7
31			0.0		0.0		0.0	0.0		62.0		0.3

Table A1. continued.

Year 1962 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	17.8	0.0	0.0	43.7
2	0.0	2.5	0.0	17.0	0.0	0.0	0.0	0.0	7.9	0.0	1.0	10.4
3	0.0	0.8	0.0	10.4	4.1	0.0	0.0	0.0	7.4	0.0	3.3	1.8
4	0.0	1.0	0.0	9.9	0.0	4.6	0.0	0.0	2.5	5.3	1.0	1.5
5	3.3	0.0	0.0	0.3	0.0	0.0	0.5	1.3	1.3	0.0	0.0	0.0
6	31.0	0.0	0.0	1.8	21.6	0.0	0.3	0.0	0.0	0.5	2.8	0.0
7	11.4	0.0	0.0	0.0	7.9	0.0	9.1	0.0	0.0	19.6	14.2	0.0
8	5.1	0.0	0.0	0.8	7.1	0.0	0.0	0.0	0.0	83.6	1.8	0.0
9	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	21.6	20.1	0.0
10	0.0	3.6	0.0	5.8	0.0	0.0	0.0	0.0	0.0	148.8	5.1	0.0
11	0.0	0.0	0.0	21.8	0.3	0.0	0.0	0.0	0.0	91.9	0.0	0.0
12	3.3	0.8	0.0	6.4	37.8	0.0	0.0	0.0	34.8	1.5	0.0	0.0
13	10.9	0.5	0.0	1.3	0.0	0.0	0.0	0.0	0.0	7.9	0.0	0.0
14	6.6	0.0	0.0	10.4	24.9	0.0	0.0	0.0	0.0	2.3	0.0	0.3
15	0.0	0.0	0.0	20.6	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.5	0.0	0.0	1.5	9.4	0.0	0.0	0.0	0.0	9.7	0.0	2.5
17	0.0	0.0	0.0	0.3	2.3	0.0	0.0	0.0	1.0	0.5	0.0	32.5
18	0.0	5.6	0.0	3.8	0.3	0.0	0.0	0.0	0.0	76.7	0.0	20.6
19	0.0	0.0	3.3	4.8	1.3	0.0	0.0	0.0	0.0	5.1	0.0	9.1
20	0.0	0.0	8.4	0.0	13.5	0.0	0.0	0.0	0.0	13.7	12.7	0.0
21	0.0	0.0	19.1	0.0	0.0	0.0	0.0	0.0	0.0	21.1	16.5	0.8
22	3.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	6.9	0.0	25.9
23	15.2	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.8
24	2.3	0.0	0.0	28.4	0.0	0.0	0.3	0.0	0.0	0.0	2.5	4.3
25	0.0	0.0	0.0	9.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.6
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	8.4
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.3	54.1
28	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.8	1.5	0.0	1.3
29	0.0		0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0
30	0.0		0.0	0.0	0.0	0.0	0.0	1.5	1.3	1.8	0.0	0.0
31	0.0		0.8		0.0		0.0	0.0		0.0		0.0

Year 1963 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	6.1	0.0	0.0	0.0	0.0	0.0	1.3	0.5	4.8	26.7
2	8.1	0.0	8.4	0.0	4.8	0.0	0.0	0.0	0.3	0.0	6.9	4.3
3	24.1	5.6	0.5	0.0	0.0	0.0	0.0	3.3	0.0	0.0	24.9	27.7
4	16.8	11.2	1.0	1.5	16.8	0.0	0.0	0.0	0.0	0.0	39.9	28.4
5	24.4	47.0	0.0	22.3	0.0	0.0	3.8	0.0	0.0	0.0	0.0	5.1
6	49.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	3.8	29.5
7	12.7	0.0	0.0	2.3	0.0	3.3	1.3	0.0	0.8	0.0	6.1	21.8
8	1.8	0.0	0.0	0.0	0.0	0.5	1.3	0.0	0.0	8.4	0.0	148.8
9	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.4	9.4
11	0.0	0.0	14.7	2.0	0.0	0.0	0.0	0.0	0.0	0.0	87.6	1.8
12	25.9	0.0	1.5	0.0	49.5	0.0	0.3	0.0	0.3	0.0	0.0	0.0
13	0.0	0.0	0.0	49.5	11.4	0.0	0.0	0.0	0.0	54.6	20.1	0.0
14	1.5	0.0	0.0	8.4	0.0	0.0	0.0	0.0	0.0	80.5	6.1	0.0
15	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	9.4	1.0	0.0
16	0.0	0.0	0.0	0.0	6.1	0.0	0.0	0.0	0.0	2.0	5.1	0.0
17	0.0	0.0	0.0	16.3	0.0	0.0	0.0	0.0	3.6	22.4	105.9	0.0
18	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	4.3	34.0	0.5
19	4.6	0.5	0.0	24.6	0.0	0.0	0.0	0.0	0.0	16.3	2.5	0.0
20	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	2.5	76.7	10.2	0.5
21	0.0	1.8	0.0	67.8	0.0	0.0	0.0	0.0	30.2	31.0	1.8	30.2
22	0.0	0.5	0.0	8.9	0.0	0.5	0.0	0.0	2.5	0.5	5.3	7.9
23	0.0	0.0	24.1	73.2	0.0	6.4	0.0	0.0	0.3	6.1	20.1	0.0
24	0.0	0.0	0.8	0.0	2.0	0.0	2.5	0.0	0.0	0.3	1.0	18.5
25	24.1	0.0	49.8	0.0	0.0	0.0	3.0	0.0	9.7	9.1	23.9	52.1
26	3.3	0.0	1.8	0.0	0.0	0.3	0.0	0.0	5.3	0.0	8.4	0.0
27	21.3	10.9	0.0	0.0	0.0	5.6	0.0	0.0	1.0	0.0	38.9	1.0
28	13.2	0.0	17.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.9	11.4
29	0.0		0.0	0.0	0.0	0.0	0.0	0.0	2.7	1.8	5.8	1.0
30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	1.3	0.0
31	0.5		0.0		0.0		0.0	0.0		0.0		46.7

Table A1. continued.

Year 1964 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	5.8	0.0	1.3	3.6	32.5	0.0	0.0	0.0	0.0	0.0	6.4	1.8
2	0.5	0.0	8.1	0.0	26.9	0.0	0.0	0.5	0.0	0.0	6.9	8.6
3	0.0	0.0	0.0	9.9	0.3	0.0	1.0	0.0	44.2	0.0	7.4	3.8
4	11.4	0.0	0.0	0.0	0.3	0.0	0.0	0.3	50.0	0.0	4.6	0.0
5	21.3	0.0	0.0	5.8	4.3	0.0	0.0	0.8	16.0	0.0	0.0	22.4
6	0.0	0.0	2.5	0.5	0.0	0.0	0.0	1.8	0.0	0.0	16.3	0.0
7	0.0	0.0	0.0	5.3	0.0	0.3	0.3	2.0	0.5	0.0	11.2	1.5
8	0.5	0.0	0.0	1.0	0.0	0.0	0.0	1.3	7.6	51.8	4.1	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	6.9	0.0	0.0	0.0
10	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	1.5	0.0	16.0	0.0
11	0.0	0.0	0.0	5.8	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.8
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.4	7.9	0.3
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	2.3	10.1	3.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	2.0
15	0.0	0.0	0.0	13.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	10.9	41.7	0.0
17	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	13.7	0.0
18	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.2	0.0
19	0.0	21.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	9.4	15.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.2	0.8
21	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
22	11.9	0.0	45.7	0.0	0.0	0.0	0.8	0.0	0.0	26.7	0.5	57.2
23	8.1	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	18.3	16.5	3.6
24	4.1	0.0	0.0	8.4	0.0	0.8	0.0	0.0	0.0	3.3	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.5
26	0.0	0.3	0.0	33.5	0.0	0.0	17.0	0.0	0.0	0.3	0.0	0.3
27	0.0	0.0	0.3	0.0	0.0	0.0	51.3	0.0	0.0	0.0	0.0	0.0
28	0.0	6.6	1.8	16.3	0.0	0.0	1.5	0.0	0.0	23.9	0.0	0.0
29	0.0	0.3	0.0	0.8	0.0	0.0	0.3	5.3	0.0	2.0	0.0	0.0
30	0.0		0.0	0.0	0.0	0.0	1.0	0.0	0.0	5.3	0.0	0.0
31	0.0		0.0		0.0		0.0	0.3		15.7		0.0

Year 1965 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	5.1	3.3
2	0.0	7.9	14.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	120.0
3	0.0	0.0	1.5	0.0	0.0	0.0	0.0	14.7	0.0	0.0	26.9	5.1
4	0.0	0.0	0.0	0.0	51.3	0.0	0.0	52.8	0.0	0.0	10.7	21.1
5	0.0	0.0	0.0	1.8	2.0	0.3	0.0	0.0	0.0	0.0	88.4	43.7
6	0.0	2.0	0.0	0.3	5.1	0.0	1.8	0.0	0.0	0.0	8.6	26.7
7	0.0	0.0	0.0	0.0	39.1	0.0	0.0	0.0	0.0	0.0	0.0	1.0
8	0.0	0.0	0.0	0.0	0.0	0.3	0.0	3.0	0.0	0.8	0.0	4.3
9	0.0	0.8	0.0	7.6	0.0	0.0	0.0	8.1	0.0	57.7	23.6	0.8
10	0.3	0.0	0.0	0.0	0.0	0.0	0.0	19.0	0.0	118.6	19.3	0.5
11	0.0	0.0	0.0	0.0	0.0	0.3	0.0	7.1	0.0	3.6	46.2	0.0
12	1.5	8.1	0.0	0.0	0.0	0.0	0.0	2.3	0.0	24.6	0.8	0.0
13	5.6	34.8	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	18.3	11.2	0.0	9.9	0.0	0.0	0.0	0.8	0.0	8.9	0.0	0.0
15	23.1	5.6	0.0	0.0	72.4	0.0	0.0	63.0	0.0	23.1	0.0	0.0
16	0.0	0.0	0.0	26.7	2.0	0.0	0.0	12.7	0.0	73.7	0.0	0.3
17	0.0	0.0	0.0	84.6	0.5	0.0	0.0	0.0	0.0	3.3	0.0	0.0
18	0.0	0.0	0.0	18.0	0.0	4.1	0.0	0.0	0.0	2.0	0.0	26.7
19	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	1.8	1.3	34.3
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	2.3	24.9
21	0.0	0.0	6.1	0.0	0.0	0.0	0.0	0.0	0.0	4.8	4.6	24.9
22	0.0	0.0	0.0	2.0	0.3	0.0	0.0	0.0	0.0	22.1	4.3	0.8
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.9	7.1	0.0
24	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	20.6	4.8	0.0
25	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	7.6	5.8	0.0
26	0.5	0.0	2.3	0.3	0.0	0.0	0.0	2.3	0.0	19.1	0.5	8.9
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	3.3	6.9	1.0
28	2.0	0.0	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	1.3
29	1.0		0.3	8.4	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0
30	0.0		24.6	0.0	0.0	0.0	0.5	0.0	0.0	8.1	62.0	0.0
31	0.5		66.0		0.0		0.0	0.0		0.0		0.0

Table A1. continued.

Year 1966

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	4.3	0.0	1.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	1.5
2	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.3	8.6	29.2
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
4	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	5.6	0.0	13.2
5	0.0	0.0	2.8	0.0	0.0	0.3	0.0	0.0	0.0	2.0	0.3	3.3
6	0.0	0.0	51.6	2.0	0.0	0.0	0.0	0.0	0.0	6.1	9.1	16.8
7	0.0	0.0	0.0	23.1	0.0	0.0	0.0	0.0	0.0	95.3	54.1	2.5
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.2	124.0	10.9
9	0.0	0.8	0.0	1.3	0.0	0.0	0.0	0.0	0.0	4.8	42.4	0.8
10	0.0	0.0	35.6	0.0	0.0	0.0	19.8	0.3	0.0	0.0	8.1	0.0
11	0.0	0.0	10.2	6.4	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0
12	0.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.2	0.0
13	0.0	0.0	69.1	0.0	0.0	0.0	0.0	0.8	1.0	8.6	54.6	0.0
14	2.8	0.0	1.3	3.6	0.0	0.0	0.0	0.0	2.0	1.8	1.3	0.0
15	33.5	1.3	1.5	5.1	0.0	0.0	0.0	0.0	0.3	2.0	43.7	3.6
16	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	50.3	0.0	1.0
17	0.0	0.0	0.0	38.1	0.0	0.0	0.0	36.6	0.0	51.1	0.0	0.5
18	0.0	0.0	0.0	15.5	0.0	0.5	0.0	0.0	0.0	2.3	0.0	0.0
19	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	79.2	0.8	3.8	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.5	18.0	4.1
21	0.0	0.0	0.0	2.0	0.0	1.3	3.3	0.0	0.0	0.0	0.0	1.3
22	4.1	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.3	4.6	6.6
23	5.8	0.0	0.0	48.8	0.0	0.0	0.0	0.0	4.6	0.0	0.0	0.0
24	9.4	0.0	0.0	0.0	0.3	0.0	0.0	0.3	0.0	0.0	0.0	7.9
25	0.0	8.9	0.0	17.0	0.0	0.0	0.0	0.0	31.0	0.0	0.5	17.0
26	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	5.1	0.0	0.0	33.8
27	0.0	0.0	0.5	0.0	0.0	0.3	0.0	0.0	1.0	0.8	0.0	0.0
28	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	1.8	8.4	0.5	0.0
29	0.3		30.5	38.4	0.0	0.0	0.0	0.0	16.8	27.2	0.3	27.9
30	0.0		1.3	33.3	0.0	0.0	0.0	0.0	0.0	15.7	6.1	34.0
31	1.5		0.0		0.0		0.0	0.0		1.3		0.3

Year 1967

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	0.0	0.0	9.1	0.0	0.0	0.0	0.0	0.0	2.0	3.6
2	2.0	0.0	3.3	0.0	34.3	0.0	0.0	0.5	0.0	0.0	0.3	0.5
3	0.0	8.1	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.5	13.0
4	0.0	108.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.4
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	139.2
6	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	8.1	0.0	0.5	145.8
7	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	1.3	2.3
8	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	16.0	0.8	0.0	0.0	0.0	0.0	0.0	0.3	0.0
11	0.0	0.0	0.0	0.8	29.0	0.0	0.0	0.0	0.0	0.0	31.2	2.0
12	0.0	0.0	0.0	3.6	0.8	0.0	0.0	0.0	0.0	0.0	0.0	3.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.0	0.0	0.0
15	3.0	0.0	0.0	0.0	0.5	1.3	0.0	0.0	0.0	11.9	0.3	2.3
16	0.5	0.0	0.0	1.3	0.8	0.0	0.0	0.0	0.0	2.5	0.0	0.0
17	0.0	0.0	0.0	5.6	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	1.8	0.0	18.3	0.0	5.3	0.0	0.0	0.0	0.8	3.6	0.0	0.0
19	1.3	0.0	75.7	0.0	0.0	0.0	0.0	0.0	0.3	34.0	0.0	0.0
20	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.3	4.7	36.8	0.0
21	0.8	1.5	0.0	16.0	0.0	0.0	0.0	0.0	0.0	108.2	2.8	0.0
22	1.0	9.4	31.8	0.0	0.0	13.2	0.0	2.3	0.8	0.0	2.5	0.3
23	6.4	0.0	0.0	16.0	0.0	0.0	5.3	0.0	0.0	0.0	0.3	0.0
24	0.0	0.0	0.0	2.3	0.0	5.1	1.3	0.0	0.0	2.8	1.5	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.5	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0.0	2.5	0.0
27	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	41.1	1.3
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.6	0.8
29	0.0		0.0	4.8	0.0	0.3	0.0	0.0	0.0	0.5	30.0	0.0
30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	101.6	1.8	0.0
31	0.0		0.0		0.0		0.0	0.0		2.8		0.0

Table A1. continued.

Year 1968

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	14.5	
2	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	
3	25.1	0.0	0.5	0.0	0.8	0.0	0.0	0.0	0.0	0.3	14.5	
4	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	
7	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.3	
8	12.2	0.0	0.0	0.0	0.0	8.1	0.0	0.0	0.0	0.0	48.8	
9	0.0	0.0	0.3	0.0	0.0	24.1	0.0	0.0	0.0	0.0	40.1	
10	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	
11	0.0	0.0	0.0	0.3	0.0	5.1	0.0	0.0	0.0	0.0	0.0	
12	0.0	0.0	0.0	6.4	0.0	1.0	0.0	0.0	0.0	2.3	0.0	
13	0.8	0.0	10.7	11.4	0.0	0.0	0.0	0.0	0.0	56.9	33.5	
14	0.0	0.0	2.5	0.5	0.0	0.3	2.5	0.0	0.0	1.5	1.0	
15	0.0	0.0	2.8	5.6	0.0	0.0	1.0	0.0	0.0	0.0	4.8	
16	0.0	0.0	3.8	35.6	9.7	0.0	2.8	0.0	0.0	0.8	36.6	
17	0.0	0.0	5.1	0.0	0.0	0.0	0.8	0.0	0.0	2.3	1.0	
18	0.0	0.0	0.3	1.0	0.0	0.0	1.0	0.0	2.8	3.3	97.0	
19	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	16.3	42.2	0.5	
20	1.8	0.0	0.0	7.1	0.0	3.0	0.8	0.0	8.6	16.3	0.3	4.7
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.9	32.5	2.5	26.9
22	0.0	0.0	0.0	8.1	0.0	0.8	0.0	0.0	0.0	8.6	0.0	1.3
23	0.0	0.3	0.0	0.0	0.0	3.6	0.0	0.0	0.0	3.6	0.0	0.0
24	0.0	0.0	0.0	8.6	0.0	0.0	0.0	0.0	0.0	2.8	1.0	0.0
25	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0
26	0.0	0.0	56.9	20.8	0.0	0.3	0.0	0.0	0.0	6.9	0.0	0.0
27	0.0	0.0	9.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0		0.0
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	1.0		0.0
29	0.0	0.0	6.4	0.0	0.0	0.0	0.0	0.0	7.9	6.4		0.0
30	0.5		0.3	0.5	0.0	0.0	0.0	0.0	1.0	54.6		0.0
31	0.0		0.8		0.0		0.0	0.0		16.8		0.0

Year 1969

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	13.7	0.0	0.0
2	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
4	0.5	0.0	0.0	1.5	1.5	1.0	0.0	0.0	0.0	0.0	0.0	9.7
5	0.3	7.4	0.0	32.8	1.3	0.0	0.0	0.0	1.3	73.9	0.3	0.0
6	5.1	5.8	0.0	0.5	0.0	0.0	0.0	0.0	0.0	8.1	3.8	0.0
7	0.3	6.6	0.0	4.3	0.0	0.0	0.0	0.0	0.0	40.6	0.0	5.1
8	0.0	3.6	0.0	0.0	0.0	0.0	1.0	0.0	0.0	3.8	0.0	41.4
9	0.0	0.8	0.0	4.6	0.0	0.0	1.5	0.0	0.0	0.0	0.0	9.1
10	21.3	0.0	0.0	7.4	4.8	0.0	0.0	0.0	0.0	6.4	3.3	2.5
11	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0
12	13.7	0.0	0.0	4.1	0.0	0.0	0.0	0.0	0.0	16.3	2.0	0.3
13	2.3	0.0	0.0	39.1	0.0	0.0	0.0	2.8	0.0	20.3	24.6	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.4	0.0	6.6	1.0	0.0
15	2.3	0.0	4.6	0.0	0.0	0.0	0.0	1.0	0.0	1.0	2.5	0.0
16	0.0	0.0	9.4	0.0	0.0	0.0	0.0	8.1	0.0	7.1	17.5	27.9
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.2	0.0	1.8	7.4	9.1
18	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.5	0.0	0.5	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	23.9	0.0	10.4
20	4.1	0.0	0.0	63.0	0.0	0.0	0.0	4.6	0.0	26.4	0.3	7.9
21	0.5	0.0	53.3	27.4	0.0	0.0	0.0	0.0	0.0	15.2	20.8	3.6
22	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.9	0.3	0.3
23	2.5	0.0	0.0	0.0	0.0	0.0	0.0	13.7	0.0	0.0	0.0	0.5
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	41.4	0.0	1.5	0.0	35.3
25	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	11.4	47.0
26	0.0	0.0	0.0	0.0	0.3	0.5	0.0	2.3	0.0	0.8	7.9	17.3
27	0.0	0.0	0.0	10.4	0.0	0.0	0.0	0.0	17.0	0.0	0.0	23.9
28	0.0	16.3	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	3.8	36.6
29	0.0		49.5	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	49.0
30	0.0		0.0	20.6	0.0	0.0	0.0	0.0	0.0	9.7	2.5	31.2
31	0.0		0.0		0.0		0.0	0.8		32.5		7.4

Table A1. continued.

Year 1970 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	2.0	26.7
2	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.4
3	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	11.4	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	90.7	0.0	18.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
6	17.0	4.3	0.0	10.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
7	1.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	29.2	11.4	0.0
8	20.8	6.9	1.5	69.6	13.2	0.0	0.0	0.0	0.0	0.0	8.6	24.4
9	6.1	1.8	1.8	0.0	0.8	0.0	0.0	0.0	6.6	0.0	3.0	11.7
10	1.3	0.0	0.3	0.0	15.0	0.3	0.0	0.3	0.0	6.1	20.6	0.8
11	2.3	1.3	0.0	0.0	0.0	0.0	0.0	0.0	36.3	0.0	55.6	12.2
12	0.8	0.0	47.5	7.6	0.0	0.0	0.0	0.0	0.0	11.4	0.0	28.7
13	0.3	0.0	0.0	6.4	0.0	0.0	0.0	0.0	0.0	43.2	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	15.5	41.7	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	3.6	0.0	7.6
16	0.0	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.2
17	3.3	20.1	0.0	0.0	66.8	0.0	0.0	0.0	0.0	5.6	0.0	15.2
18	14.0	0.8	0.0	0.0	0.3	0.0	0.0	0.0	0.0	15.0	13.7	0.3
19	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	23.6	1.8	0.0
20	7.4	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.8	1.8	0.3
21	0.0	0.0	0.0	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
23	0.0	0.0	0.0	3.6	0.0	0.0	10.7	0.3	6.6	0.0	0.0	3.0
24	0.0	0.0	0.0	1.3	0.0	0.0	0.5	0.0	0.0	0.0	4.1	5.1
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0
26	0.0	0.0	6.6	4.6	0.5	0.0	0.0	0.0	0.0	0.0	37.8	0.3
27	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	27.4	0.0	36.1	9.1
28	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.8	0.0
29	0.0		14.7	0.0	17.8	0.0	0.0	0.0	0.0	5.1	15.0	0.5
30	0.0		0.0	0.0	0.3	0.0	4.4	0.0	0.0	1.0	0.0	0.0
31	0.0		0.0		0.3		0.3		0.0	3.6		0.0

Year 1971 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	2.5	5.6	57.2	0.0	0.0	0.0	0.0	0.0	0.3	0.0
2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.3	2.0
3	16.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.5	6.9
4	42.7	0.0	1.3	29.7	0.0	0.0	0.0	0.0	0.0	0.0	21.3	31.5
5	2.5	0.0	0.0	5.1	0.0	0.5	0.0	0.0	0.0	0.0	0.0	17.8
6	10.9	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	7.6
7	11.7	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	5.3	43.7
8	3.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	58.2
9	15.5	0.0	0.0	0.0	0.0	0.5	1.5	0.0	0.0	0.0	0.0	21.6
10	25.1	0.0	11.7	0.0	0.0	0.5	0.0	0.0	8.1	0.0	0.0	57.4
11	0.5	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	2.8
12	0.0	0.0	0.0	8.9	0.0	0.0	0.0	2.0	0.0	0.0	0.0	24.6
13	0.0	0.0	0.0	28.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8
14	0.0	0.0	6.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.0
15	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	39.9	7.6
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	23.6	0.0	9.4	35.6
17	0.0	0.0	0.0	4.3	17.3	0.0	0.0	19.1	3.0	0.0	0.0	5.6
18	0.0	0.0	0.0	34.8	3.0	4.1	0.0	22.6	0.0	16.8	0.0	1.3
19	0.0	0.0	0.0	1.8	19.1	21.6	0.0	68.8	0.0	30.2	0.0	0.0
20	0.0	7.4	0.0	4.1	0.5	4.1	0.0	2.5	0.0	19.1	0.5	0.0
21	0.3	0.0	0.0	0.0	0.0	2.3	0.0	0.0	5.6	7.4	0.5	0.0
22	7.4	18.0	0.0	3.3	0.0	2.5	0.0	0.0	7.6	10.2	0.0	0.0
23	2.0	0.8	0.0	4.8	0.0	0.0	0.0	0.0	2.3	12.2	0.0	2.8
24	15.2	0.3	0.0	3.0	0.0	1.5	0.3	0.0	11.7	15.0	2.3	0.0
25	0.0	0.0	0.0	5.1	0.0	0.0	0.3	0.0	2.3	17.0	1.0	1.0
26	29.0	0.8	0.0	10.2	0.0	0.0	0.0	0.0	0.5	0.8	3.6	0.0
27	18.3	56.6	0.0	0.0	0.5	0.0	0.0	0.0	0.0	30.0	0.0	8.1
28	0.0	0.5	0.0	57.2	0.0	0.0	0.0	0.0	2.0	2.8	0.0	0.0
29	0.0		0.0	9.7	0.0	0.0	0.0	0.0	6.4	29.2	2.5	2.0
30	0.0		0.0	72.1	0.0	0.0	0.0	0.0	0.3	0.0	0.8	8.4
31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Table A1. continued.

Year 1972 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	1.8	62.8	0.0
2	0.0	0.0	0.0	7.4	0.0	0.0	0.0	0.0	0.0	8.1	14.0	0.0
3	0.0	0.0	0.0	0.0	26.7	0.0	0.0	0.0	0.0	56.4	3.3	6.4
4	0.0	0.0	0.0	0.0	8.4	0.0	0.0	0.0	0.0	1.5	0.0	18.0
5	0.0	0.0	0.0	5.6	0.5	0.0	0.0	0.0	0.0	2.5	0.0	6.1
6	0.0	0.0	11.7	0.0	0.0	0.0	0.0	0.0	0.0	2.0	1.8	0.0
7	0.0	0.0	0.0	0.5	27.2	0.0	0.0	0.0	0.0	0.0	6.4	0.0
8	0.0	0.0	0.0	0.3	2.3	0.0	0.0	0.0	0.0	0.0	3.8	0.0
9	0.0	0.0	0.0	10.2	23.4	0.0	0.0	0.0	0.0	0.0	41.1	3.8
10	0.0	0.0	0.0	0.5	6.6	0.0	0.0	0.0	0.0	2.0	4.1	0.0
11	0.0	0.0	0.0	34.0	10.7	0.0	19.1	0.0	0.0	18.5	0.0	0.0
12	0.0	0.0	0.0	0.0	25.1	0.0	0.0	0.0	0.0	2.5	0.0	0.0
13	0.0	0.0	0.0	0.0	11.4	0.0	0.0	0.0	0.0	35.1	1.5	0.8
14	0.0	0.0	0.0	0.0	17.0	0.0	0.0	0.0	7.4	10.7	2.8	0.0
15	0.0	0.0	1.8	1.3	0.5	0.0	0.0	0.0	0.0	20.8	24.4	6.9
16	0.0	0.0	0.0	14.5	0.0	0.0	0.5	0.0	0.0	4.6	0.5	5.1
17	0.5	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	52.8	5.6	8.9
18	1.8	0.0	0.0	39.6	0.0	0.0	0.0	0.0	0.0	31.8	0.0	1.8
19	10.2	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1
20	0.3	0.0	0.0	7.4	0.0	0.0	0.0	0.0	0.0	7.1	0.0	56.1
21	0.0	0.0	0.0	7.4	0.0	0.0	1.0	0.0	0.3	3.8	0.0	3.0
22	0.0	0.0	0.0	1.0	0.0	1.0	0.0	0.0	3.0	0.5	0.0	0.3
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.9	0.0	0.0	2.8
24	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	11.4	6.6	0.0	4.1
25	0.0	0.0	0.0	6.4	0.0	0.0	0.0	0.0	0.0	26.7	1.0	31.2
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	15.7	7.6
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	1.5	0.5	0.0
28	0.0	0.0	0.0	14.5	0.0	0.0	0.0	0.0	40.9	0.3	3.8	0.0
29	0.0	0.0	0.0	5.1	0.0	0.0	0.0	0.0	2.0	17.0	0.0	0.0
30	12.2		4.3	7.9	0.0	0.0	0.0	0.0	0.0	4.1	0.0	0.0
31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Year 1973 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.5	0.0	16.0
2	0.0	0.0	0.0	0.0	6.1	0.0	0.0	0.0	0.0	0.0	0.5	1.8
3	0.0	0.0	0.0	19.6	4.2	0.0	0.0	0.0	0.0	0.0	11.7	5.1
4	0.0	0.0	0.0	0.0	0.0	1.5	1.3	0.0	0.0	0.0	4.3	13.5
5	0.0	0.8	0.0	0.0	0.0	0.0	10.9	0.0	0.0	0.0	6.1	4.3
6	0.0	0.0	0.0	0.0	0.0	0.0	10.1	0.0	0.0	0.0	2.5	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
9	0.0	0.0	0.0	30.5	0.0	0.0	0.0	17.3	0.0	0.0	0.0	0.0
10	0.0	8.6	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	2.3	0.0
11	0.0	0.0	0.0	8.1	0.0	1.8	0.0	10.7	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.9
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	61.7	93.2	0.0	16.3
15	0.0	0.0	0.0	26.4	0.0	0.0	0.0	0.0	21.1	0.0	0.0	3.3
16	0.0	0.0	0.0	1.8	0.0	0.3	0.0	0.0	0.0	3.8	0.3	1.0
17	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	2.5	0.0	10.7
18	0.0	0.0	0.0	1.3	0.0	2.0	0.0	0.0	3.0	4.3	0.5	16.5
19	0.0	0.0	0.0	0.0	0.3	7.4	0.0	0.0	0.0	4.8	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	1.0
21	0.0	0.0	0.0	0.0	5.3	0.0	0.8	0.0	0.0	0.5	0.0	0.5
22	0.0	3.0	0.0	1.0	7.6	0.0	27.4	0.0	0.0	18.5	0.0	0.0
23	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	15.7
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	15.5	33.5
25	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	3.0	4.8	1.3	7.1
26	0.0	0.0	0.0	0.0	2.8	0.0	0.0	1.8	0.0	15.0	26.9	49.3
27	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.5	24.9	28.2	0.8	97.3
28	5.6	0.0	0.0	0.0	0.0	0.0	0.5	0.0	2.5	1.3	1.3	28.7
29	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.6	1.5	0.0
30	0.0		0.0	0.0	0.0	0.0	1.3	0.0	0.0	5.8	0.8	47.0
31	0.0		8.9		0.0		0.5	0.0		2.5		0.0

Table A1. continued.

Year 1974

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	3.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	12.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	17.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
5	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.6
6	0.0	0.0	0.0	1.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.5
7	0.5	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.3	8.6	0.0
8	0.0	0.0	0.0	4.1	0.0	0.8	4.1	0.0	0.0	0.8	16.8	7.9
9	0.0	0.0	0.0	24.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
10	0.0	0.0	0.0	34.5	0.0	0.0	0.0	0.0	0.8	0.0	0.0	26.9
11	0.0	0.0	0.8	0.8	24.9	0.0	0.3	5.8	0.0	0.0	0.0	49.5
12	0.0	2.0	0.0	43.7	0.0	0.0	0.0	0.0	0.8	0.0	0.0	2.0
13	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	148.8	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.2	0.0	0.0	0.0
15	0.0	0.0	0.0	2.8	4.3	0.0	0.0	0.8	1.8	0.0	1.3	0.0
16	0.0	0.0	0.0	72.9	0.0	0.0	0.0	0.3	1.8	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	3.3	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	40.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	2.0	0.0	0.0	0.0
22	0.0	0.0	0.0	53.6	0.3	0.0	0.0	0.0	13.5	0.0	8.9	0.5
23	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.8	0.0	14.5	1.5
24	0.0	0.0	0.0	0.0	5.8	0.0	0.0	0.0	0.0	0.0	14.7	2.3
25	0.0	54.3	4.8	4.3	0.0	0.0	0.0	0.0	0.0	0,0	33.0	16.8
26	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	19.3	0.0	1.3
27	0.0	22.1	3.0	0.0	10.7	0.0	0.0	0.0	0.0	0.0	0.5	4.8
28	0.0	19.3	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	50.0
29	0.0		0.0	0.0	0.5	0.0	0.0	0.0	0.0	8.6	0.8	1.0
30	0.0		1.8	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0
31	0.0		12.4		0.0		0.3	0.0		0.0	0.0	0.0

Year 1975

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	11.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6	0.0
2	0.8	0.0	4.1	18.9	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0
3	0.0	4.3	16.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0
4	0.3	19.3	12.7	0.0	0.0	2.5	0.0	0.0	0.0	16.0	0.0	1.5
5	0.0	0.0	32.8	0.0	0.0	11.2	0.0	0.0	0.0	0.0	0.3	3.8
6	0.0	0.0	22.9	43.2	0.0	0.8	0.0	0.0	0.0	0.0	1.0	31.5
7	0.0	0.0	8.4	17.5	0.0	0.0	0.0	0.0	0.0	0.0	3.6	23.4
8	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	31.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	3.8	0.0
10	0.0	0.0	0.0	2.0	0.0	0.0	0.0	1.3	0.0	0.0	2.3	0.0
11	0.0	0.0	7.1	27.9	0.0	0.0	4.3	0.3	0.0	0.0	1.0	0.0
12	0.0	0.0	0.0	10.4	0.0	0.0	0.0	0.0	0.0	0.0	0.3	2.8
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.4	4.3	0.0
14	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.8	17.3
15	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	12.2	0.0	3.0	11.4
16	1.0	0.0	0.0	32.0	0.0	0.0	0.0	0.0	0.0	0.0	19.8	8.9
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	51.8	6.4
18	14.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.3	1.3	15.0	11.7
19	9.1	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	1.0	12.7
20	6.4	0.0	0.3	1.8	0.0	0.0	41.7	31.2	0.8	0.0	24.9	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	26.7	21.6	5.1	0.0
22	0.0	0.3	0.0	3.6	0.0	0.0	25.4	0.0	0.0	4.3	7.6	3.0
23	1.3	1.5	0.0	3.8	0.0	0.0	3.3	0.0	0.0	5.6	10.9	2.8
24	14.2	0.0	0.0	4.6	129.9	0.0	8.4	0.0	0.5	27.7	1.8	0.0
25	12.7	0.0	0.0	0.0	0.0	0.0	0.0	29.9	6.1	10.9	2.3	0.0
26	0.8	0.0	0.0	0.3	0.5	0.0	0.0	0.0	0.0	1.5	4.1	0.0
27	0.0	0.0	0.0	21.6	0.0	0.0	0.0	0.0	0.0	1.8	0.8	0.0
28	0.0	1.0	0.0	72.9	2.0	0.3	0.0	0.0	0.0	1.3	0.0	3.3
29	0.0		0.0	1.0	0.0	0.0	0.0	0.0	0.0	7.9	0.0	1.3
30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0	0.0
31	0.0		0.0		0.0		0.0	1.3		0.8		0.0

Table A1. continued.

Year 1976

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	0.0	39.9	0.0	0.0	0.0	0.0	0.0	1.0	24.6	22.4
2	0.0	0.0	0.0	50.5	0.0	0.0	0.3	0.0	0.0	0.0	43.2	4.1
3	0.0	0.0	0.0	9.4	0.0	0.0	0.0	0.0	0.0	8.6	2.3	1.5
4	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	7.9
5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	1.5	2.8
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	37.1	8.4
7	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0
8	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	117.3	0.0	0.0
9	2.0	0.0	0.0	21.1	0.0	0.0	0.0	0.0	0.0	12.2	0.8	2.8
10	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	41.1	0.0
11	0.0	0.0	0.0	43.7	0.0	0.0	0.0	0.0	0.0	9.4	3.6	0.3
12	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	33.3	16.8
13	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	14.0	0.5	0.0
14	0.0	0.0	0.0	30.5	0.0	0.0	0.0	0.0	0.0	28.2	9.1	0.5
15	0.0	0.0	0.0	8.6	0.0	0.0	2.5	0.0	0.0	42.9	1.3	0.0
16	0.0	0.0	0.0	10.9	0.0	0.0	0.0	0.0	0.0	0.0	2.5	14.0
17	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	8.4	5.3	34.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	16.0	0.3
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	27.9
21	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	7.4	50.5
22	0.0	0.0	0.0	25.4	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.8
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	10.7	0.5
24	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.3	0.0	0.0	6.6	6.9
25	0.0	0.0	0.0	22.1	0.0	0.0	0.0	0.0	0.0	0.0	23.6	15.5
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	2.5	0.0
27	0.0	0.0	0.0	3.8	0.0	0.0	0.0	1.0	0.0	0.0	10.7	0.0
28	2.3	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.1	0.0
29	9.4	0.0	11.7	0.0	0.0	0.0	0.0	0.0	0.0	3.6	1.0	0.0
30	0.5		2.3	0.0	0.0	0.0	0.0	0.0	45.2	0.0	49.3	0.0
31	0.0		45.2		0.0		0.0	0.0		31.8		0.0

Year 1977

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	5.6	0.0	4.8	0.0	0.0	0.0	0.0	17.7	0.0	8.6
2	0.0	0.0	1.3	0.0	27.2	0.0	0.0	0.0	0.0	0.0	0.0	0.3
3	0.0	5.8	0.0	0.0	4.1	0.0	0.0	0.0	0.0	0.1	14.8	1.0
4	0.0	0.0	0.0	0.0	54.4	0.0	0.0	0.0	0.0	4.0	7.4	0.0
5	5.1	0.0	0.8	0.0	0.8	0.0	0.8	0.0	0.0	16.7	1.1	0.0
6	0.0	0.0	9.4	31.2	1.5	0.0	0.0	0.0	0.0	17.6	1.0	0.0
7	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	17.4	0.0
8	2.5	6.1	0.0	0.0	12.4	0.0	0.0	0.0	0.0	3.5	2.4	0.0
9	80.5	0.0	0.0	2.8	0.8	0.0	1.5	0.0	0.0	18.9	0.0	0.0
10	1.8	0.0	0.0	14.7	3.8	0.0	4.5	97.2	0.0	8.4	0.0	1.7
11	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	20.7	0.8
12	0.0	0.0	0.0	1.0	0.0	16.0	19.3	0.0	0.0	31.4	7.4	26.9
13	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	1.2	146.8	0.5
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	49.0	1.9	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.3	1.3	0.0
16	0.0	0.0	0.5	20.3	0.0	0.0	0.0	0.0	0.0	2.1	0.0	6.0
17	0.0	3.8	0.0	10.2	0.0	0.0	0.0	0.0	4.3	59.6	0.0	48.9
18	0.0	1.5	11.7	1.0	0.4	0.0	0.0	0.0	0.0	34.6	0.0	6.5
19	0.0	15.0	1.5	0.8	0.0	0.0	0.0	0.0	1.8	2.8	0.0	1.5
20	0.0	0.0	3.6	9.4	0.0	0.8	0.0	2.0	0.0	53.8	0.0	24.6
21	0.0	0.0	0.0	5.6	0.0	0.0	0.0	0.0	0.0	22.3	0.0	1.1
22	0.0	6.9	0.0	1.8	0.0	0.0	0.0	0.0	0.0	79.3	1.5	2.5
23	0.0	0.0	0.0	5.6	0.0	0.0	0.0	0.0	0.0	42.8	1.5	7.7
24	0.0	0.0	0.0	2.3	0.0	0.0	0.0	3.1	66.3	21.1	10.4	1.0
25	0.0	0.0	5.1	1.8	0.0	0.0	0.0	0.0	5.0	3.0	30.0	0.0
26	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.7	0.0	7.4	0.0
27	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	0.0	0.0	0.0	49.5	1.1	0.0	0.0	0.0	1.5	25.8	0.0	0.0
29	0.0		0.3	30.2	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0		0.0	0.3	2.3	0.0	0.0	0.0	18.5	0.0	0.0	0.0
31	0.0		0.0		0.0		0.0	0.0		0.0		3.6

Table A1. continued.

Year 1978

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	25.2	0.0	2.6	0.0	0.0	0.0	0.0	0.0	20.8	0.0
2	3.6	0.0	0.0	0.0	36.3	0.0	0.0	0.0	0.0	0.0	93.9	0.0
3	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.5	0.5
4	0.0	0.0	0.4	0.0	4.9	0.0	0.0	0.0	0.0	0.0	39.1	3.3
5	0.0	0.0	0.0	0.0	40.3	0.0	0.0	0.0	0.0	0.0	2.9	12.0
6	0.0	0.0	0.0	41.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0
7	0.0	0.0	0.0	0.0	15.7	0.0	0.0	0.0	0.0	0.0	0.0	4.5
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	5.2
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.6	0.0	2.4	8.5
10	0.0	0.0	0.0	0.0	73.3	0.0	0.0	0.5	0.0	0.2	7.2	16.1
11	0.0	0.0	0.0	4.1	1.0	0.0	0.0	0.0	0.2	0.0	5.6	15.0
12	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.9
13	0.0	0.0	0.0	0.0	4.8	0.0	0.1	0.0	0.0	0.0	0.0	1.5
14	0.0	0.0	0.0	0.0	8.1	0.0	14.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	96.3	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	1.9	0.0	3.3
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0
19	0.0	43.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.3	0.0	0.0
20	0.0	0.0	0.0	18.2	0.0	0.0	0.0	0.0	0.0	18.5	4.7	0.0
21	0.0	0.0	0.0	7.3	0.0	0.0	0.0	0.0	0.0	60.9	0.8	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	53.6	26.7	9.4
23	0.0	0.0	0.2	0.6	0.0	0.0	0.0	0.0	0.0	0.1	285.6	110.6
24	16.8	0.0	2.0	0.4	0.0	0.0	0.0	0.0	0.0	5.0	39.0	3.5
25	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	18.8
26	0.4	0.0	15.0	0.0	0.0	0.0	0.0	0.0	1.2	31.7	0.0	3.8
27	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	2.2	1.6	0.0	0.0
28	0.0	0.0	0.0	26.6	0.0	0.0	0.0	0.0	0.0	94.8	3.5	1.7
29	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0
30	0.0		0.6	0.0	1.3	0.0	0.0	0.0	5.9	0.0	0.0	0.0
31	0.0		0.0		0.0		0.0	0.0		9.7		0.3

Year 1979

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	1.1	24.1
2	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	24.8
3	0.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.7	0.0	7.2	0.0
4	0.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	6.1
5	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	5.8	0.0	0.0	27.2
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	1.2
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	3.2
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8	0.6
9	0.0	0.0	8.3	19.0	23.8	0.0	0.0	0.0	1.8	0.0	4.5	11.8
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.9	0.0	12.5	6.0
11	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	24.3	15.4	24.3	0.0
12	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	3.9	40.3	6.5	0.0
13	0.0	0.0	0.0	21.3	0.0	2.2	0.0	0.0	2.3	39.7	1.4	4.6
14	0.0	0.0	0.0	15.9	0.0	0.0	0.0	0.0	79.2	7.0	53.5	0.0
15	0.0	0.0	0.0	7.4	0.0	0.0	0.0	0.0	0.2	0.4	1.6	0.0
16	0.0	0.0	0.0	3.8	0.0	0.0	1.5	0.0	0.0	1.3	36.1	0.0
17	0.0	0.0	0.0	14.0	1.4	0.0	0.3	0.0	0.0	0.0	6.2	0.0
18	0.0	0.0	0.0	30.2	0.0	0.0	0.0	0.0	0.0	0.0	15.9	0.0
19	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.4	1.0	0.6
20	0.0	21.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.3	4.2
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.7	15.3	0.2
22	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.2	28.0	0.0
23	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.2	1.3	0.0
24	5.9	0.0	0.0	0.0	0.0	0.0	15.6	0.0	1.0	0.1	8.6	0.0
25	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	22.7	0.0	1.6
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	15.3	11.6
27	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	10.6	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.6	0.7	0.6
29	0.0		0.0	0.0	0.0	0.0	0.0	0.2	0.0	36.5	2.0	0.8
30	0.0		0.8	0.0	0.0	0.0	0.0	3.6	0.0	38.0	1.3	0.0
31	0.0		0.0		0.0		0.0	0.0		0.0		0.1

Table A1. continued.

Year 1980

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	0.0	0.3	82.5	20.0	0.7	0.0	0.0	1.7	0.0	11.2
2	0.0	0.0	0.0	1.5	0.0	6.2	0.0	0.0	0.0	0.0	25.8	15.5
3	0.0	0.0	0.0	16.1	0.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.6	0.0	5.7	2.1
6	0.0	0.0	0.0	19.2	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
7	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	18.6	2.6
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
9	0.0	0.0	0.0	61.1	23.6	0.0	0.0	0.0	0.0	3.4	29.4	0.0
10	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	10.2	11.8	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.5	12.4	3.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.6	92.7	38.1
13	0.2	0.0	0.7	0.9	0.2	0.0	0.0	0.0	0.0	49.0	67.2	0.0
14	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	1.8	3.7	1.4
15	0.0	0.0	0.0	19.2	2.4	0.0	0.0	0.0	0.0	33.0	18.3	0.0
16	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	11.4	52.0	8.7
17	0.0	0.0	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	1.0	43.7
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6	0.0	0.0	0.0	2.6
20	0.0	0.0	0.0	11.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	1.5	0.0	3.8	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.6	0.0	2.5	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	41.1	9.5	5.1	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.8	28.6	51.4	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	87.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	1.5	0.0
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	1.4	13.2	0.0
28	0.0	0.0	0.0	19.6	0.9	0.0	0.0	0.0	0.0	3.7	0.3	0.0
29	0.0	0.0	29.1	8.2	0.0	0.0	0.0	0.0	0.0	4.3	4.3	0.0
30	0.0		14.1	1.2	0.0	11.2	0.0	0.0	0.3	0.0	0.0	9.7
31	0.0		0.3		1.5		0.0	0.0		0.0		15.8

Year 1981

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	10.1	0.0	0.0	0.0	0.3	0.0	0.0	0.0	21.1	0.0	13.6	26.9
2	16.5	0.0	0.0	5.9	0.0	0.0	0.0	0.0	0.0	0.0	42.7	0.0
3	30.5	0.0	0.0	0.0	0.2	2.1	0.0	0.0	0.0	0.0	0.0	23.4
4	0.0	3.9	0.0	0.0	5.2	1.2	0.0	0.0	0.0	0.0	0.0	0.4
5	0.0	4.3	0.0	35.8	0.0	0.0	5.4	0.0	0.0	0.0	0.0	0.0
6	0.0	0.9	17.8	45.6	0.8	0.0	0.4	0.0	9.6	0.0	0.0	0.0
7	0.0	0.5	0.4	1.8	0.0	0.2	0.0	0.0	0.0	0.0	12.5	0.0
8	0.0	0.0	0.0	0.3	36.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	21.9	24.3	0.0	0.0	0.4	6.3	0.0	0.0	0.0
10	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	14.6	0.2	1.9	0.0	0.0	39.5	0.0	0.0	0.0
12	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.0	6.0	3.5	0.0	0.0
13	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	47.1	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	5.1
15	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.5	0.3	0.0	12.8
16	0.0	0.0	0.0	0.0	0.0	0.3	22.3	0.0	24.0	0.0	2.8	15.0
17	0.0	0.0	0.0	0.0	0.0	0.0	2.2	3.7	4.1	17.2	0.0	18.2
18	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	1.8	33.8	0.0	4.6
19	0.0	0.0	0.0	0.0	0.0	0.0	29.6	0.0	2.6	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	12.9	0.0	0.0	10.8	0.0	0.4
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.2	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
24	0.0	0.0	0.0	33.4	0.0	0.0	0.0	28.2	0.0	13.9	0.0	0.0
25	0.0	0.0	0.0	11.0	0.0	0.0	0.0	13.0	0.0	15.0	0.0	13.6
26	0.0	0.0	9.1	0.0	0.0	0.0	2.2	0.6	0.0	14.9	0.0	1.7
27	0.0	0.0	0.0	7.3	0.0	0.0	14.9	0.0	0.0	16.7	5.1	0.0
28	0.0	0.0	0.0	0.0	1.0	0.0	0.5	0.0	0.0	0.0	61.3	0.0
29	0.0		0.0	0.0	2.9	0.0	0.0	0.0	0.0	3.1	2.5	1.1
30	0.0		7.5	3.0	6.6	0.0	0.0	0.0	0.0	0.0	55.6	0.0
31	0.0		0.8		3.3		0.0	0.7		2.0		0.0

Table A1. continued.

Year 1982												
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.1	20.1
2	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	17.7	2.8	40.4
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	9.4	7.7
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	46.2	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	8.5	4.7	0.6
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	13.0	0.0	0.0	7.6	0.0	0.0	0.0	31.6	0.0	0.0
8	0.0	0.0	0.0	1.1	0.0	1.4	0.0	0.0	0.0	12.3	5.7	0.0
9	0.0	0.0	0.0	0.0	7.0	0.0	0.0	0.0	0.0	14.5	25.0	0.9
10	0.0	0.0	0.0	0.0	55.0	0.0	0.0	0.0	0.0	6.5	2.5	2.8
11	0.0	0.0	0.0	0.8	5.8	0.0	0.0	0.0	0.0	0.0	0.0	21.5
12	0.0	0.0	3.9	10.2	0.0	0.0	0.0	4.7	0.0	0.0	18.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.6	0.0
14	0.0	0.0	0.0	3.0	26.6	0.0	0.0	0.0	0.0	0.0	7.0	0.0
15	0.0	0.0	0.0	8.6	0.5	0.5	0.0	0.0	0.0	0.0	1.1	10.0
16	0.0	0.0	0.0	2.1	26.0	0.0	0.0	0.0	0.0	0.0	0.2	0.7
17	0.0	0.0	0.0	0.0	8.5	0.0	0.0	0.0	6.0	1.8	3.6	16.3
18	0.0	0.0	0.0	0.0	1.5	5.5	0.0	0.0	33.5	0.0	3.4	7.1
19	0.0	0.0	0.0	22.0	0.0	0.0	0.1	0.0	2.5	0.0	26.5	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.7	0.0
21	0.0	0.0	3.5	0.0	18.0	0.0	0.0	0.0	0.0	0.0	11.8	3.4
22	0.0	0.0	0.0	19.0	3.2	0.0	0.0	0.0	0.0	0.0	2.2	5.7
23	0.0	0.0	37.9	0.0	4.2	0.0	0.0	0.0	0.0	42.2	40.8	0.0
24	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	27.0	1.4	0.0
25	0.0	0.0	16.1	5.6	3.0	0.0	0.0	0.0	0.0	12.7	0.0	8.7
26	0.0	0.0	0.5	10.8	0.0	0.0	0.0	0.0	0.0	13.3	3.4	0.0
27	0.0	0.0	21.5	0.0	0.0	0.0	0.0	0.0	0.0	7.7	16.2	0.0
28	0.0	0.0	0.0	28.5	3.6	0.0	0.0	0.0	0.0	1.6	10.6	0.0
29	0.0		0.0	3.1	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0
30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.3	3.6	0.0
31	0.0		0.0		0.0		0.0	0.0		5.1		0.0

Year 1983												
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.1	0.0
2	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.5	0.0	0.0	6.6	0.8
3	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	16.1	15.4
4	0.0	0.0	0.0	0.3	42.8	0.0	0.0	0.0	0.0	0.0	25.2	4.1
5	0.0	0.0	0.0	0.0	44.3	0.0	0.0	0.0	0.0	0.0	3.0	0.0
6	0.0	0.0	0.0	0.0	17.2	0.0	0.0	0.0	0.0	0.0	6.4	2.0
7	0.0	0.0	0.0	0.0	0.0	7.6	0.0	0.0	0.0	0.0	5.5	14.1
8	0.0	0.0	0.0	0.0	10.0	1.4	0.0	0.0	0.0	0.0	2.7	32.3
9	0.0	0.0	0.0	0.0	42.8	0.0	0.0	0.0	0.0	0.0	0.0	3.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	38.3
11	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	21.9	0.0	0.5
12	4.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7	0.0	0.0	0.0	1.6
13	0.0	0.0	0.0	0.0	0.0	6.4	0.0	0.0	0.0	0.0	0.0	33.4
14	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.8	0.0	0.0	0.7
15	0.0	0.0	0.0	0.0	0.0	12.1	0.0	0.0	0.0	0.0	0.0	7.1
16	0.0	0.0	0.0	0.0	24.5	0.0	0.0	0.0	14.7	0.0	1.0	5.6
17	0.0	0.0	0.0	50.6	32.8	0.0	0.0	0.0	0.0	7.6	0.6	76.7
18	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	8.1	1.9	5.5
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	11.8	18.9
20	0.0	0.0	0.0	0.0	0.0	0.0	7.5	0.0	0.0	6.8	0.0	57.5
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	20.2
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	2.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	77.8
24	1.2	0.0	0.0	2.4	0.5	0.5	0.0	0.0	0.0	2.4	0.0	23.9
25	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	15.6
26	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0 0	0.3
27	0.0	0.0	0.0	5.5	0.0	0.0	19.5	0.0	0.0	0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	0.0	31.0
29	0.0		0.0	12.5	0.0	0.0	0.0	0.0	0.0	25.8	5.5	0.0
30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1	0.6	2.0
31	0.0		0.0		0.0	0.0	0.0		41.0		5.0	

Table A1. continued.

Year 1984

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.0	0.0	46.2	0.0	0.0	0.0	1.6	0.0	0.0	1.4	0.0	0.0
2	4.9	0.0	24.5	24.6	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0
3	0.5	13.3	7.4	3.2	0.0	0.0	0.0	0.0	0.0	4.0	9.3	0.0
4	7.1	50.5	0.0	53.4	0.0	0.0	0.0	0.0	0.0	1.5	0.5	0.0
5	2.7	1.8	175.2	7.0	0.0	0.0	0.0	0.0	0.0	0.4	1.3	0.0
6	9.0	8.0	27.4	0.0	1.5	0.0	0.0	0.0	0.0	0.0	1.2	1.9
7	0.0	39.8	5.0	15.2	0.0	0.0	0.0	0.0	0.0	0.3	3.5	0.3
8	0.0	0.5	43.1	1.0	0.0	0.0	5.7	0.0	0.0	0.0	0.3	0.0
9	0.0	35.8	0.0	0.7	0.0	0.0	24.9	0.0	0.0	0.0	0.0	94.9
10	53.2	12.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.9	2.5
11	44.0	41.8	0.0	10.0	0.0	0.0	15.9	0.0	0.0	0.0	1.5	0.0
12	17.2	0.6	0.0	4.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
13	13.3	0.0	0.0	3.4	0.0	0.0	11.6	0.0	0.0	0.0	0.0	0.0
14	25.4	113.1	0.0	7.7	0.0	0.0	2.7	0.0	0.0	0.0	81.1	0.0
15	0.0	26.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	5.5	0.0
17	0.0	4.2	0.0	4.5	7.0	0.0	0.0	0.0	0.0	0.0	31.0	0.0
18	4.8	0.0	0.0	7.0	21.2	0.0	0.0	0.0	0.0	0.0	12.2	0.0
19	0.0	0.0	0.0	0.8	2.5	0.0	0.0	0.0	0.0	0.0	9.2	0.0
20	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.5	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	56.5	0.0	0.0	0.0
22	0.0	3.0	0.0	6.0	0.0	0.0	0.0	0.0	15.0	0.0	1.8	2.4
23	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	48.8	0.0	9.0	18.2
24	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0	88.8	0.0	6.5	2.3
25	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	23.2	0.5
26	0.0	0.0	11.5	0.0	0.0	0.0	0.0	0.0	1.7	0.0	10.1	2.8
27	1.5	6.0	0.0	0.0	0.0	0.0	0.0	0.0	18.9	77.0	19.0	5.0
28	0.0	93.5	2.5	0.0	0.0	0.0	0.0	0.0	37.3	13.0	19.6	0.5
29	1.0	22.5	8.5	12.5	0.0	0.0	0.0	0.0	7.8	0.0	0.0	21.5
30	0.0		29.8	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	3.9
31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Year 1985

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	9.5	9.0	0.0	1.5	0.0	0.0	0.5	0.0	0.0	1.0	4.5	0.0
2	0.0	10.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	53.5	0.0
3	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	0.0
4	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	66.9	0.0
5	0.9	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	18.5	1.9
7	0.0	43.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	21.0	0.3
8	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	15.0	0.0
9	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	18.3	94.9
10	0.0	0.0	8.7	0.0	10.4	0.0	0.0	0.0	2.6	0.0	12.1	2.5
11	0.0	0.0	11.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.2	0.0
12	0.0	0.0	0.0	0.0	4.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0
14	0.4	0.0	0.0	0.0	6.0	2.5	0.0	0.0	0.0	0.0		0.0
15	15.5	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0		0.0
16	5.5	0.0	0.0	0.0	18.4	0.0	0.0	0.0	0.0	0.0		0.0
17	0.0	0.0	8.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0		0.0
18	1.0	0.7	0.0	0.0	16.3	0.0	12.6	0.0	0.0	0.5		0.0
19	0.0	0.0	0.4	0.0	0.0	0.0	13.0	0.0	0.0	4.5		0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	61.5	8.4	0.0	6.5		0.0
21	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	5.2		0.0
22	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	5.5	0.0		2.4
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.3	0.0		18.2
24	0.0	0.0	0.0	0.0	0.0	3.0	0.0	1.5	17.0	0.0		2.3
25	0.4	0.0	0.0	0.0	0.0	13.3	0.0	0.0	8.0	68.5		0.5
26	0.0	2.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	20.0		2.8
27	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5		5.0
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.4		0.5
29	5.6		0.0	12.5	0.0	1.5	0.0	0.0	0.5	38.2		21.5
30	2.7		0.0	0.0	0.0	4.4	0.0	0.0	1.6	11.6		3.9
31	7.7		0.0		0.0		0.0	0.0		5.8		0.0

Table A2. Daily pan evaporation data for Maha Illuppallama

Year 1953

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	3.6							6.9	5.3	3.5	3.6
2	2.1	5.8							3.6	5.0	1.5	3.2
3	4.2	3.0							8.6	3.5	3.6	2.2
4	0.5	4.1							7.4	4.3	0.0	2.7
5	2.7	2.4							4.1	6.1	2.2	4.4
6	5.5	6.0							5.6	4.8	5.0	3.0
7	4.4	6.9							3.8	4.9	3.9	2.8
8	4.0	3.0							4.6	4.8	3.4	3.1
9	5.0	4.1							8.8	1.9	4.5	1.2
10	3.4	3.1							7.1	5.9	2.9	3.7
11	4.1	7.9							8.5	4.2	3.6	2.6
12	3.6	5.1							8.3	4.3	3.1	2.7
13	2.5	4.6							6.4	8.8	1.9	5.6
14	2.2	3.6							3.9	6.2	1.7	3.9
15	2.0	5.4							7.2	9.9	1.4	6.4
16	4.3	4.1							6.2	3.1	3.8	1.9
17	2.1	8.0							5.9	2.4	1.5	1.5
18	5.0	2.4							9.0	2.7	4.5	1.7
19	3.9	3.8							7.3	3.0	3.4	1.9
20	1.8	5.5							4.1	0.6	1.2	0.3
21	3.5	5.6							6.9	6.9	2.9	4.4
22	5.7	3.0							8.5	5.4	5.1	3.2
23	0.2	8.3							5.7	2.8	0.0	1.7
24	4.6	2.8							8.6	3.4	4.0	2.2
25	2.6	5.8							5.4	0.0	2.0	0.0
26	5.7	4.8							10.0	4.8	5.2	3.1
27	2.1	5.0							6.8	4.9	1.6	3.1
28	2.9	5.8							6.1	8.5	2.3	5.4
29	4.1								5.6	7.0	3.6	4.5
30	3.0								6.2	2.5	2.4	1.5
31	3.9									1.5		0.9

Year 1954

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.1	4.9							5.3	1.0	3.3	1.6
2	5.3	1.8							3.7	7.4	0.5	2.5
3	4.3	6.5							8.4	5.9	4.8	1.1
4	1.5	5.4							6.9	1.6	3.8	4.3
5	2.8	2.3							6.7	3.6	1.0	5.1
6	1.2	3.8							5.5	1.2	2.3	1.6
7	1.9	2.0							6.2	2.2	0.7	2.7
8	5.5	2.7							7.6	7.7	1.4	1.7
9	4.1	6.7							6.6	5.5	5.0	6.0
10	5.3	5.1							6.3	7.4	3.5	3.4
11	5.1	5.8							6.6	7.1	4.8	3.0
12	3.5	6.3							4.3	4.6	4.6	2.1
13	1.4	4.5							7.4	1.4	2.9	3.7
14	4.2	2.1							6.1	5.6	0.8	2.6
15	3.3	5.2							6.1	4.6	3.6	6.0
16	3.0	4.3							9.7	3.9	2.8	1.1
17	5.7	3.9							7.7	8.0	2.5	2.3
18	4.2	6.9							10.5	5.7	5.2	3.8
19	1.5	5.3							5.2	1.6	3.7	3.9
20	3.9	2.3							4.7	5.3	0.9	1.6
21	5.2	4.9							4.9	7.3	3.4	6.3
22	2.9	6.4							5.1	3.7	4.7	1.5
23	5.3	3.8							3.3	7.4	2.4	4.1
24	2.6	6.5							8.2	3.2	4.8	3.2
25	6.6	3.5							7.1	9.3	2.0	3.4
26	3.8	7.9							5.0	5.1	6.1	4.1
27	3.2	4.8							5.5	4.1	3.2	2.8
28	3.0	4.1							2.7	3.6	2.6	1.7
29	3.3								6.6	3.4	2.3	2.0
30	2.7								6.7	6.4	2.7	0.7
31	4.7									4.4		4.6

Table A2. continued.

Year 1955

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2.2	5.1							5.5	2.6	2.1	0.6
2	3.1	2.9							7.8	4.1	4.1	4.7
3	1.6	5.2							4.9	1.8	1.6	3.7
4	4.9	1.2							6.0	6.7	2.6	1.0
5	5.7	3.6							4.2	8.0	1.0	2.3
6	2.2	6.7							8.0	2.6	4.3	0.7
7	3.1	5.5							9.0	4.1	5.2	1.4
8	2.3	5.0							4.9	2.7	1.6	4.9
9	6.6	6.2							6.0	9.4	2.6	3.5
10	4.0	4.4							5.0	5.4	1.7	4.7
11	3.6	5.2							10.0	4.7	6.1	4.5
12	2.7	4.6							7.1	3.4	3.5	2.9
13	4.3	3.3							6.5	5.9	3.0	0.9
14	3.2	3.1							5.4	4.2	2.1	3.6
15	6.7	2.8							7.4	9.4	3.8	2.7
16	1.7	5.4							6.1	1.8	2.6	2.4
17	2.9	2.9							10.1	3.7	6.2	5.1
18	4.4	6.1							4.3	6.0	1.1	3.6
19	4.5	5.0							5.7	6.1	2.3	1.0
20	2.2	2.5							8.4	2.6	3.8	3.3
21	6.9	4.5							7.6	9.8	3.9	4.6
22	2.0	6.9							4.9	2.4	1.6	2.3
23	4.7	0.8							10.5	6.5	6.4	4.7
24	3.8	5.7							4.7	5.0	1.4	2.0
25	4.7	3.4							7.9	5.3	4.2	6.0
26	3.4	6.9							6.7	6.5	3.2	3.2
27	2.3	3.0							7.0	4.4	3.4	2.6
28	2.6	3.8							7.8	2.8	4.2	2.3
29	1.2	5.1							6.3	3.2	2.8	2.7
30	5.2								5.0	1.1	1.7	2.1
31	4.0									7.2		4.1

Year 1956

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3.9	3.6							7.1	5.5	2.0	3.5
2	3.8	5.8							4.8	2.5	0.6	1.6
3	2.8	3.0							7.2	5.6	4.7	3.6
4	3.3	4.1							2.9	0.1	3.4	0.0
5	4.5	2.4							5.5	3.4	3.2	2.2
6	3.6	6.0							8.8	7.7	2.2	4.9
7	3.4	6.9							7.5	6.0	2.7	3.8
8	3.6	3.0							7.0	5.3	4.0	3.4
9	1.7	4.1							8.2	6.9	3.1	4.4
10	4.3	3.1							6.3	4.5	2.8	2.9
11	3.2	7.9							7.2	5.6	3.1	3.6
12	3.3	5.1							6.6	4.8	1.1	3.1
13	6.3	4.6							5.2	3.0	3.8	1.9
14	4.5	3.6							4.9	2.7	2.6	1.7
15	7.0	5.4							4.6	2.3	2.7	1.4
16	2.5	4.1							7.4	5.9	5.7	3.7
17	2.0	8.0							4.8	2.5	4.0	1.6
18	2.2	2.4							8.2	6.9	6.5	4.4
19	2.4	8.8							6.9	5.3	4.2	3.3
20	0.9	5.5							4.4	2.0	1.5	1.2
21	5.0	5.6							6.4	4.6	1.6	2.9
22	4.0	3.0							9.0	7.9	1.8	5.1
23	2.3	8.3							2.5	0.0	0.3	0.0
24	1.1	2.8							7.7	5.5	4.5	4.0
25	0.3	5.8							5.3	3.2	3.5	2.0
26	3.6	4.8							9.0	8.0	1.7	5.1
27	3.7	5.0							4.8	2.6	2.2	1.6
28	6.1	5.8							5.7	3.7	0.0	2.3
29	5.1	4.3							7.1	5.5	3.1	3.5
30	2.1								5.8	3.9	3.1	2.4
31	1.5									5.2		3.3

Table A2. continued.

Year 1957

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3.0	1.8	4.8	7.6	4.6	3.0	6.4	5.8	8.9	7.1	3.8	3.3
2	3.8	3.6	3.8	5.1	8.4	2.8	5.6	4.3	9.6	8.6	2.5	1.8
3	5.6	4.3	6.4	7.6	6.9	3.0	3.8	5.6	7.6	6.4	2.8	2.3
4	2.3	5.3	4.6	2.5	5.1	4.1	6.1		10.4	6.4	2.6	0.3
5	5.3	5.1	5.3	8.1	4.6	5.6	10.4		8.4	7.4	2.3	1.8
6	4.3	8.1		9.6	4.6	4.6	8.6	7.6	8.4	7.4	1.5	0.3
7	4.1	5.1	3.8	7.6	4.6	4.3	7.4	9.1	7.6	8.1	1.3	2.0
8	4.1	4.8	7.9	8.1	7.1	3.8	9.6	8.1	7.9	7.1	3.6	3.8
9	2.5	1.8	7.1	5.6	4.6	2.5	6.4	7.1	9.1	9.9	3.8	0.5
10	1.3		7.9	9.9	6.1	7.4	8.4	7.9	5.1	8.4	3.0	4.8
11	1.8		7.6	5.8	6.6	5.3	7.1	8.9	9.1	6.4	1.8	1.0
12	4.3	2.5	9.1	6.1	3.6	6.4	5.6	9.6	8.6	6.1	2.0	0.3
13	4.3	2.3	3.6	4.1	5.6	5.1	6.6	9.6	8.1	8.9	2.5	2.3
14	5.3		5.8	7.9	3.6	5.6	5.6	7.1	8.1	4.8	2.8	3.3
15	3.8	0.5	3.3	4.3	5.6	5.1	8.1	8.6	8.6	9.1	4.3	2.8
16	1.0		9.6	3.8	0.3	5.6	6.6	7.6	8.9	4.6	1.0	1.3
17	0.5	0.2	7.9	3.8	2.3	4.3		9.1	9.6	3.3	3.0	0.3
18	1.0	2.0	9.4	6.9	3.8	7.1			9.4	2.0	2.3	2.3
19	3.6	5.6	6.6	3.0	5.8	7.9		9.9	9.6	3.0	1.5	2.2
20	4.3	4.8	6.9	3.6	4.8	5.8	8.6	8.1	9.1	2.5	2.8	0.3
21	4.3	6.6	7.4	5.3	5.8	6.9	7.1	8.4	7.6	4.6	2.3	3.5
22	4.6	4.8	7.4	3.8	5.1	5.6	7.1	8.1	9.6	2.5	0.3	0.5
23	5.3	5.1	8.4	13.0	3.6	7.1	6.6	8.4	9.9	5.1	1.3	1.3
24	4.6	6.6	8.4	1.8	3.3	6.1	4.3	8.1	8.8	3.0	2.3	2.0
25	7.6	6.1	6.9	7.9	3.3	5.6	3.6	10.2	7.6	2.0	1.3	2.4
26	5.6	6.4	7.9	5.8	4.3	6.4	10.4	9.1	8.1	2.3	0.8	2.1
27	4.3	6.6	7.1	6.4	5.3	6.9	6.6	8.4	9.9	2.3	1.5	1.5
28	5.1	6.4	8.1	5.6	1.8	6.4	9.6	9.9	7.9	2.5	4.1	1.0
29	0.8		7.1	6.9	7.6	7.9	4.1	8.1	7.1	2.8	1.8	1.3
30	0.8		10.7	5.3	3.3	7.6	5.6		5.8	2.8	1.5	3.8
31	2.8		6.6		3.6		7.6	5.8		3.3		2.0

Year 1958

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3.6	0.5	6.4	6.1					7.1	5.5	1.8	4.2
2	5.8	1.3	5.3	5.3					4.8	2.5	1.7	4.1
3	1.0	3.8	7.6	5.6					7.2	5.6	1.8	2.1
4	3.0	3.3	8.1	1.0					2.9	0.1	3.3	3.7
5	1.8	5.3	6.4	5.6					5.5	3.4	3.6	2.3
6	2.0	2.5	6.4	4.3					8.8	7.7	3.6	3.8
7	2.5	3.8	6.6	6.1					7.5	6.0	3.1	4.5
8	2.3	2.8	6.4	5.3					7.0	5.3	3.6	4.2
9	2.5	5.8	1.5	2.0					8.2	6.9	2.7	4.2
10	3.6	5.1	3.8	6.6					6.3	4.5	3.6	3.8
11	3.6	3.3	1.0	5.1					7.2	5.6	2.2	3.1
12	2.8	5.1	2.0	6.4					6.6	4.8	2.4	3.6
13	2.3	5.6	8.8	4.3					5.2	3.0	1.6	4.7
14	2.0	5.3	2.8	6.6					4.9	2.7	2.3	5.1
15	3.8	5.1	4.3	6.9					4.6	2.3	2.3	3.7
16	5.1	4.3	5.3	5.8					7.4	5.9	2.6	2.7
17	3.8	3.6	6.6	5.8					4.8	2.5	1.9	3.2
18	5.1	4.6	7.4	5.8					8.2	6.9	1.7	4.2
19	4.1		5.6	6.6					6.9	5.3	1.5	4.3
20	4.3		5.8	4.8					4.4	2.0	2.0	4.7
21	3.8		6.4	2.5					6.4	4.6	4.7	4.6
22	3.8	5.3	6.9	2.3					9.0	7.9	4.0	4.3
23	5.1	6.9	2.5	4.8					2.5	0.0	5.2	1.1
24	3.0	6.4	3.0	5.3					7.7	5.5	2.2	1.9
25	2.3	6.9	6.1	6.4					5.3	3.2	2.2	1.1
26	5.1	4.1	5.6	6.1					9.0	8.0	3.1	1.6
27	3.7	7.4	6.1	5.8					4.8	2.6	3.6	2.8
28	3.0	4.1	6.4	5.3					5.7	3.7	3.2	3.8
29	3.1		5.3	2.0					7.1	5.5	2.9	4.2
30	3.3		6.9	4.6					5.8	3.9	3.9	3.6
31	1.0		7.6							5.2		3.5

Table A2. continued.

Year 1959 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3.7	4.0	6.8	4.4	3.2	5.6	6.8	7.6	8.1	5.8	4.6	2.0
2	3.6	3.1	6.6	5.6	3.4	4.7	5.8	7.9	7.6	5.8	3.0	1.4
3	4.8	3.9	6.9	5.1	3.9	5.8	4.5	7.7	8.2	4.7	3.7	2.2
4	4.1	4.0	6.4	4.4	7.2	6.4	6.4	8.1	7.8	3.4	1.3	3.1
5	4.6	4.6	6.7	4.2	4.0	6.6	5.6	7.8	7.6	5.5	1.3	3.5
6	4.2	4.5	6.0	4.6	4.9	6.7	5.6	7.7	7.9	6.6	2.9	3.3
7	3.9	5.0	7.2	3.7	5.2	6.2	6.8	8.0	7.9	8.0	3.3	3.2
8	3.8	4.9	6.9	3.9	4.6	5.6	6.6	7.3	7.6	7.3	3.2	4.0
9	1.8	4.9	7.3	3.7	3.9	3.6	7.0	8.1	7.8	7.6	2.0	2.8
10	3.5	4.6	7.2	4.4	4.6	5.6	7.1	7.7	8.0	7.7	2.0	2.5
11	3.9	4.6	6.6	4.6	4.5	5.4	7.3	7.6	7.7	7.8	2.2	2.6
12	4.0	4.2	6.5	5.8	1.4	6.3	6.8	7.5	7.3	7.7	2.4	1.1
13	2.9	4.6	6.8	3.4	3.1	6.7	6.3	6.9	7.6	7.6	3.9	1.7
14	1.3	5.1	6.3	5.4	2.8	5.8	6.9	7.6	7.9	7.3	3.0	1.8
15	1.7	5.6	6.0	1.2	2.1	2.2	7.3	7.5	7.1	7.7	2.2	3.5
16	1.4	4.7	6.5	2.9	3.4	4.2	7.5	8.0	4.3	6.1	1.8	2.4
17	2.6	5.7	6.7	3.3	4.8	3.5	7.0	8.0	5.2	5.1	2.9	2.4
18	4.1	5.6	6.9	3.1	5.0	4.6	6.7	8.1	5.6	5.7	2.2	2.5
19	3.9	2.4	6.7	3.5	3.3	3.6	6.0	8.2	5.4	5.2	3.7	1.9
20	3.6	3.5	5.2	5.3	4.3	2.5	7.2	8.1	5.8	2.6	1.4	1.6
21	3.6	3.6	6.6	5.8	4.9	3.8	5.9	7.7	4.7	2.6	1.3	2.6
22	3.8	4.6	5.8	6.0	4.9	4.4	7.0	8.2	6.8	2.3	1.8	4.5
23	3.4	5.4	6.1	7.0	5.3	6.1	6.6	8.1	4.2	3.1	0.9	3.9
24	4.2	6.6	5.6	5.4	5.0	6.3	7.5	8.1	3.3	3.1	2.0	3.6
25	4.1	6.7	6.5	5.2	5.9	5.1	8.0	7.9	6.0	1.4	2.2	2.0
26	4.0	6.6	6.5	5.7	5.4	4.6	5.6	7.9	6.1	2.0	1.6	3.8
27	4.1	6.5	7.0	5.5	5.4	6.1	7.9	7.7	6.9	2.2	2.1	2.9
28	4.2	6.8	6.5	6.1	5.9	6.2	7.7	8.1	7.6	2.1	1.3	1.4
29	3.6		6.7	5.2	4.7	6.3	7.8	8.1	7.7	4.4	3.0	3.1
30	4.3		6.5	5.4	5.7	5.6	8.2	7.8	7.6	3.6	2.3	2.9
31	4.1		5.7		4.9		6.9	8.0		3.4		3.7

Year 1960 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2.1	3.1	3.1	3.5			6.3		7.5	7.6	1.8	3.2
2	1.7	4.5	3.9	2.9			6.7		7.4	7.9	1.5	2.8
3	1.7	4.4	4.3	3.2			6.5		6.5	8.1	3.3	2.6
4	3.7	4.4	4.1	3.6			6.8		7.6	7.6	3.7	2.6
5	3.6	4.8	3.8	4.2			5.9		7.2	8.1	2.6	2.0
6	4.4	4.9	3.7	4.9			6.5		7.9	8.1	2.1	4.8
7	3.1	4.2	4.3	2.6					8.0	7.9	1.1	2.1
8	3.5	3.7	4.3	3.3			6.9		7.7	8.1	0.0	2.4
9	3.7	3.4	3.7	2.8			6.8		7.6	7.9	1.0	2.3
10	4.0	3.2	3.3	3.2			6.8		7.9	7.8	1.5	3.5
11	3.9	3.7	4.2	4.0			5.8		7.2	7.8	2.9	2.2
12	3.4	4.1	4.4	4.5			7.1		4.8	7.4	2.2	2.4
13	2.3	4.0	4.7	2.5			6.5		4.1	5.6	2.8	3.1
14	1.4	3.5	4.8	2.7			7.2		7.3	5.4	1.9	3.6
15	3.8	3.8	4.9	3.2			7.7		7.3	5.9	1.6	3.0
16	3.8	3.9	5.1	3.6			7.8		7.6	5.5	0.6	3.9
17	3.5	3.6	4.6	3.8			7.6		6.3	5.8	2.1	5.4
18	3.8	4.9	5.4	3.0			7.1		7.6	4.5	3.0	3.6
19	3.3	1.8	4.9	2.5			7.3		8.3	4.4	3.6	4.2
20	2.2	2.2	4.6	3.1			7.3		8.3	3.3	2.9	3.0
21	2.5	1.0	4.8	4.8			6.8		7.7	3.1	3.4	3.2
22	1.6	1.1	5.2	3.4			5.4		8.2	3.1	2.6	2.9
23	2.7	1.1	4.9	3.1			7.2		7.9	3.2	1.3	2.8
24	1.7	0.6	5.0	1.7			7.7		7.6	2.5	1.7	4.3
25	3.1	2.5	4.7	4.6			7.9		6.9	2.3	2.1	3.6
26	4.7	1.7	5.3	4.9			7.6		7.2	2.4	2.3	4.2
27	4.9	3.3	5.4	3.7			7.3		6.9	2.7	3.4	1.6
28	4.7	3.2	5.9	4.4			7.1		7.1	1.7	3.9	1.5
29	4.4	3.0	5.5	3.6			7.7		5.6	2.8	2.2	3.4
30	2.5		2.1	4.2			6.5		7.2	4.6	1.2	3.4
31	2.1		1.4				6.7			4.1		2.9

Table A2. continued.

Year 1961

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.1	4.9		5.1	2.6	5.5	4.6	6.4	7.2	7.1	3.3	3.6
2	5.3	1.8		4.3	4.2	5.2	6.7	6.6	7.9	7.8	2.6	2.2
3	4.3	6.5		2.1	4.4	5.3	5.1	7.1	7.6	7.5	3.9	2.4
4	1.5	5.4		2.1	4.2	5.1	6.3	7.3	7.2	7.1	5.8	2.3
5	2.8	2.3		2.3	3.2	5.3	4.8	6.8	6.7	7.6	4.9	3.5
6	1.2	3.8		3.3	5.8	5.1	6.4	6.1	7.5	7.3	5.1	1.3
7	1.9	2.0		5.1	5.2	3.3	6.6	6.5	7.7	7.7	4.2	1.4
8	5.5	2.7		4.9	5.8	5.6	6.4	7.3	7.8	8.1	3.7	2.3
9	4.1	6.7		4.5	6.1	5.3	6.3	6.5	6.9	7.5	4.4	2.6
10	5.3	5.1		4.8	6.4	5.6	6.3	5.4	4.9	7.5	2.2	2.6
11	5.1	5.8		4.2	6.1	5.6	5.6	6.1	6.5	7.7	3.3	2.5
12	3.5	6.3		5.2	5.7	6.0	5.5	5.6	7.3	7.9	2.6	1.8
13	1.4	4.5		4.7	6.4	6.9	5.3	6.3	6.9	6.6	3.2	1.6
14	4.2	2.1		4.9	3.1	6.0	6.3	6.7	7.6	5.7	2.0	2.0
15	3.3	5.2		6.3	2.3	6.6	6.5	4.3	7.9	5.0	1.8	1.4
16	3.0	4.3		6.0	2.9	6.3	6.3	6.3	7.9	6.5	1.7	5.5
17	5.7	3.9		4.9	5.0	6.9	6.0	6.3	7.4	7.6	2.0	3.9
18	4.2	6.9		6.0	5.8	6.7	5.8	7.2	7.3	3.5	3.1	4.1
19	1.5	5.3		6.3	5.7	6.2	6.7	6.5	7.3	4.1	2.2	4.8
20	3.4	2.3		6.6	5.5	7.1	5.6	6.7	5.2	5.2	3.1	4.3
21	5.2	4.9		5.5	6.0	7.1	4.9	7.2	6.6	3.6	2.9	4.8
22	2.9	6.4		7.0	3.7	6.0	5.3	6.7	6.1	3.7	2.3	3.4
23	5.3	3.8		5.5	3.5	7.6	5.6	6.6	7.0	3.1	1.4	4.4
24	2.6	6.5		5.8	6.5	7.3	5.9	7.0	7.3	2.1	1.3	4.2
25	6.6	3.5		4.6	6.0	7.4	6.8	6.7	4.6	2.9	1.5	4.5
26	3.8	7.9		4.1	6.9	5.3	6.2	7.6	3.9	3.4	3.0	3.7
27	3.2	4.8		2.9	6.3	2.7	7.0	7.0	5.7	2.5	3.8	3.8
28	3.0	4.1		3.4	5.2	2.0	5.9	7.1	6.7	3.6	4.7	2.5
29	3.3			4.9	4.2	4.6	6.5	7.6	7.5	3.5	1.6	1.1
30	2.7			3.1	7.0	6.1	6.5	7.6	7.6	3.3	1.3	2.2
31	4.7				5.8		6.3	7.3		2.8		1.1

Year 1962

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2.8	1.9	6.3	5.8	4.7	6.3	7.6	7.4	3.8	7.2	4.1	2.3
2	3.9	2.6	6.5	2.1	4.7	5.2	7.1	7.4	4.7	6.0	3.6	2.1
3	4.2	3.3	5.5	2.8	4.6	6.1	7.8	7.3	4.6	6.7	2.3	3.2
4	4.1	3.4	5.3	2.7	3.4	5.1	6.5	7.4	4.9	7.2	1.8	3.9
5	2.5	4.3	4.9	3.8	3.9	5.6	6.9	6.8	6.2	4.4	4.1	4.4
6	1.1	3.6	5.3	4.0	3.4	5.3	6.0	7.0	6.7	3.1	3.6	3.6
7	1.1	4.0	5.2	4.2	2.8	6.0	3.6	7.3	7.6	2.7	1.7	3.7
8	1.4	4.2	4.7	4.1	2.9	6.2	6.4	7.4	7.1	2.2	1.3	4.6
9	3.6	4.6	5.7	4.2	3.3	6.3	6.5	7.6	6.8	2.7	2.0	4.2
10	5.9	4.2	5.3	4.9	3.1	6.4	7.3	7.7	6.6	3.3	1.5	3.9
11	3.5	4.2	5.9	4.4	3.7	6.6	7.1	7.7	6.5	3.0	3.5	4.2
12	1.9	2.4	5.6		2.8	6.9	7.3	7.7	4.3	4.5	3.8	4.3
13	1.3	3.5	6.3		2.7	7.2	7.7	7.6	5.9	2.8	3.6	3.5
14	2.4	5.0	6.4		2.4	7.0	7.0	7.9	6.1	3.1	4.0	3.6
15	3.7	3.6	6.8		4.9	6.7	7.0	8.2	5.6	6.0	4.1	4.4
16	4.0	4.6	6.6		3.3	6.4	7.1	7.9	6.4	3.5	4.0	4.8
17	3.6	2.9	5.8		3.4	6.1	8.0	7.7	6.9	3.3	4.4	2.5
18	3.6	3.5	6.1		4.2	6.9	7.0	7.9	6.4	2.6	3.8	1.0
19	2.9	3.7	4.3	3.7	4.3	7.2	7.4	7.7	7.1	1.9	4.2	2.6
20	2.9	4.6	4.3	4.5	1.8	7.4	6.3	7.8	7.3	1.4	1.7	3.6
21	2.2	4.6	3.8	4.2	4.6	7.2	7.5	7.3	6.9	2.0	1.5	3.4
22	1.2	4.2	3.9	4.2	5.1	6.9	6.9	7.8	7.2	1.1	3.3	1.4
23	1.1	4.1	4.5	2.7	5.2	7.5	7.4	7.6	7.1	4.3	3.6	1.9
24	1.0	3.8	4.9	2.9	6.8	7.2	7.3	8.0	6.5	3.3	2.9	2.1
25	1.2	4.2	5.2	1.9	6.2	6.7	7.2	7.9	4.4	4.1	3.1	2.4
26	2.0	4.2	5.2	3.6	6.5	7.7	7.4	7.6	5.8	4.8	3.6	1.6
27	3.5		4.6	2.9	4.7	7.4	7.5	7.0	6.5	3.8	1.3	1.8
28	2.8		2.2	4.4	6.3	6.2	7.4	5.0	5.6	3.2	3.5	1.8
29	4.0		3.2	4.1	5.0	6.1	7.6	4.3	5.3	5.2	2.1	3.4
30	4.2		5.2	4.2	6.3	6.6	5.5	2.9	7.0	4.6	2.1	3.6
31	4.3		4.0		6.4		7.7	4.2		5.0		3.4

Table A2. continued.

Year 1963												
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3.5	4.4	2.6	4.2	4.1	6.5	7.1	7.0	4.7	5.4	4.4	1.5
2	2.1	4.1	2.0	4.6	3.2	7.1	7.1	7.1	7.5	6.9	1.3	1.5
3	1.4	1.8	2.0	4.6	4.0	7.4	6.9	4.9	7.5	7.4	1.4	1.2
4	1.2	2.0	3.2	4.1	3.6	6.7	6.2	6.6	7.4	7.8	2.1	1.4
5		1.2	3.8	4.2	3.7	6.1	6.2	6.8	7.7	7.6	2.6	1.0
6		2.8	4.2	4.0	4.0	5.5	6.1	6.9	7.8	6.8	2.0	1.5
7	1.3	3.4	3.5	3.1	4.5	5.1	6.6	7.0	7.3	7.0	3.7	2.7
8	1.9	5.3	3.8	4.4	4.7	5.2	5.6	7.1	8.0	5.3	4.9	2.8
9	2.6	4.0	3.6	4.8	4.8	6.1	6.8	6.7	8.1	7.0	4.1	2.9
10	2.4	4.0	4.6	4.4	3.5	6.0	6.9	7.0	7.8	7.0	4.0	2.5
11	3.2	4.9	4.2	3.4	4.0	6.4	6.3	7.4	6.5	7.3	1.1	2.4
12	1.5	3.6	4.2	3.5	3.8	6.5	5.6	6.8	7.6	6.8	2.5	3.4
13	4.2	3.5	4.0	3.5	2.5	5.8	6.4	6.5	8.2	5.4	2.8	3.7
14	4.2	4.2	3.9	3.2	3.1	6.5	6.9	6.6	7.9	2.6	1.4	3.2
15	3.8	4.2	3.6	3.7	3.2	7.2	6.9	7.1	7.1	2.0	1.7	3.5
16	3.5	5.8	4.7	4.0	3.3	7.3	6.8	6.9	7.6	2.9	1.7	3.5
17	3.0	4.4	5.1	3.3	3.4	7.4	6.7	7.2	7.1	3.1	2.5	3.4
18	3.4	4.2	4.3	3.6	3.2	7.3	7.1	7.5	7.6	2.5	2.7	3.3
19	2.8	3.8	3.5	3.9	4.3	7.2	7.6	7.7	6.4	2.7	2.6	4.4
20	3.0	2.2	4.9	3.4	4.9	6.4	7.6	7.7	6.6	1.5	2.1	3.6
21	4.7	2.9	5.2	2.9	4.2	7.1	7.0	7.4	5.0	3.3	2.4	1.8
22	4.1	2.2	5.5	3.1	5.0	7.2	6.4	7.4	6.3	0.8	3.1	1.3
23	4.6	3.6	1.7	2.8	4.6	4.8	6.1	7.4	6.8	1.0	1.5	2.3
24	3.5	3.7	3.6	3.4	5.0	6.0	6.7	7.3	6.8	3.8	2.6	1.6
25	1.6	5.8	3.0	3.6	6.1	6.7	6.4	7.1	5.4	5.1	1.3	1.1
26	1.0	3.1	4.5	3.6	6.3	6.4	6.1	5.5	5.1	5.4	1.9	2.1
27	1.4	3.7	3.5	4.2	6.5	5.6	7.0	7.1	3.8	4.2	1.3	3.6
28	1.0	3.2	2.9	4.0	6.2	6.1	7.3	8.3	6.6	5.4	1.2	1.9
29	3.7		4.2	3.3	6.4	7.0	7.1	7.1	5.2	3.7	1.9	2.0
30	3.7		4.4	4.0	6.0	6.1	6.4	6.9	5.8	4.3	2.3	3.3
31	2.4		4.4		6.1		7.0	7.0		5.3		1.9

Year 1964												
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.1	1.0	2.3	5.1	4.5	7.6	5.1	4.6	7.1	6.6	3.0	3.3
2	0.5	4.1	3.0	5.6	2.1	7.6	7.6	4.1	5.1	9.1	2.5	2.5
3	1.0	3.3	3.0	5.8	2.8	7.6	7.1	4.6	4.7	8.9	3.0	0.8
4	1.5	3.8	3.0	5.6	2.8	7.9	5.6	4.8	3.9	7.1	2.3	3.6
5	0.2	2.5	3.8	4.6	2.3	7.4	5.6	3.3	5.2	8.1	0.6	1.0
6	1.5	3.0	3.3	2.8	6.1	5.6	7.6	3.6	5.6	6.4	3.6	3.8
7	1.5	3.6	4.6	5.3	5.6	8.4	5.3	2.3	6.1	9.9	3.0	4.3
8	0.8	4.3	5.1	5.6	6.0	7.6	7.4	4.3	5.8	5.4	2.0	3.3
9	1.3	3.3	4.6	6.1	6.0	7.6	7.4	6.9	1.8	7.6	3.8	3.6
10	2.5	4.8	6.1	3.8	6.0	6.6	7.4	7.1	1.8	5.1	1.8	6.4
11	2.5	4.1	4.6	6.1	4.6	5.6	9.4	6.6	5.6	6.1	3.8	4.6
12	2.0	4.3	6.1	4.8	8.6	6.9	5.6	6.9	5.1	3.6	3.0	2.8
13	2.5	3.6	6.6	5.6	7.1	7.1	7.9	5.8	4.1	4.8	5.1	2.5
14	2.0	2.0	5.6	5.6	5.1	7.1	6.9	6.1	5.1	5.6	3.6	2.5
15	1.8	4.9	4.3	2.8	6.6	7.6	7.1	6.1	6.9	5.6	3.6	3.3
16	2.0	4.7	4.8	4.3	6.6	6.9	7.1	6.6	6.9	4.8	1.6	4.3
17	3.3	4.1	5.6	4.3	7.6	4.1	7.1	7.4	6.1	3.0	0.6	4.3
18	2.5	3.6	5.1	5.3	7.1	6.4	7.6	7.6	7.1	5.1	2.3	4.6
19	3.0	1.9	4.1	5.6	7.1	5.6	6.6	6.1	6.6	5.6	4.3	3.6
20	2.8	3.0	3.3	6.4	6.6	6.6	6.1	8.1	8.1	6.6	4.8	0.8
21	2.3	2.0	3.0	5.8	5.6	7.6	5.6	6.1	6.9	5.1	1.8	4.6
22	0.6	2.5	2.0	3.8	7.6	6.1	7.4	7.6	7.6	4.8	1.0	0.3
23	0.6	3.3	4.6	8.4	6.6	7.1	6.6	7.6	7.1	3.6	0.6	0.8
24	4.3	3.8	5.6	3.8	8.6	7.1	7.4	7.1	6.1	5.8	4.1	3.6
25	2.5	3.0	5.1	5.6	7.4	4.8	3.8	7.6	5.6	5.1	1.5	2.5
26	2.0	3.6	5.6	5.6	7.4	5.6	2.0	6.6	7.2	5.3	4.8	3.0
27	2.0	4.1	3.6	7.1	7.6	7.1	2.2	8.1	6.6	4.8	4.3	3.8
28	3.6	1.5	2.8	3.2	7.4	6.6	4.6	7.1	6.1	3.9	4.8	4.8
29	4.6	2.3	5.1	2.1	7.6	7.6	6.4	3.3	11.9	2.0	5.6	3.8
30	5.1		5.6	5.6	7.1	8.1	4.6	2.5	8.9	2.8	4.1	3.6
31	4.1		5.1		7.4		3.6	3.0		1.8		3.8

Table A2. continued.

Year 1965 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2.8	4.0	3.3	6.1	7.4	8.1	7.1	8.6	8.1	7.9	2.0	2.3
2	4.3	1.8	4.1	6.1	7.1	6.6	7.9	7.4	8.1	6.9	4.3	1.7
3	3.8	4.3	3.8	6.9	2.8	7.4	7.4	5.4	8.4	6.4	1.8	0.8
4	4.6	3.3	6.4	6.4	3.3	7.4	8.4	2.5	7.6	7.1	3.6	0.3
5	3.0	4.1	6.9	6.6	4.3	6.9	5.8	5.1	8.6	8.1	3.2	1.8
6	2.5	3.3	7.1	5.8	2.5	5.8	6.9	6.4	8.0	8.4	3.3	1.5
7	3.6	3.8	6.6	6.9	2.0	6.9	9.1	6.4	7.6	6.6	4.8	2.8
8	2.8	6.1	6.9	7.4	4.1	6.9	8.1	4.6	9.4	7.4	4.8	2.8
9	4.8	3.6	6.6	4.3	5.1	7.6	7.9	3.6	8.1	2.8	1.5	3.9
10	5.3	5.3	7.4	6.1	4.6	8.1	6.4	2.8	8.1	3.9	2.0	3.6
11	4.1	6.1	4.3	6.4	6.6	7.4	7.1	4.1	7.4	4.1	5.1	3.8
12	2.5	1.8	5.1	7.4	6.4	7.9	7.9	2.8	7.4	2.8	2.8	4.8
13	1.5	1.8	6.9	6.1	7.4	6.1	6.9	6.1	7.4	5.3	1.8	3.8
14	1.0	1.3	8.4	4.3	5.3	6.6	7.1	5.8	7.4	4.6	5.6	3.8
15	1.3	1.8	7.4	5.1	4.2	5.3	7.1	1.5	7.4	3.4	4.1	3.6
16	4.1	4.1	7.9	3.3	5.1	9.6	7.1	1.5	8.4	3.4	5.1	4.8
17	4.3	5.1	6.9	2.8	5.6	7.4	6.6	4.3	7.4	3.8	4.6	4.3
18	3.8	4.8	5.8	4.3	5.8	6.4	7.1	5.6	8.1	4.3	4.8	1.5
19	4.6	5.3	6.9	5.1	7.4	6.6	6.9	5.6	7.9	4.8	3.0	0.8
20	3.6	4.6	6.4	5.3	7.1	5.1	8.1	7.1	7.6	5.8	4.8	1.7
21	5.1	5.1	7.4	5.3	6.6	6.4	7.9	7.4	7.9	1.8	1.5	0.9
22	5.8	5.1	6.1	5.6	6.9	6.9	7.6	7.1	6.9	3.3	1.8	0.8
23	3.6	5.8	6.4	5.6	3.8	8.1	8.4	6.9	7.4	3.0	2.1	2.8
24	4.6	6.6	7.1	5.6	5.1	6.6	7.9	5.8	8.6	2.3	2.8	2.8
25	4.3	6.6	7.1	5.8	6.6	7.6	7.4	7.6	7.1	1.5	2.3	3.6
26	5.6	6.6	5.6	6.1	6.4	7.1	8.9	5.6	8.1	3.6	3.3	1.0
27	6.1	4.8	6.6	4.8	7.4	8.6	8.1	5.3	5.3	2.5	4.1	2.8
28	3.0	6.9	6.9	4.3	5.1	6.1	7.1	5.1	6.1	4.8	2.3	2.3
29	3.8		6.9	5.3	7.6	7.6	8.9	7.4	7.1	4.8	1.5	3.6
30	5.1		5.1	4.3	6.6	7.9	7.1	7.6	8.6	3.6	0.8	3.3
31	3.6		4.3		6.1		7.4	7.6		3.6		2.5

Year 1966 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	5.6	5.3	5.8	4.6	7.1	7.1	8.6	6.4	6.4	2.5	2.3
2	4.1	4.8	5.6	6.9	5.8	5.3	6.9	7.4	6.9	5.1	3.3	2.0
3	3.0	6.9	4.6	6.4	6.4	7.9	6.9	8.4	7.9	5.6	4.8	5.3
4	4.3	5.8	5.6	7.4	6.1	6.6	7.6	8.6	8.1	1.3	4.6	2.3
5	4.1	4.8	4.1	6.9	6.1	5.8	7.1	7.9	7.9	2.0	5.1	1.8
6	4.8	5.3	3.6	6.9	7.4	6.4	7.9	8.4	8.6	1.8	2.5	3.6
7	4.1	5.6	5.8	3.3	6.6	6.4	6.6	7.6	7.9	3.8	4.0	2.0
8	4.8	5.6	8.1	6.4	7.4		6.9	7.9	8.6	3.0	2.7	3.9
9	5.1	4.6	7.1	5.1	6.1		6.6	7.1	8.9	4.5	4.4	2.8
10	4.1	6.1	1.3	5.6	6.4	6.4	3.3	6.1	8.9	3.8	0.8	3.0
11	4.1	7.4		4.8	6.4	7.4	5.6	7.9	8.9	5.1	2.8	4.3
12	3.8	2.5		5.8	6.4	7.4	7.4	8.4	7.1	6.4	4.3	4.8
13	5.3	5.1		5.6	5.3	7.4	7.4	5.6	5.8	4.3	4.4	5.8
14	3.6	4.8		6.4	6.9	6.1	6.6	8.4	7.4	4.3	3.0	3.8
15	0.3	4.1	3.8	7.1	7.4	6.9	7.1	8.1	6.6	5.6	3.1	2.8
16	4.1	5.6	5.3	5.8	7.1	7.1	7.4	6.4	8.9	3.1	1.7	2.3
17	3.3	5.8	4.3	6.6	6.1	7.1	6.1	4.1	8.6	3.0	3.6	3.0
18	4.8	5.3	7.1	5.1	7.9	6.1	7.4	7.6	7.6	1.5	5.3	3.6
19	4.6	6.6	5.6	4.8	8.6	5.8	6.6	8.1	6.6	2.8	2.3	3.3
20	5.1	5.3	4.8	5.6	6.9	6.6	7.1	6.1	4.1	3.8	3.6	4.8
21	4.8	5.3	6.6	3.6	7.1	5.3	4.8	6.9	6.9	3.3	3.8	3.8
22	3.3	7.1	6.1	5.6	7.9	6.9	3.3	7.9	6.1	4.1	3.6	2.8
23	1.0	7.4	4.3	2.8	8.6	7.1	6.6	7.4	4.6	4.6	3.3	2.5
24	0.5	5.8	6.4	4.1	6.9	7.6	7.1	7.4	4.3	6.1	3.3	3.0
25	3.0	2.0	7.1	6.4	7.1	8.1	8.4	4.1	3.0	4.6	4.6	3.3
26	5.6	5.1	7.4	5.1	7.1	6.9	8.1	7.6	3.6	5.1	4.3	1.5
27	4.1	5.3	5.8	5.3	4.8	7.1	7.9	7.4	5.1	3.3	4.1	2.8
28	4.3	5.1	6.4	2.8	4.3	7.6	7.6	6.4	6.6	2.3	3.0	4.3
29	4.1				6.6	7.9	8.1	6.6	1.5	1.5	1.0	2.3
30	5.6			3.3	7.6	7.6	7.4	6.6	3.3	2.0	7.1	2.6
31	3.8		4.6		7.1		7.6	4.1		2.3		0.5

Table A2. continued.

Year 1967												
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.5	5.8	4.8	6.4	5.8	7.6	6.9	5.8	8.6	9.9	4.8	1.0
2	2.5	5.1	2.8	5.6	3.6	8.6	5.3	5.1	7.1	7.4	3.8	1.5
3	3.8	2.8	0.0	6.4	6.1	7.6	5.3	4.6	8.1	6.1	4.6	1.8
4	3.8	0.0	3.3	6.4	5.8	6.1	6.6	6.9	8.4	7.6	2.9	1.0
5	4.6	4.3	5.3	9.1	4.6	8.6	6.6	5.1	6.6	6.4	4.1	3.5
6	3.6	3.6	6.9		3.8	8.1	6.8	6.6	7.4	7.4	4.6	1.3
7	3.3	4.3	6.1	7.6	4.1	7.6	7.4	7.1	6.4	5.6	3.3	1.8
8	3.8	6.6	5.8	6.9	4.1	7.6	7.9	8.1	8.9	7.6	6.1	1.9
9	4.3	5.3	5.8	7.9	4.1		9.1	6.1	10.7	7.1	4.3	2.5
10	3.8		6.1	6.1	3.3	6.1		7.4	8.1	7.6	3.8	4.6
11	3.0		6.4	1.8	3.8	6.6	6.6	7.9	7.4	6.6	2.3	0.3
12	4.6	5.6	6.9	3.8	4.3	6.6	7.4	8.6	7.1	7.1	5.3	1.0
13	5.1	2.8	5.8	6.4	0.0	7.6	2.5	8.9	8.9	7.4	5.3	2.3
14	2.3	4.6	4.3	6.6	6.4	6.6	6.9	5.3	9.4	2.5	4.8	3.3
15	2.3	4.3	6.1	6.9	6.1	8.6	7.1	7.1	8.4	3.8	3.6	3.6
16	4.1	5.3	6.1	6.9	6.6	3.0	7.6	8.4	7.6	3.8	3.8	2.5
17	4.8	3.0	6.6	5.8	0.8	6.9	6.1	8.4	8.6	5.3	4.6	5.3
18	2.5	5.6	7.6	7.1	4.6	6.4	5.6	7.6	6.6	4.8	4.8	4.1
19	2.5	6.6		6.9	1.8	4.3	4.1	7.4	6.6	1.3	4.3	2.8
20	5.1	2.5	3.6	6.1	2.0	5.8	6.6	7.1	6.4	0.8	2.0	4.3
21	2.3	1.0	4.6	4.8	3.8	7.9	6.1	9.1	8.9	5.4	0.3	5.3
22	3.6			5.3	6.6	5.6	4.8	5.6	3.3	1.3	3.0	0.8
23	2.0	3.8	5.6	5.1	6.6	2.0	7.4	8.1	7.6	4.3	1.5	4.6
24	3.8	5.8	3.0	5.6	6.6	6.6	3.6	4.8	8.1	6.1	4.6	1.0
25	4.6	3.6	6.4	5.8		6.1	4.6	7.4	4.1	5.3	2.8	1.0
26	5.1	4.8	7.1	5.8		6.6	6.6	8.1	1.5	6.6	2.5	4.6
27	4.8	4.8	5.6	6.4		6.1	6.9	7.1	5.1	4.6	4.5	0.0
28	5.1	5.6	6.6	5.8		5.6	5.6	7.1	7.1	4.6	3.1	0.5
29	4.1		6.9	5.8	4.1	5.6	5.6	9.1	7.4	2.3	3.2	3.0
30	3.8		7.6	5.8	6.9	6.1	4.3	8.6	7.6	7.4	1.9	0.3
31	5.1		5.8		6.4			6.9		4.9		3.8

Year 1968												
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.5	3.6	8.1			4.1			5.5	2.6	2.1	1.6
2	1.5	5.8	3.8			4.3			7.8	4.1	4.1	2.5
3	0.0	3.0	7.4			5.1			4.9	1.8	1.6	1.1
4	2.0	4.1	5.8			4.8			6.0	6.7	2.6	4.3
5	3.0	2.4	4.8			3.8			4.2	8.0	1.0	5.1
6	2.5	6.0	4.8			2.8			8.0	2.6	4.3	1.6
7	3.8	6.9	7.1			5.1			9.0	4.1	5.2	2.7
8	0.8	3.0	5.6			6.6			4.9	2.7	1.6	1.7
9	2.5	4.1	6.1			6.6			6.0	9.4	2.6	6.0
10	4.1	3.1	5.3			5.6			5.0	5.4	1.7	3.4
11	4.1	7.9	6.4			7.4			10.0	4.7	6.1	3.0
12	4.1	5.1	5.3			6.1			7.1	3.4	3.5	2.1
13	1.8	4.6	5.8			6.4			6.5	5.9	3.0	3.7
14	3.3	3.6	3.0			5.8			5.4	4.2	2.1	2.6
15	4.3	5.4	2.0			2.5			7.4	9.4	3.8	6.0
16	5.6	4.1	3.3			6.4			6.1	1.8	2.6	1.1
17	4.3	8.0	2.0			3.6			10.1	3.7	6.2	2.3
18	4.3	2.4	3.3			2.5			4.3	6.0	1.1	3.8
19	3.3	3.8	4.8			4.8			5.7	6.0	2.3	3.9
20	0.8	5.5	7.4			4.8			8.4	2.6	3.8	1.6
21	1.0	5.6	6.6			4.3			7.6	9.8	3.9	6.3
22	6.6	3.0	4.8			6.1			4.9	2.4	1.6	1.5
23	3.8	8.3	3.8			6.9			10.5	6.5	6.4	4.1
24	3.8	2.8	7.4			5.8			4.7	5.0	1.4	3.2
25	4.8	5.8	2.5			5.3			7.9	5.3	4.2	3.4
26	5.1	4.8				5.3			6.7	6.5	3.2	4.1
27	5.3	5.0				5.8			7.0	4.4	3.4	2.8
28	5.8	5.8				5.6			7.8	2.8	4.2	1.7
29	5.6	5.1	3.3			5.3			6.3	3.2	2.8	2.0
30	4.1		4.1			6.4			5.0	1.1	1.7	0.7
31	2.8		6.4			7.1				7.2		4.6

Table A2. continued.

Year 1969

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2.2	4.8		4.6	3.6	5.8	6.4		4.1	2.8	2.0	6.1
2	3.1	0.6		6.4	5.3	4.8	6.4	6.4	5.1	2.8	3.8	4.1
3	1.6	5.8		6.4	4.8	6.4	6.4	5.8	5.3	4.1	3.8	3.8
4	4.9	5.4		4.3	4.3	4.8	6.9	6.1	4.8	4.6	3.8	2.3
5	5.7	4.0		5.1	1.8	6.6	6.1	5.8	3.0	3.4	3.3	2.8
6	2.2	4.8		1.0	3.8	6.6	6.6	6.1	5.1	2.5	2.5	3.3
7	3.1	5.6		2.5	3.3	5.6	6.4	6.4	6.4	1.0	3.3	1.8
8	2.3	6.1		4.8	4.3	5.6	4.8	6.9	5.8	3.5	4.6	3.4
9	6.6	5.7		3.0	5.6	5.1	4.8	6.9	6.1	4.6	3.3	1.9
10	4.0	4.7		4.3	5.6	5.3	4.8	7.6	5.6	7.9	4.3	3.4
11	3.6	5.9		4.1	5.1	6.4	4.6	6.1	6.1	3.0	3.6	2.3
12	2.7	6.4		3.3	6.4	4.6	5.1	6.9	5.1	1.7	2.3	2.3
13	4.3	6.0			5.8	5.8		6.1	5.6	5.2	0.8	3.0
14	3.2	2.5			5.1	5.8			4.6	2.3	1.5	3.3
15	6.7	4.8		4.8	4.6	5.3	5.3	3.0	5.6	1.8	2.5	4.1
16	1.7	6.8		5.1	4.3	5.1	5.6	4.3	4.3	3.8	2.9	1.8
17	2.9	3.1		4.8	5.1	4.6	6.1	5.1	5.7	3.2	2.9	2.3
18	4.4	4.0		3.8	6.9	6.4	5.8	4.1	3.3	1.8	1.5	3.8
19	4.5	5.4		5.8	5.3	6.4	5.3		4.7	4.6	2.3	3.6
20	2.2	4.9			5.6	6.4	7.1	4.1	5.8	2.7	4.1	1.3
21	6.9	5.0			5.6	6.6	6.1	4.8	6.4	3.5	1.5	2.5
22	2.0	3.7			6.9	4.8	5.1	3.8	6.6	0.5	2.5	3.0
23	4.7	5.5		5.1	4.8	5.6	4.3	4.3	5.8	2.3	2.8	2.5
24	3.8	3.9		5.1	3.8		4.8		3.8	3.0	4.1	2.8
25	4.7	4.0		5.6	4.6		5.3	4.1	5.6	1.5	3.8	4.5
26	3.4	2.5		3.6	5.3	3.3	6.6	4.8	6.1	5.1	2.5	3.6
27	2.3	5.1		5.1	4.6	5.1	6.9	5.1	4.8	2.0	3.3	3.3
28	2.6	2.5		5.3	5.6	2.8	5.6	3.8	5.1	3.0	2.3	4.1
29	1.2			4.8	4.3	6.6	5.3	5.8	6.4	3.0	3.0	2.9
30	5.2			4.3	6.9	7.4	7.4	3.8	4.1	1.3	2.5	2.9
31	4.0				5.1			3.8		0.0		3.4

Year 1970

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	5.4	3.5							8.3	6.0	3.2	4.8
2	4.2	1.9							7.8	4.7	0.0	3.6
3	3.8	6.4							6.2	6.1	4.2	3.2
4	4.8	5.0							4.6	3.4	3.8	4.2
5	4.2	4.8							6.2	3.8	2.5	3.6
6	5.2	3.7							5.6	4.7	3.3	4.6
7	4.2	4.3							7.6	2.1	3.9	3.6
8	4.3	5.6							5.9	6.7	4.4	3.7
9	6.2	4.6							7.5	4.8	4.1	5.5
10	2.4	4.3							6.5	5.3	3.2	1.8
11	4.8	4.6							7.6	3.4	4.2	4.2
12	3.6	2.5							5.4	5.2	4.7	3.0
13	3.7	5.4							5.8	7.0	4.3	3.1
14	4.3	4.1							6.1	2.1	1.2	1.4
15	2.1	4.2							5.1	4.6	3.2	1.6
16	5.3	7.5							7.6	7.0	5.0	4.7
17	4.6	5.6							6.6	7.5	1.6	4.0
18	3.8	8.4							7.0	5.2	2.5	3.2
19	5.9	3.3							5.8	8.3	3.8	5.2
20	5.9	2.9							6.0	8.2	3.4	5.3
21	0.9	3.1							9.8	8.6	3.5	0.4
22	3.4	3.3							6.0	6.7	2.2	1.9
23	3.2	1.6							3.7	4.4	3.9	3.6
24	3.7	6.2							5.0	3.5	2.4	2.2
25	1.7	5.1							4.4	3.6	2.5	1.2
26	3.6	3.2							6.5	1.9	1.1	6.0
27	0.7	3.6							4.2	6.9	3.5	3.1
28	4.3	0.9							4.5	5.3	3.0	3.7
29	4.0								6.3	6.1	1.8	2.4
30	3.0								6.7	5.5	2.4	3.4
31	3.8									6.6		4.2

Table A2. continued.

Year 1971

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	6.1	6.2							6.8	4.0	3.1	5.5
2	2.7	5.8							5.3	5.9	3.7	2.2
3	2.1	4.3							5.5	4.5	2.6	1.5
4	1.6	2.7							4.5	2.5	3.4	1.1
5	3.1	4.3							7.9	1.8	4.2	2.6
6	2.2	5.6							9.4	2.7	5.6	1.6
7	3.6	5.7							5.7	7.1	2.2	3.0
8	4.0	4.0							8.5	2.7	1.5	3.4
9	4.4	5.5							7.7	5.8	1.0	3.8
10	3.2	4.5							5.4	5.3	2.6	2.6
11	4.9	5.6							6.5	3.4	1.6	4.3
12	3.2	3.6							4.3	5.2	3.1	2.6
13	4.5	3.9							7.4	7.0	3.5	3.9
14	2.8	4.1							5.0	2.1	3.8	2.2
15	2.9	3.2							4.6	4.6	2.6	2.3
16	4.0	5.6							4.4	7.0	4.3	1.3
17	3.6	4.7							3.9	7.5	2.6	3.6
18	3.6	5.1							4.4	5.2	3.9	3.5
19	2.9	3.9							5.1	8.3	2.2	1.5
20	2.9	4.1							6.3	8.2	2.3	4.3
21	2.2	7.6							6.9	8.6	1.3	0.1
22	1.2	4.0							3.2	6.7	3.6	3.3
23	1.1	1.9							5.1	4.4	3.5	2.8
24	1.0	3.2							4.5	3.5	1.5	3.3
25	1.2	2.6							5.4	3.6	4.3	0.7
26	2.0	4.6							5.8	1.9	0.0	3.2
27	3.5	2.4							4.5	6.9	3.4	0.0
28	2.8	2.7							6.6	5.3	2.8	4.1
29	4.0								8.3	6.1	3.3	3.7
30	4.2								9.0	5.5	0.6	2.5
31	4.3									5.6		3.2

Year 1972

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.5	4.8							6.7	3.7	5.6	3.9
2	4.9	3.4							2.3	5.3	4.5	4.3
3	4.6	3.6							7.9	2.2	1.5	4.0
4	3.7	2.6							7.4	5.8	0.9	3.1
5	4.8	5.9							6.3	4.7	4.9	4.2
6	5.3	7.2							6.8	5.9	3.7	4.7
7	4.8	3.8							7.6	2.2	3.2	4.2
8	1.7	6.4							8.1	7.4	4.3	1.2
9	3.8	5.7							7.7	6.5	3.6	3.2
10	5.6	3.5							6.7	5.1	4.7	5.0
11	2.2	4.6							7.9	6.6	3.6	1.7
12	3.1	2.4							8.5	7.3	3.8	2.5
13	4.3	5.4							8.0	6.4	5.6	3.7
14	3.9	3.1							4.3	5.3	1.8	3.3
15	4.0	2.7							6.7	6.6	4.2	3.4
16	2.8	2.4							8.9	7.1	3.0	2.2
17	4.4	2.1							4.9	4.7	3.1	3.8
18	3.0	2.5							5.9	1.6	3.7	2.4
19	3.1	3.5							7.4	1.1	1.6	2.5
20	1.7	4.1							6.9	5.4	4.7	1.2
21	4.1	4.4							7.0	6.5	4.0	3.5
22	3.5	1.8							5.5	2.3	3.2	2.9
23	2.3	3.4							7.5	6.0	5.3	1.8
24	3.0	2.6							5.8	8.0	5.4	2.4
25	3.8	3.2							5.8	5.5	0.3	3.2
26	2.5	3.4							4.3	4.1	1.9	2.0
27	2.7	3.0							7.1	7.3	3.6	2.1
28	1.8	4.4							6.4	4.7	2.2	1.3
29	4.8								5.0	6.8	1.1	4.2
30	6.0								5.8	4.7	6.1	5.4
31	2.9									7.8		2.3

Table A2. continued.

Year 1973												
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	5.3	4.8							6.6	7.3	3.3	4.7
2	4.6	0.6							7.3	6.3	2.0	4.0
3	2.6	5.8							5.9	3.3	2.1	2.1
4	3.6	5.4							7.0	4.7	1.3	3.0
5	1.6	4.0							7.9	1.7	4.2	1.0
6	4.3	4.8							9.5	5.9	5.5	3.7
7	2.3	5.6							5.5	2.8	2.3	1.7
8	1.9	6.1							4.8	2.2	4.7	1.4
9	1.6	5.7							4.2	1.8	4.1	1.1
10	1.4	4.7							6.0	1.4	2.1	0.8
11	1.8	5.9							4.8	2.0	3.1	1.2
12	2.6	6.4							6.5	3.2	1.0	2.0
13	3.2	6.0							7.0	4.2	3.3	2.6
14	3.4	2.5							7.5	4.8	1.7	2.8
15	1.1	4.8							6.0	1.0	1.4	0.6
16	2.5	6.8							8.0	3.2	1.1	2.0
17	1.9	3.1							6.6	8.4	0.8	1.3
18	2.3	4.0							7.7	2.8	1.2	1.8
19	2.5	5.4							5.6	3.1	2.0	1.9
20	2.2	4.9							5.7	2.6	2.8	1.6
21	3.4	5.0							4.5	4.5	2.9	2.8
22	5.5	3.7							7.2	7.7	0.5	4.9
23	5.8	5.5							7.1	8.1	2.0	5.1
24	5.1	3.9							7.4	7.0	1.3	4.5
25	4.7	4.0							5.9	6.5	1.7	4.1
26	3.4	2.5							6.8	4.4	1.9	2.8
27	1.9	5.1							7.6	2.2	1.6	1.4
28	3.3	4.5							8.1	4.3	2.9	2.7
29	4.5								7.7	6.1	5.0	3.9
30	4.5								6.9	6.1	5.2	3.9
31	3.1									4.0		2.5

Year 1974												
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.4	4.7							9.4	8.6	4.6	3.8
2	3.5	5.3							9.3	3.5	4.2	3.0
3	4.5	3.9							4.8	2.5	2.8	3.9
4	2.7	5.0							4.0	1.8	1.4	2.1
5	3.0	5.9							8.7	4.1	2.8	2.4
6	3.2	7.4							7.3	2.6	4.0	2.6
7	2.3	3.6							6.8	4.8	3.9	1.8
8	4.5	2.9							8.0	5.4	2.5	3.9
9	3.7	2.4							7.2	6.0	3.9	3.1
10	4.0	4.1							8.4	4.2	3.0	3.4
11	3.0	3.0							7.2	6.7	4.0	2.4
12	3.2	4.6							7.4	4.1	2.1	2.6
13	6.3	5.0							9.6	6.1	2.4	5.7
14	3.1	5.5							5.1	3.6	2.6	2.5
15	1.2	4.1							7.9	3.7	1.8	0.6
16	2.3	6.0							6.5	2.1	3.9	1.7
17	1.8	4.1							6.6	5.6	3.1	1.3
18	3.6	5.6							7.3	5.5	3.5	3.0
19	1.7	3.7							4.8	2.4	2.4	1.1
20	1.9	3.8							8.5	6.7	2.6	1.3
21	3.4	2.7							7.7	0.2	5.8	2.9
22	3.7	5.2							6.7	5.6	2.5	3.1
23	4.4	5.1							9.2	4.4	0.6	3.8
24	2.6	2.9							9.3	5.2	1.7	2.0
25	4.6	6.1							3.4	1.1	1.2	4.0
26	3.8	1.3							5.2	5.0	3.0	3.2
27	3.2	4.9							7.2	0.0	1.1	2.6
28	1.4	4.3							5.5	6.5	1.3	0.9
29	4.9	4.9							4.3	5.9	2.9	4.3
30	1.8								10.0	4.0	3.2	1.3
31	4.5									5.1		3.9

Table A2. continued.

Year 1975												
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.1	6.0							8.0	6.1	4.3	2.3
2	1.6	4.3							6.2	6.8	2.8	3.4
3	3.7	3.7							5.6	6.3	2.2	1.3
4	6.0	3.7							5.6	5.0	2.3	3.7
5	5.6	2.5							4.3	6.5	1.1	2.9
6	1.3	6.1							8.2	7.3	4.4	3.7
7	4.5	4.9							6.9	6.7	3.4	1.4
8	2.8	5.6							7.6	1.9	4.0	4.7
9	4.5	5.1							7.1	5.0	3.5	4.1
10	4.1	5.2							7.2	7.8	3.6	3.2
11	2.1	3.8							5.7	2.7	2.3	4.2
12	4.2	5.0							6.9	4.0	3.4	4.6
13	0.5	2.7							4.5	5.9	1.3	4.1
14	2.7	5.3							7.3	5.2	3.7	3.4
15	5.5	4.5							6.4	1.3	3.0	4.2
16	4.4	5.4							7.4	3.5	3.8	4.5
17	4.0	2.7							4.6	6.1	1.3	2.9
18	5.0	6.5							8.6	3.9	4.8	1.0
19	3.4	5.9							7.9	3.9	4.2	0.6
20	4.1	4.8							6.8	1.9	3.4	3.4
21	3.6	5.9							7.9	5.5	4.2	4.1
22	2.5	6.4							8.5	4.6	4.7	1.4
23	2.2	5.8							7.8	2.8	4.2	3.8
24	2.0	5.0							7.0	3.8	3.4	5.1
25	4.3	6.0							8.0	5.1	4.3	3.5
26	2.1	6.3							8.3	3.2	4.6	2.6
27	5.0	4.5							6.6	3.4	3.0	4.5
28	3.9	2.3							4.1	2.1	0.9	2.9
29	1.8								3.7	6.6	0.6	4.3
30	3.5								7.0	8.4	3.5	3.0
31	5.7									3.7		5.0

Year 1976												
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.2	3.7	6.1		6.0	6.1	7.9	8.2	7.8	4.9	3.3	3.8
2	4.0	4.4	6.0		6.2	6.2	8.0	7.0	7.8	3.3	2.0	1.8
3	4.0	3.5	6.1		6.2	6.3	7.6	8.0	7.8	5.3	2.1	3.8
4	4.0	4.6	6.0		6.8	6.4	7.6	7.1	7.8	5.0	1.3	0.3
5	3.0	2.8	6.0	5.0	6.8	6.1	7.9	8.1	7.8	4.0	5.1	2.4
6	4.4	4.6	6.2	5.6	6.9	7.8	8.0	5.3	8.0	4.3	4.2	5.1
7	4.0	4.7	5.3	4.0	6.1	8.3	7.9	8.1	7.9	2.2	5.5	4.0
8	2.0	4.6	5.8		6.7	7.2	8.0	8.4	7.9	3.4	1.2	3.0
9	2.0	4.2	6.0	1.2	6.7	7.4	8.0	7.9	8.0	4.3	1.6	5.1
10	3.8	4.1	5.9		6.8	7.4	8.1	6.0	7.9	4.7	1.7	3.6
11	2.2	4.5	6.0	6.0	6.0	6.4	8.0	8.9	8.3	1.7	4.7	6.4
12	2.0	4.7	6.0		5.8	6.4	8.1	8.0	8.8	6.1	4.1	4.0
13	2.0	4.1	7.4	6.0	6.0	6.4	8.0	9.0	7.9	4.7	2.1	4.6
14	4.0	4.2	8.0	6.1	6.1	7.3	6.0	8.9	7.9	3.5	3.1	2.2
15	4.0	4.0	6.2		6.1	7.5	8.0	9.1	7.8	5.3	1.0	3.6
16	5.0	6.0	6.0		6.6	7.4	4.9	8.7	7.9	3.4	3.8	3.4
17	4.0	5.6	6.5		6.4	8.0	7.8	8.0	6.1	3.4	1.7	3.1
18	2.0	5.3	7.0	2.3	6.4	7.9	8.0	7.4	6.1	4.4	1.4	3.8
19	4.9	4.8	6.8	6.0	6.5	7.6	8.1	7.2	7.0	3.6	1.1	2.0
20	4.8	4.7	7.2	6.3	6.0	7.7	6.0	8.0	7.0	6.6	0.8	3.4
21	4.9	5.9	7.4	6.2	6.1	7.8	8.1	7.9	7.0	5.4	1.2	3.3
22	4.8	6.0	7.3		6.0	7.6	8.4	8.5	8.0	5.2	2.0	2.2
23	3.3	4.1	7.2		6.4	7.7	8.0	7.9	8.0	6.0	1.3	2.0
24	3.8	5.9	7.7	6.0	6.1	7.8	8.0	6.0	8.0	6.3	2.6	2.0
25	2.0	6.0	6.0		6.2	8.1	7.9	7.8	8.2	5.7	2.9	1.7
26	3.8	6.3	7.7		6.4	8.1	8.0	9.1	8.0	5.0	0.5	4.0
27	2.0	6.0	7.4	5.9	6.2	8.1	8.0	6.2	7.4	5.4	2.0	1.1
28	4.4	6.0	8.1		6.8	8.4	8.0	6.0	8.3	5.3	1.3	1.9
29	2.1	6.1	8.0	4.2	6.5	8.4	8.4	7.6	7.5	5.2	1.7	4.1
30	3.9			5.8	6.9	8.5	7.9	7.6	8.0	1.8	3.5	3.4
31	1.3				7.3		8.1	7.5		4.3		4.1

Table A2. continued.

Year 1977

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.2	7.7	5.2	6.0	4.2	5.2	6.9	6.9	5.0	6.0	4.1	3.0
2	4.3	6.9	3.6	5.9	5.0	5.2	4.2	6.8	7.0	2.5	6.1	5.2
3	4.4	6.0	3.4	5.9	5.9	4.0	5.1	4.2	6.7	7.3	4.1	2.7
4	4.5	3.0	4.1	6.1	2.9	5.3	6.8	5.1	7.2	6.0	4.2	3.7
5	4.3	5.7	6.0	6.2	3.0	6.8	6.5	6.9	4.1	4.0	3.9	2.9
6	5.3	4.0	5.2	7.8	3.3	5.1	7.7	6.7	6.8	4.4	3.2	4.4
7	2.1	4.0	2.6	7.1	3.8	6.8	7.0	6.2	7.3	4.0	3.9	2.8
8	3.3	4.4	4.5	4.2	3.9	5.1	6.9	6.1	7.3	3.9	2.6	5.6
9	3.6	3.3	4.1	6.0	4.0	6.2	7.3	6.0	8.0	3.0	4.0	3.0
10	5.3	4.1	5.8	4.0	3.2	6.8	3.4	6.0	7.1	2.6	4.1	3.4
11	2.2	4.2	6.0	3.9		6.0	5.0	4.0	7.1	2.0	4.6	3.8
12	4.2	4.3	6.0	6.0		5.9	2.2	3.9	8.0	4.1	4.4	4.1
13	7.0	4.0	6.5	5.9		1.0	2.5	6.2	8.1	2.2	2.3	4.2
14	5.7	4.0	8.0	5.5		3.7	5.9	6.4	8.1	3.3	2.6	1.0
15	6.5	4.1	8.0	6.1	3.0	3.4	6.8	6.0	8.0	4.0	2.0	2.7
16	6.1	4.1	7.8	6.1	1.2	3.5	5.1	6.3	8.0	4.2	4.1	2.6
17	5.1	4.3	4.1	7.3	4.3	3.8	3.1	6.1	8.2	3.0	2.1	3.0
18	4.5	3.9	4.3	5.6	4.3	5.8	3.0	5.9	8.0	1.1	2.0	2.8
19	6.2	3.3	6.0	5.1	2.9	6.1	3.4	5.8	8.1	2.6	4.1	1.2
20	8.0	3.3	1.8	4.8	4.4	6.2	4.1	3.9	6.8	4.2	4.2	2.0
21	5.4	4.1	2.0	5.1	3.6	5.6	5.9	3.8	7.0	2.8	5.2	2.0
22	5.1	2.9	4.4	4.9	4.9	5.1	6.0	4.2	7.0	2.4	6.8	2.8
23	5.0	4.1	6.1	5.9	5.2	6.0	6.8	4.0	8.4	1.6	4.0	4.0
24	4.8	4.4	6.0	4.6	4.7	5.1	6.2	6.0	7.3	1.4	2.0	4.0
25	4.9	4.7	4.2	6.0	5.1	5.3	7.5	5.2	5.4	2.1	2.5	4.2
26	5.1	5.0	1.4	4.0	5.2	5.2	6.8	6.8	5.6	3.0	2.1	4.1
27	4.8	5.1	6.8	3.6	5.1	7.0	6.9	6.6	5.5	4.0	2.3	4.1
28	4.4	5.1	4.1	1.9	5.3	6.8	6.0	6.0	6.7	4.1	2.4	3.5
29	4.6		6.4	2.0	5.3	6.8	7.5	6.1	7.0	4.2	6.0	5.8
30	5.0		6.0	3.2	3.6	6.4	7.4	6.2	5.9	4.0	4.1	4.0
31	6.2		5.5		2.3		7.6	6.1		4.2		2.6

Year 1978

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2.8	5.2	5.3	6.0	5.8	5.4	7.6	5.7	6.0	5.0	5.0	5.5
2	2.6	5.0	6.0	6.0	4.5	5.8	7.5	5.5	6.0	5.1	3.9	5.7
3	2.5	4.2	6.2	6.2	5.6	6.0	8.6	5.4	5.9	5.4	5.6	5.7
4	1.3	4.3	4.2	5.8	5.4	5.9	8.6	5.6	5.8	5.6	4.6	5.6
5	2.7	4.3	5.0	5.4	4.8	5.8	7.8	6.0	5.7	7.8	4.7	5.5
6	2.9	5.5	6.0	3.9	5.9	6.0	7.8	5.4	5.8	7.8	7.2	6.0
7	3.0	5.8	6.0	5.2	5.9	7.1	8.0	5.5	6.1	5.6	5.8	5.9
8	5.3	5.7	5.5	4.5	5.7	6.9	8.1	5.4	7.6	7.6	4.0	5.0
9	3.6	5.8	5.0	5.4	5.7	6.0	8.2	5.4	7.5	8.1	5.0	5.2
10	2.9	5.8	3.4	5.4	6.0	6.2	5.7	6.6	6.4	8.1	5.1	4.0
11	3.1	5.8	5.5	5.5	5.5	5.5	7.9	6.8	6.0	5.6	2.5	4.4
12	3.6	5.9	5.6	4.2	5.7	5.6	7.7	7.2	5.5	7.8	3.1	5.6
13	3.1	5.8	3.1	4.6	7.6	5.6	8.0	7.1	6.2	7.7	5.8	5.8
14	3.6	5.5	5.5	4.7	5.6	5.8	7.7	7.0	6.3	7.7	5.1	5.6
15	3.6	5.0	6.3	4.8	5.0	5.9	6.4	6.9	7.4	7.7	5.4	6.0
16	4.5	5.2	6.4	5.8	4.4	5.9	4.9	7.0	7.3	8.0	5.5	5.7
17	5.7	5.8	6.5	5.9	5.7	6.0	5.8	6.9	7.4	5.9	5.4	4.0
18	4.0	6.0	6.6	5.0	7.6	5.9	5.8	6.4	7.4	6.1	5.6	3.8
19	2.9	6.0	6.6	6.0	5.6	6.0	5.4	6.4	7.3	5.7	5.7	5.5
20	4.0	6.0	6.4	5.5	5.4	6.9	5.5	6.3	7.4	5.2	5.2	5.5
21	4.0	5.8	6.0	6.1	5.5	6.7	5.5	6.3	7.1	4.8	5.6	5.4
22	5.0	6.0	6.8	6.0	5.5	6.9	6.0	5.5	7.4	5.8	3.0	2.9
23	5.5	5.7	5.8	5.5	5.6	7.0	5.5	6.0	8.1	5.6	2.7	1.9
24	3.0	5.7	3.4	5.6	6.8	7.0	5.4	5.6	5.6	2.0	5.5	1.9
25	3.6	5.4	2.7	4.9	5.5	6.2	5.4	5.7	6.8	2.2	5.6	1.5
26	0.6	5.8	3.1	5.6	5.5	5.4	4.5	5.5	6.7	2.0	5.0	3.7
27	2.2	6.4	4.1	6.1	5.5	6.0	5.2	6.7	6.6	2.4	5.6	4.0
28	3.0	5.6	5.1	5.5	3.4	7.5	6.0	5.6	6.5	2.4	5.7	4.4
29	5.8		5.0	6.0	5.3	7.3	6.0	5.7	7.4	2.0	6.3	4.5
30	5.2		5.2	6.1	5.9	7.6	6.2	5.8	7.6	1.9	6.4	5.5
31	4.9		4.9		3.2		5.5	6.0		2.2		5.8

Table A2. continued.

Year 1979 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	5.3	5.6	6.0	6.9	7.5	7.8	7.9	7.7	6.8	7.5	3.4	2.3
2	5.8	5.7	4.5	6.5	6.5	7.9	8.5	7.8	6.2	7.7	2.1	3.6
3	5.5	5.8	3.6	4.4	4.5	7.2	8.6	7.6	5.8	7.7	3.5	3.6
4	4.1	5.7	5.4	5.3	5.7	7.3	8.6	7.7	5.8	7.7	3.1	2.9
5	5.1	5.6	4.4	6.8	5.1	7.3	7.5	7.9	6.8	7.9	4.7	2.7
6	5.3	5.7	2.1	6.9	6.0	7.4	8.5	7.8	3.5	8.0	3.4	3.1
7	5.4	5.4	3.8	7.6	6.0	7.6	7.6	7.6	6.8	8.0	4.4	3.0
8	5.6	5.8	5.8	7.4	3.4	7.5	7.9	7.6	6.0	8.1	3.3	2.5
9	5.4	5.8	6.0	7.6	3.4	7.4	8.5	7.7	6.0	8.1	4.3	3.0
10	5.4	5.9	4.4	7.9	4.6	7.7	8.6	7.5	5.7	8.1	4.3	2.7
11	5.4	5.5	4.4	5.5	3.8	7.7	8.6	7.8	4.6	8.1	4.3	2.6
12	5.4	5.2	6.0	6.8	4.1	7.5	7.5	7.7	2.0	7.0	4.4	3.9
13	5.6	6.0	5.6	6.3	3.4	7.8	8.6	7.7	2.2	5.9	3.1	4.1
14	5.6	5.1	5.0	7.7	4.8	5.8	7.6	8.3	2.6	5.8	3.2	3.9
15	5.4	6.0	5.1	5.8	7.7	5.8	7.6	8.3	1.9	5.7	4.9	3.4
16	5.5	6.1	5.4	4.9	7.7	7.5	8.3	7.7	2.6	4.9	2.0	3.5
17	5.7	6.1	5.3	5.5	7.7	6.4	5.6	8.4	2.5	4.0	2.6	3.4
18	5.8	5.9	5.5	6.0	4.8	6.6	7.5	7.5	2.5	2.4	3.6	3.0
19	4.5	5.9	5.6	5.8	7.7	6.8	7.6	7.9	4.0	4.5	2.3	3.2
20	5.0	5.7	5.6	4.1	7.8	6.8	7.6	7.5	4.2	6.5	2.6	3.6
21	4.6	4.3	5.5	3.8	7.8	7.5	7.5	7.9	7.6	6.9	3.3	2.2
22	4.1	4.3	6.8	5.5	7.8	6.5	7.5	7.7	7.5	5.0	3.4	2.7
23	5.0	3.9	6.0	5.5	7.8	7.7	7.5	7.9	7.6	3.3	2.7	3.0
24	5.6	6.0	6.8	5.4	7.8	7.8	6.8	7.8	7.5	2.5	3.4	3.8
25	5.5	6.0	7.4	5.7	7.4	7.8	4.0	7.8	7.4	2.9	3.7	3.8
26	5.6	5.8	5.7	5.9	7.5	7.8	7.6	8.1	7.2	4.7	4.3	3.6
27	5.4	5.9	7.4	5.9	5.6	7.8	7.6	7.7	7.4	3.8	4.4	2.6
28	5.6	5.8	7.4	6.8	6.8	7.6	7.6	7.5	7.4	3.8	4.6	2.3
29	5.6		7.5	7.6	6.8	7.5	7.3	7.6	7.5	3.8	4.7	3.4
30	5.2		5.2	7.5	6.9	7.5	7.3	7.6	7.5	3.6	3.8	3.6
31	5.5		6.0		7.6		7.0	7.5		3.6		3.8

Year 1980 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3.5	4.6	7.4	7.4	5.9	6.0	5.4	8.0	8.8	6.8	5.8	1.8
2	3.7	4.2	5.1	7.3	5.7	4.6	6.6	7.8	8.6	6.9	6.1	2.6
3	3.5	3.9	5.0	7.2	5.5	4.5	7.3	7.8	7.7	6.0	5.9	1.7
4	4.2	4.6	7.6	6.9	5.2	4.2	7.4	7.9	7.8	6.1	5.7	2.1
5	4.6	5.2	7.6	6.6	3.4	4.1	7.7	7.9	7.3	6.2	5.8	2.4
6	4.7	7.3	8.1	5.8	5.5	4.0	7.7	8.0	7.6	6.2	1.9	2.4
7	4.8	7.4	8.1	5.1	5.5	4.6	7.8	8.1	8.7	6.2	1.9	2.0
8	4.8	7.5	7.6	2.4	5.9	5.4	7.9	8.1	7.6	6.1	1.0	2.2
9	4.6	7.3	8.5	3.4	6.1	6.2	8.1	8.3	6.7	6.2	4.9	2.1
10	4.4	7.2	8.6	5.8	6.1	5.9	8.3	7.2	9.6	6.2	1.0	2.6
11	4.3	7.3	6.1	6.8	4.4	6.2	8.3	7.5	8.1	6.0	0.9	3.5
12	3.5	7.4	5.2	4.0	4.2	5.8	8.3	7.5	7.6	4.7	0.6	3.1
13	3.5	7.6	7.3	4.6	5.6	5.1	8.3	7.6	7.6	4.4	0.9	2.2
14	3.2	5.1	6.1	2.8	5.8	5.2	8.3	7.7	7.6	3.5	1.0	3.4
15	3.0	4.8	5.9	3.6	5.2	6.7	6.8	7.7	7.4	3.1	2.1	3.1
16	4.9	5.1	6.0	3.8	5.7	6.8	7.2	7.5	8.2	3.0	1.6	3.4
17	4.2	7.3	7.3	4.3	5.9	6.9	6.5	7.2	8.5	2.4	2.1	3.6
18	3.8	6.9	7.3	5.1	6.8	6.7	7.2	7.6	8.5	3.4	2.7	0.6
19	4.4	5.1	6.8	4.2	7.0	6.5	6.0	7.4	8.6	5.1	2.8	3.4
20	3.9	5.5	6.9	4.7	6.7	6.8	8.5	7.6	8.7	5.6	2.9	0.9
21	4.6	7.2	7.8	4.5	6.9	6.7	7.8	7.3	8.5	6.5	3.2	3.5
22	4.2	5.4	7.9	5.0	6.0	6.7	7.9	8.0	6.2	6.8	3.1	3.5
23	5.1	5.2	7.8	5.6	6.8	6.7	8.4	8.6	5.9	6.1	3.2	3.5
24	5.2	6.0	7.9	5.1	6.7	6.8	7.5	8.6	5.6	5.0	3.0	3.6
25	4.6	6.0	7.9	5.1	6.9	6.9	7.6	8.5	6.1	4.7	1.3	3.7
26	5.4	6.1	7.6	5.6	7.0	5.7	8.7	7.9	6.1	3.9	2.1	3.7
27	4.3	6.1	7.7	5.5	7.1	5.5	8.4	8.6	5.9	3.5	1.8	3.9
28	4.3	6.2	7.7	6.8	7.0	5.7	7.5	8.6	6.9	4.8	1.6	3.9
29	4.2	6.2	7.4	6.6	6.7	5.9	8.3	8.7	6.9	3.6	1.7	3.4
30	4.6		7.1	6.4	6.7	5.9	7.1	8.7	6.9	4.1	2.1	3.6
31	4.7		7.3		6.8		7.9	8.6		4.6		3.1

Table A2. continued.

Year 1981

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3.0	5.4	6.0	7.4	5.0		6.8	4.2	5.0	6.8	2.9	2.4
2	3.1	5.4	6.0	5.6	4.6		6.8	6.3	5.6	6.9	2.6	2.5
3	2.6	1.8	6.6	5.5	6.0		6.9	6.1	4.1	7.0	2.5	3.0
4	2.4	4.8	6.7	6.8	5.6	6.0	7.0	5.8	4.1	5.8	4.2	2.8
5	2.0	3.1	6.6	7.3	5.3	5.0	7.0	5.5	4.8	5.9	1.4	2.8
6	3.9	4.3	6.8	7.5	5.5	5.2	6.0	4.8	4.6	5.1	3.8	2.1
7	5.1	3.8	7.1	7.1	5.1	5.1	3.4	6.3	4.4	3.2	5.2	4.1
8	4.0	5.2	6.1	5.4	6.4	5.0	5.6	4.2	4.2	3.5	3.5	4.8
9	3.9		5.8	3.6	5.6	4.9	5.8	4.0	4.4	3.7	2.6	4.2
10	4.3		5.1	1.8	5.8	5.1	5.7	4.1	2.8	2.8	4.6	4.8
11	3.8		6.6	1.2	4.2	5.2	6.0	4.2	4.8	5.1	3.0	4.8
12	3.9		5.9	2.9	5.9	5.4	5.8	6.2	2.3	4.2	4.4	6.0
13	3.9		6.0	2.6	5.6	5.3	6.0	8.3	2.4	4.6	3.0	4.1
14	4.7	5.3	6.8	2.8	5.5	5.9	6.1	6.5	4.0	3.5	5.1	4.3
15	3.8	5.6	7.0	4.8	5.1	6.1	6.3	7.4	4.0	5.0	0.5	4.6
16	3.9	6.9	7.2		6.8	6.2	6.4	8.3	2.0	4.8	1.0	5.4
17	3.9	7.0	7.2		7.1	6.4	7.2		2.5	4.9	3.1	2.4
18	3.9	6.8	7.4		7.4	6.3	5.3		2.6	3.8	5.5	1.1
19	3.4	5.8	6.8		7.5	6.8	4.9	5.6	3.4	4.0	2.0	0.5
20	3.9	6.8	7.1		7.4	6.7	3.9	4.8	5.6	3.8	0.7	2.0
21	4.0	6.7	7.5		7.3	6.4		5.5	4.7	3.4	4.0	2.9
22	5.5	6.9	7.7			6.2		7.5	3.4	3.5	2.2	4.4
23	5.9	6.7	7.4	6.0		6.9		7.5	5.0	3.0	4.0	4.8
24	5.3	6.8	7.3	6.1		7.0	6.7	7.7	6.8	3.0	3.5	4.6
25	5.0	5.9	7.4	6.4		6.9	6.8	6.5	6.9	2.9	1.5	4.7
26	4.9	6.1	6.1	5.9		6.3	5.6	6.2	7.0	2.8	3.6	3.0
27	4.0	6.0	6.4	6.0		6.9	4.4	4.6	5.8	2.8	2.2	2.7
28	5.7	5.8	7.2	5.1		6.4	4.9	5.1	5.9	3.9	5.0	2.7
29	5.7		6.8	6.1		6.1	1.2	5.4		2.8	3.6	2.7
30	5.9		7.5	5.6		6.8	2.8	4.9		2.3	3.4	1.4
31	5.1		5.9				4.8	5.5		2.8		4.8

Year 1982

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2.7	4.8		4.8	3.4	3.1	3.4	5.1		5.6	2.0	2.6
2	2.1	5.1		6.3	3.4	5.2	5.1	4.6	6.0	5.1	2.3	7.2
3	2.1	4.8	7.5	8.2	4.3	2.3	5.6	6.7	5.6	9.5	2.8	2.6
4	4.8	4.1	4.8	7.3	6.3	3.0	4.1	4.6	5.8	3.1	3.8	6.3
5	4.1	5.5	5.5	8.9	5.2	3.9	6.6	5.6	7.7	9.0	3.6	2.6
6	4.1	5.5	8.3	5.3	5.1	3.9	4.6	7.2	7.5	6.4	3.1	0.6
7	4.1	5.5	4.8	6.1	4.6	3.1	8.3	5.6	6.1	3.1	5.1	6.2
8	4.1	6.8		6.0	6.4	5.0	5.6	2.1	8.2	2.6	2.6	0.5
9	4.1	4.1	6.3	6.2	6.0	1.7	7.7	5.1	8.2	5.7	10.8	0.8
10	4.1	4.8	6.8	6.8	6.6	4.6	5.1	9.2	6.7	6.3	3.6	0.4
11	3.4	5.4	6.8	4.7	8.2	5.6	4.6	4.6	8.2	3.9	5.6	3.2
12	4.1	5.4	6.3	4.2	5.4	4.3	5.5	6.7	8.1	1.3	5.1	1.0
13	3.4	6.1	6.6	6.1	3.8	5.1	6.2	4.7	7.2	5.6	3.6	4.1
14	4.9	6.1	4.1	2.0	3.8	3.6	6.6	5.1	7.7	2.1	8.3	1.6
15	6.1	6.1	8.9	3.8	5.7	4.1	4.6	6.2	6.6	3.1	2.9	5.1
16	4.8	5.5	5.5	5.2	3.4	4.3	5.1	5.7	5.6	5.6	2.5	2.8
17	4.6	6.3	6.1	2.9	8.9	3.8	5.6		6.0	2.6	1.0	2.8
18	3.4	6.3	6.8	4.2	4.5	4.1	4.1		6.4	2.3	3.6	2.5
19	4.1	6.3	8.8	7.4	3.4	4.0	5.6		9.2	4.1	0.7	3.0
20	4.1	4.8	6.8	6.0	3.0	3.1	5.1		2.5	5.1	5.9	1.6
21	4.1	6.1	6.8	3.4	3.4	6.7	3.1		4.0	4.1	1.7	3.1
22	4.1	6.1	2.8	6.0	2.0	4.1	6.3		8.2	4.1	4.6	0.8
23	3.8	6.1	4.8	8.0	4.6	6.4	7.7		5.1	5.6	5.1	1.6
24	4.8	7.5	4.8	3.9	2.5	3.1	4.6		6.7	7.8	5.9	3.1
25	5.1	7.5	0.4	3.3	3.1	7.2	5.4		4.7	7.8	1.4	2.6
26	4.1	8.3	6.1	6.3	4.2	3.8	7.7		6.7	5.0	3.6	1.0
27	5.3	7.5	0.5	6.6	3.8	5.7	5.1		5.1	5.8	0.3	2.1
28	3.4		6.5	2.2	2.7	4.6	6.1		6.2	2.6	4.2	1.1
29	5.1		5.1	6.2	4.6	5.1	4.6		5.6	0.9	2.9	1.0
30	5.1		6.3	0.4	3.1	5.1	5.1		3.6	1.1	4.1	5.6
31	4.8		7.5		4.1		6.4			6.2		1.0

Table A2. continued.

Year 1983

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	5.2	4.1		6.2	2.0	5.2	7.2	6.0	5.2	7.7	8.6	3.2
2	4.1	4.1		6.6	5.6	5.6	5.6	3.8	6.7	7.7	3.6	2.6
3	2.1	3.1		6.6	6.2	6.7	6.7	5.8	5.6	7.7	3.5	1.1
4	2.1	6.2		2.2	5.6	5.1	6.7	5.9	6.1	7.7	3.3	4.1
5	3.6	5.2	6.8	6.2	2.6	8.2	6.2	4.9	7.7	7.7	4.6	4.1
6	4.1	3.1	6.6	6.2	3.4	7.2	6.7		6.1	8.2	2.1	2.6
7	3.1	4.7	5.6	5.6	8.6	5.6	7.2		5.2	6.7	1.8	4.6
8	3.6	3.1	5.6	5.1	2.0	6.2	6.7		6.6	7.2	5.5	4.8
9	4.1	4.0	6.7	6.7	1.1	7.2	7.7		5.2	6.2	2.7	1.5
10	3.6	4.6	5.6	5.2	6.4	5.1	6.1		4.6	7.7	3.6	1.1
11	3.1	5.7	5.6	8.2	3.6	5.6	7.7		3.1	8.2	4.1	3.3
12	4.1	4.8	5.6	6.7	4.1	6.7	6.2		4.6	6.5	3.1	2.1
13	4.0	5.1	6.2	7.5	5.2	6.7	6.6		6.7	5.6	3.1	2.6
14	0.5	6.0	6.7	6.2	3.3	1.0	6.9		5.6	6.8	5.6	5.6
15	7.7	4.1	6.1	7.7	5.2	2.0	5.9		5.4	7.2	3.6	4.3
16	5.4	5.1	6.1	6.7	6.7	4.9	4.1		7.7	6.8	3.1	5.5
17	3.1	4.1	7.2	2.6	7.7	2.0	6.0		4.5	7.0	0.5	0.9
18	4.1	5.6	6.1	6.7	9.1	5.2	6.7		3.1	6.9	2.2	4.1
19	2.1	5.6	5.1	5.6	3.6	6.1	7.7		7.2	6.5	0.2	1.9
20	2.9	5.1	6.2	5.1	6.2	6.4	5.6		4.7	6.7	3.2	2.5
21	4.6	6.7	7.2	5.6	5.1	5.2	3.6		2.6	6.6	3.2	2.7
22	3.6	6.2	5.1	5.2	5.1	6.2	7.7		4.6	6.6	3.6	3.0
23	4.6	2.7	7.7	5.1	3.6	4.1	6.7		3.8	7.2	4.6	2.0
24	3.7	5.6	6.4	5.6	4.1	6.2	4.6		4.5	7.2	5.2	3.1
25	3.1	5.6	6.0	4.6	5.6	6.2	6.1		5.1	6.4	2.8	2.3
26	4.1	5.1	5.2	2.9	3.6	6.2	6.1	5.6	5.6	5.3	3.6	4.0
27	4.6	5.1	6.2	2.2	6.1	6.2	6.7	7.7	6.6	4.2	4.1	1.8
28	6.2	7.2	8.1	5.5	4.1	6.7	5.1	5.6	6.6	5.1	5.6	3.0
29	4.6		7.7	2.0	4.1	6.2	5.2	7.2	7.7	6.7	5.6	8.6
30	4.0		7.2	2.2	5.2	5.1	6.2	8.6	7.1	5.6	1.9	1.0
31	3.2		6.6		6.6		6.3	5.6		6.7		4.0

Year 1984

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2.4	2.1		4.6						1.0	4.2	0.6
2	2.6	1.0		2.9						1.7	1.4	1.1
3	3.8	3.1		3.6						4.9	3.8	3.1
4	2.0	2.5	2.2	3.6						8.4	5.2	5.4
5	0.5		3.6							3.2	3.5	2.0
6	2.7	4.4								1.3	2.6	0.8
7	3.9	3.4	3.6							6.2	4.6	3.9
8	2.0	5.3	4.0							3.5	3.0	2.2
9	4.6	1.1								6.2	4.4	3.9
10	3.0		4.1						7.8	5.1	3.0	3.2
11		4.3	5.8						4.6	6.6	5.1	4.2
12			4.1						7.4	7.3	0.5	4.6
13		2.0	4.1						9.0	6.4	1.0	4.1
14	3.2	1.5	4.8						7.1	5.3	3.1	3.4
15			3.6						6.0	6.6	5.5	4.2
16	1.0	0.3	4.6						8.3	7.1	2.0	4.5
17	1.6	2.1	4.6						6.5	4.7	0.7	2.9
18	4.3	3.2	4.1						8.1	1.6	4.0	1.0
19	4.8	3.1	4.6						6.5	1.1	2.2	0.6
20		3.1	4.6						8.9	5.4	4.0	3.4
21	2.0	3.0	4.6						3.6	6.5	3.5	4.1
22	4.6	3.6	3.6						4.2	2.3	1.5	1.4
23	4.1	2.8	3.6						6.6	6.0	3.6	3.8
24	5.1	3.1	5.1						9.3	8.0	0.0	5.1
25	3.6	5.1	4.6						5.3	5.5	2.2	3.5
26	1.4	5.6	5.2						3.8	4.1	5.0	2.6
27	2.6	3.6	5.9						7.6	7.3	3.9	4.5
28	1.5	0.9	4.6						5.6	4.7	3.4	2.9
29	1.0		4.5						7.6	6.8	4.5	4.3
30	2.5		4.4						7.9	4.7	2.9	3.0
31	3.1		6.6							7.8		5.0

Table A2. continued.

Year 1985 Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2.9	5.5							7.5	7.6	3.9	
2	3.9	3.5							5.3	5.7	2.0	
3	1.9	5.7							7.8	5.1	4.1	
4	4.2	4.8							6.8	6.6	3.2	
5	3.5	4.1							6.0	5.6	2.6	
6	4.3	2.2							4.0	7.2	0.9	
7	1.9	6.0							8.1	5.7	4.4	
8	5.3	2.6							4.5	5.9	1.3	
9	4.7	5.6							7.6	8.7	4.0	
10	3.8	4.0							5.9	2.9	2.5	
11	4.8	5.4							7.4	6.5	3.8	
12	5.2	4.4							6.3	4.7	2.9	
13	4.7	2.9							4.8	4.9	1.5	
14	4.0	2.4							4.2	5.8	1.1	
15	4.9	3.0							4.9	2.6	1.6	
16	5.1	6.3							8.3	7.3	4.6	
17	3.5	3.1							4.9	6.3	1.7	
18	1.5	5.3							7.3	5.0	3.7	
19	1.2	5.0							6.9	8.2	3.4	
20	4.0	3.6							5.5	8.3	2.1	
21	4.7	4.9							6.9	0.7	3.3	
22	1.9	6.2							8.2	3.0	4.5	
23	4.4	2.6							4.5	5.6	1.3	
24	5.7	4.5							6.4	3.4	3.0	
25	4.1	6.2							8.3	1.9	4.6	
26	3.1	6.6							8.7	9.3	4.9	
27	5.1	4.9							6.8	4.9	3.3	
28	3.5	7.1							9.2	5.8	5.4	
29	4.9								9.2	3.9	5.3	
30	3.6								9.4	5.3	5.5	
31	5.6									5.6		

Appendix B
Weekly Rainfall and Pan Evporation Data For Maha Iluppallama

Table B1. Weekly rainfall data (mm). Weeks beginning September 10

Year		September			October				November				December				January	
	10-16	17-23	24-30	01-06	07-14	15-21	22-28	29-04	05-11	12-18	19-25	26-02	03-09	10-16	17-23	24-30	31-06	07-13	14-20
1952/53									3.8	29.7	33.6	3.0	54.8	12.4	7.4	24.6	4.6	5.1	28.8
1953/54	52.9	0.3	0.3	9.4	246.5	26.4	38.1	80.5	0.0	136.1	43.7	31.0	0.3	39.9	15.0	160.6	51.0	50.3	1.3
1954/55	0.0	0.0	0.0	0.8	123.4	77.4	27.9	5.3	58.4	86.6	112.1	111.8	139.5	48.8	79.8	37.2	50.5	19.7	34.3
1955/56	225.8	25.6	56.9	0.0	7.1	66.5	4.6	138.2	3.8	59.1	50.3	53.9	20.1	0.0	0.5	13.7	0.0	50.1	0.0
1956/57	0.0	0.3	8.4	8.2	53.3	0.5	62.9	19.3	102.3	38.4	20.6	8.1	14.8	1.0	13.8	99.5	1.3	22.6	28.5
1957/58	1.5	0.0	36.8	0.0	14.0	129.8	163.3	172.7	63.9	91.4	98.9	54.9	90.4	147.9	351.6	476.8	16.2	2.6	0.0
1958/59	0.0	0.0	0.0	44.3	64.8	11.4	7.4	144.6	16.0	43.7	68.1	1.5	11.5	3.8	28.4	42.4	0.0	21.6	48.2
1959/60	18.0	65.2	3.6	0.0	0.0	72.4	47.3	54.8	90.0	42.7	96.4	150.0	4.9	88.6	32.6	21.6	33.8	8.4	45.2
1960/61	68.8	0.0	0.0	0.0	47.5	23.4	85.4	81.7	175.5	106.2	49.2								
1961/62	7.9	0.0	0.0	0.0	6.4	36.0	199.1	73.2	86.9	24.4	50.5	124.7	90.4	40.1	0.0	51.6	34.6	30.7	7.1
1962/63	34.8	1.0	4.1	25.4	357.6	126.8	10.7	7.1	44.0	0.0	31.7	79.7	3.3	2.8	89.7	90.7	123.2	45.2	6.1
1963/64	0.3	39.1	18.7	1.0	143.5	162.1	16.0	80.6	108.9	172.2	64.8	109.3	261.8	11.2	39.1	84.0	85.7	0.5	0.0
1964/65	3.0	0.0	0.0	0.0	76.5	10.9	72.5	48.3	51.9	88.9	28.7	10.4	27.7	6.1	63.9	1.8	0.0	7.4	41.4
1965/56	0.0	0.0	0.0	0.0	214.2	112.0	83.6	50.8	186.1	0.8	30.2	198.1	102.7	0.8	111.6	11.2	0.0	0.0	36.9
1966/67	3.3	84.8	55.7	109.3	29.4	109.0	9.5	53.1	240.8	110.8	26.9	37.6	47.5	4.6	12.5	120.6	2.3	0.0	7.6
1967/68	0.0	2.2	21.9	0.0	13.0	164.9	2.8	167.7	33.3	0.3	43.9	86.1	308.7	7.3	0.3	2.1	29.5	13.0	1.8
1968/69	0.0	37.6	11.4	0.8	60.7	97.4	22.9	109.1	95.0	173.9						0.0	5.9	37.6	6.4
1969/70	0.0	0.0	17.0	136.3	53.4	75.9	14.2	44.5	11.0	55.0	32.8	14.2	65.3	30.7	31.8	240.3	30.0	32.6	28.3
1970/71	36.3	10.7	27.0	29.2	76.2	48.6	0.0	11.7	99.2	55.4	11.0	176.8	37.6	78.5	18.8	15.0	73.2	55.8	0.0
1971/72	31.7	18.5	23.2	0.0	0.0	73.5	88.0	87.6	5.3	49.3	4.3	8.9	187.3	165.8	9.7	19.5	0.0	0.0	12.8
1972/73	7.4	14.2	59.1	72.3	68.8	120.9	37.1	101.2	57.2	34.8	1.0	20.0	34.3	12.8	78.0	42.9	0.0	0.0	0.0
1973/74	85.3	3.0	30.4	1.5	93.2	19.7	71.6	60.4	11.4	0.8	16.8	49.1	22.9	32.5	44.4	262.9	0.0	0.5	0.0
1974/75	183.2	19.6	1.5	0.3	0.8	0.0	19.3	8.9	25.4	1.3	71.1	1.3	17.5	78.4	2.0	76.2	1.1	0.0	30.5
1975/76	12.5	30.6	6.6	16.0	26.9	22.9	53.1	24.9	43.0	95.0	53.6	4.9	60.2	40.4	36.6	4.6	1.0	3.1	0.0
1976/77	0.0	0.0	45.2	11.1	184.9	51.8	0.0	105.5	85.6	56.6	64.9	96.1	23.4	31.6	114.0	22.4	5.1	84.8	0.0
1977/78	0.0	6.1	92.0	56.1	112.4	184.5	172.0	22.2	42.6	157.4	43.4	16.3	1.0	35.9	92.8	1.0	14.2	2.0	0.0
1978/79	0.2	0.0	9.3	0.0	0.2	98.5	188.9	183.4	22.0	0.0	356.8	3.5	34.0	43.8	120.0	27.8	0.3	0.0	0.0
1979/80	122.8	0.0	1.0	0.0	102.4	36.8	77.0	90.3	58.2	121.2	64.5	68.2	50.1	10.6	5.0	14.6	0.1	0.2	0.0
1980/81	0.0	77.2	114.6	1.7	85.5	44.4	43.2	30.1	78.3	236.0	62.8	46.0	5.9	51.2	46.3	9.7	72.9	0.0	0.0
1981/82	71.5	8.5	0.0	0.0	50.6	70.3	60.7	61.4	12.5	2.8	0.0	151.4	23.8	32.9	23.2	16.4	0.0	0.0	0.0
1982/83	0.0	42.0	0.0	105.0	33.3	1.8	104.5	65.2	37.9	43.9	83.4	94.3	9.2	35.0	32.5	8.7	0.0	4.0	0.0
1983/84	21.5	5.4	0.4	0.0	21.9	22.5	6.5	185.9	17.6	3.5	11.8	6.9	70.9	87.2	258.6	72.8	29.2	127.0	31.2
1984/85	0.0	120.3	158.5	17.6	1.0	0.3	90.0	9.8	53.7	129.8	64.2	48.7	97.1	2.5	20.6	36.5	40.2	0.0	22.4
1985/86	2.6	35.8	27.1	8.8	0.0	16.7	97.4	183.2	120.1										

Table B1. Continued. Weeks beginning September 11

Year		September				October				November				December				January	
	11-17	18-24	25-01	02-07	08-15	16-22	23-29	30-05	06-12	13-19	20-26	27-03	04-10	11-17	18-24	25-31	01-07	08-14	15-21
1952/53									3.8	38.6	24.7	3.8	54.0	12.4	11.2	22.1	6.1	2.6	40.9
1953/54	33.8	0.3	0.3	47.8	209.6	26.4	36.6	80.5	3.8	132.3	51.6	23.1	7.2	33.0	58.2	134.4	46.7	37.6	1.3
1954/55	0.0	0.0	0.0	0.8	137.1	68.3	23.3	8.3	55.4	94.0	104.7	125.3	133.1	41.7	97.6	20.7	65.4	3.5	39.4
1955/56	238.2	28.4	41.7	0.0	7.1	66.5	41.2	105.4	0.0	84.0	25.4	59.0	15.0	0.0	5.6	8.6	0.0	50.1	0.0
1956/57	0.0	0.3	9.7	6.9	53.3	0.5	64.9	17.3	104.3	37.4	23.7	4.0	15.3	6.3	28.3	79.2	1.3	22.6	28.5
1957/58	0.0	0.0	36.8	0.0	16.8	230.9	65.0	173.7	57.3	101.6	90.7	53.7	124.5	201.4	467.9	272.1	16.7	2.1	0.0
1958/59	0.0	0.0	0.0	61.8	50.1	8.6	31.5	120.5	18.5	54.4	54.9	12.2	0.8	3.8	43.4	27.4	0.0	37.3	32.5
1959/60	47.2	37.3	2.3	0.0	0.0	80.5	39.2	56.1	97.1	34.3	124.8	122.4	22.1	90.2	13.0	21.6	35.1	7.1	46.0
1960/61	68.8	0.0	0.0	0.0	47.5	23.4	85.7	154.3	106.4	102.4	49.2								
1961/62	0.0	0.0	0.0	0.0	22.1	82.0	140.4	70.2	93.2	22.4	52.5	118.9	89.9	40.1	0.0	51.9	45.7	25.9	0.5
1962/63	35.8	0.0	4.1	109.0	274.0	133.7	3.8	7.1	44.0	0.0	36.0	77.2	1.5	35.3	61.5	86.4	135.9	34.0	4.6
1963/64	3.9	35.5	19.2	8.9	144.5	153.2	17.3	78.8	108.9	174.7	70.7	128.6	243.5	1.8	57.6	112.2	39.0	0.5	0.0
1964/65	1.5	0.0	0.0	51.8	24.7	37.6	47.8	46.3	59.8	81.0	28.7	14.2	23.9	6.1	63.9	1.8	0.0	25.7	23.1
1965/56	0.0	0.0	0.0	0.8	236.5	111.0	61.5	139.2	98.5	1.3	29.4	202.7	98.1	0.3	111.6	11.2	0.0	2.8	34.1
1966/67	3.3	84.8	55.7	123.5	17.2	107.3	36.4	26.2	251.7	103.4	23.1	37.6	47.5	5.1	19.9	113.0	2.0	1.0	7.4
1967/68	0.0	2.2	21.9	0.0	24.9	153.0	3.3	167.2	33.3	0.3	46.4	96.6	295.7	7.3	0.3	2.1	29.5	13.0	1.8
1968/69	0.0	37.6	11.9	0.3	60.7	106.0	20.7	103.2	94.5	174.4	5.3					0.0	6.2	37.3	6.9
1969/70	0.0	0.0	30.7	126.4	50.6	86.8	4.6	42.5	12.7	53.0	40.7	6.3	67.8	37.3	58.0	212.4	23.6	31.6	28.3
1970/71	36.3	10.7	27.4	29.2	79.8	45.0	5.1	6.6	99.2	57.2	47.0	139.0	38.4	92.9	8.7	9.9	84.9	44.1	0.3
1971/72	26.6	27.2	11.5	0.0	0.0	83.7	107.0	58.4	5.3	49.3	7.9	12.2	237.8	114.0	4.1	19.5	0.0	0.0	12.8
1972/73	7.4	25.6	49.5	70.5	89.6	100.6	53.6	84.2	57.2	34.8	16.7	10.7	27.9	21.7	73.2	38.8	0.0	0.0	0.0
1973/74	85.3	3.0	31.9	0.0	93.2	38.2	88.7	30.9	5.3	0.8	43.7	27.3	17.8	43.2	67.2	229.4	0.5	0.0	0.0
1974/75	185.7	16.3	1.5	1.1	0.0	0.0	27.9	0.3	25.4	1.3	71.1	1.3	44.4	51.5	4.3	73.9	1.1	0.0	30.5
1975/76	15.3	28.3	6.1	16.0	26.9	27.2	56.7	17.3	43.0	95.7	56.7	0.8	60.2	46.8	30.2	4.6	1.0	3.1	0.0
1976/77	0.0	0.0	46.2	127.4	110.5	8.9	3.6	103.4	117.4	39.3	51.4	95.1	21.9	65.6	86.9	15.5	5.1	84.8	0.0
1977/78	4.3	68.1	43.4	41.9	118.2	254.5	92.7	23.3	48.9	150.0	50.8	9.9	1.7	83.1	44.9	3.6	10.6	2.0	0.0
1978/79	0.2	0.0	9.3	0.0	0.2	152.1	136.7	184.9	19.1	0.0	356.8	4.0	49.6	27.7	123.5	24.6	0.0	0.0	0.0
1979/80	109.9	1.0	0.0	0.0	102.8	44.6	105.3	53.8	64.7	115.7	78.8	52.9	56.1	4.6	5.0	14.7	0.0	0.2	0.0
1980/81	0.0	103.0	90.5	0.0	118.5	11.4	47.5	31.5	165.3	143.3	64.3	44.5	5.9	94.9	2.6	25.5	57.1	0.0	0.0
1981/82	75.6	4.4	0.0	0.0	50.9	70.0	63.8	58.3	12.5	2.8	0.0	174.8	0.4	51.1	5.0	16.4	0.0	0.0	0.0
1982/83	6.0	36.0	0.0	117.3	21.0	1.8	109.0	65.4	51.2	52.4	60.3	98.6	4.3	48.5	16.2	8.7	0.0	4.0	0.0
1983/84	17.5	5.4	0.4	0.0	21.9	22.5	32.3	163.1	14.6	15.3	0.0	22.3	93.8	125.6	205.8	53.9	24.2	153.1	5.8
1984/85	0.0	209.1	71.1	16.2	1.0	0.3	90.0	11.1	52.4	139.0	65.1	38.6	99.6	0.0	22.9	34.2	40.2	0.4	22.0
1985/86	0.0	52.8	11.1	7.8	0.0	16.7	135.6	145.0	120.1										

Table B1. Continued. Weeks beginning September 12

Year	September					October				November				December				January	
	12-18	19-25	26-02	03-09	10-16	17-23	24-30	31-06	07-13	14-20	21-27	28-04	05-11	12-18	19-25	26-01	02-08	09-15	16-22
1952/53									3.3	28.6	24.7	4.1	54.0	8.1	14.5	22.1	3.6	8.2	55.3
1953/54	3.6	0.3	0.3	53.9	204.0	26.2	116.3	0.5	16.3	119.8	54.6	20.1	7.2	33.5	131.6	60.5	55.6	28.7	2.3
1954/55	0.0	0.0	0.3	0.5	141.2	69.8	23.0	58.4	0.5	96.3	101.9	158.1	100.3	41.7	97.9	35.1	50.7	3.5	50.5
1955/56	248.6	37.6	22.1	7.1	1.0	65.5	45.3	101.3	0.0	97.7	11.7	59.2	15.0	0.0	11.2	3.0	0.0	50.1	0.0
1956/57	0.0	0.3	11.0	5.6	53.3	27.9	39.0	15.8	115.2	35.1	15.1	4.0	15.3	6.3	86.4	20.8	1.3	23.1	28.0
1957/58	0.0	0.0	36.8	0.0	16.8	230.9	74.1	185.4	43.1	104.4	85.4	84.1	123.8	188.2	664.5	57.7	15.2	0.8	0.0
1958/59	0.0	0.0	0.0	62.1	58.4	0.0	50.4	101.6	20.0	62.6	45.2	12.2	2.6	2.0	67.0	3.8	0.0	45.4	24.4
1959/60	80.2	5.8	0.8	0.0	10.4	70.1	52.9	42.4	97.6	51.3	108.3	121.4	33.0	79.8	24.7	15.0	29.5	7.1	77.0
1960/61	68.8	0.0	0.0	0.0	47.5	23.4	85.7	155.1	112.2	95.8	49.2								
1961/62	0.0	0.0	0.0	0.0	22.1	118.3	105.4	68.9	93.2	22.4	52.5	126.0	103.1	19.8	0.0	51.9	50.8	20.8	3.5
1962/63	35.8	0.0	4.1	130.6	262.1	126.3	3.3	8.1	41.2	12.7	44.6	57.4	0.0	55.9	63.5	63.8	137.7	32.2	4.6
1963/64	3.9	45.2	9.5	8.9	146.5	157.3	13.5	80.3	125.2	164.8	99.4	118.1	216.9	0.5	109.2	65.9	33.7	0.0	11.9
1964/65	1.5	0.0	0.0	51.8	35.6	45.0	34.5	57.3	53.6	81.8	18.5	14.2	24.7	5.3	65.4	0.3	0.0	48.8	0.0
1965/56	0.0	0.0	0.0	58.5	252.5	48.2	58.7	139.7	89.9	3.6	34.0	216.9	77.0	27.0	84.9	11.2	0.0	36.3	4.7
1966/67	3.3	115.8	25.0	128.0	62.7	57.0	52.1	19.6	297.2	66.8	5.1	50.8	34.3	5.1	36.9	96.0	2.0	4.0	5.4
1967/68	0.8	16.9	6.4	0.0	27.4	150.5	104.9	66.1	32.8	37.1	50.7	63.4	289.3	5.3	0.3	2.4	41.4	0.8	1.8
1968/69	2.8	34.8	11.9	0.3	61.5	108.8	71.7	53.9	122.7	141.2						0.0	6.2	39.6	11.2
1969/70	0.0	0.0	30.7	126.4	57.7	79.7	14.3	36.6	33.5	28.7	40.4	16.0	58.1	37.3	105.0	165.4	44.4	10.8	28.3
1970/71	0.0	10.7	27.4	29.2	79.8	45.0	6.1	5.6	99.2	59.0	81.3	102.9	50.6	81.0	8.4	9.9	87.9	41.1	7.7
1971/72	36.6	29.5	9.2	0.0	0.0	95.9	94.8	58.4	5.3	49.8	7.4	43.7	209.1	112.5	3.8	18.5	0.0	0.0	12.8
1972/73	7.4	25.6	57.6	62.4	94.2	96.0	57.7	81.9	56.9	33.3	17.2	28.2	9.9	23.5	102.6	7.6	0.0	0.0	0.0
1973/74	88.3	3.0	28.9	0.0	97.0	36.2	92.7	27.6	2.8	0.8	44.5	40.0	4.3	59.7	57.8	222.3	0.5	0.0	0.0
1974/75	185.7	16.3	1.5	1.1	0.0	0.0	27.9	0.3	25.4	1.3	71.6	0.8	93.9	2.0	21.1	57.1	1.1	0.0	30.5
1975/76	15.6	34.1	0.0	17.0	25.9	32.8	56.7	12.7	46.3	116.3	32.6	1.5	58.7	58.5	18.5	4.6	1.0	3.1	0.0
1976/77	0.0	0.0	46.2	139.6	98.3	8.9	3.6	140.5	80.8	39.1	61.8	92.3	14.3	65.3	102.4	0.0	7.6	82.3	0.0
1977/78	4.3	73.1	38.4	60.8	101.4	295.2	49.9	24.3	194.7	3.2	50.8	9.9	2.5	88.8	38.4	3.6	10.6	2.0	0.0
1978/79	0.0	0.0	9.3	0.0	2.1	150.3	136.6	186.5	17.5	4.7	352.1	7.3	61.3	12.7	142.3	5.8	0.0	0.0	0.0
1979/80	85.6	1.0	0.0	0.0	104.1	64.5	122.1	20.2	61.7	124.6	68.5	59.0	50.0	4.6	6.6	13.1	0.0	0.2	0.0
1980/81	0.0	190.0	3.5	3.4	126.5	9.5	38.0	31.9	232.1	76.1	77.5	31.3	8.9	91.9	2.6	35.6	47.0	0.0	0.0
1981/82	37.9	2.6	0.0	0.0	50.9	70.2	63.6	58.3	12.5	2.8	5.1	170.1	0.0	55.7	14.0	2.8	0.0	0.0	0.0
1982/83	39.5	2.5	17.7	114.1	6.5	44.0	78.1	54.1	61.8	42.8	75.8	82.4	25.8	34.1	17.8	0.0	0.0	4.0	0.0
1983/84	17.5	5.8	0.0	0.0	21.9	22.5	37.4	164.4	8.2	15.3	0.0	26.4	90.2	130.6	215.9	38.3	24.2	153.1	5.8
1984/85	0.0	211.6	78.6	6.2	1.3	0.0	90.0	12.3	51.2	153.5	69.6	19.6	99.6	0.0	23.4	43.2	30.7	15.9	6.5
1985/86	0.0	60.8	3.1	7.8	0.0	16.7	147.2	151.9	104.6										

Table B1. Continued. beginning September 13

Year		September				October				November				December				January	
	13-19	20-21	27-03	04-10	11-17	18-24	25-31	01-07	08-14	15-21	22-28	29-05	06-12	13-19	20-26	27-02	03-09	10-16	17-23
1952/53								11.9	0.0	99.4	3.9	11.5	50.6	10.4	16.5	17.8	5.1	6.7	66.7
1953/54	0.0	0.3	0.3	81.1	177.1	25.9	116.3	0.5	17.8	118.3	74.7	0.0	9.0	32.5	166.1	26.7	56.1	27.5	3.0
1954/55	0.0	0.0	0.8	0.0	142.0	70.0	22.0	58.4	1.8	193.3	14.0	160.1	88.2	73.4	83.2	17.8	51.7	3.0	110.7
1955/56	248.6	47.3	12.4	7.1	1.0	65.5	122.0	24.6	2.5	95.2	16.5	54.2	15.0	0.0	14.2	0.0	13.0	37.1	0.0
1956/57	0.0	0.3	12.5	21.1	36.3	33.5	35.7	16.5	113.5	33.8	16.1	7.1	11.2	6.3	111.7	5.8	1.8	36.1	14.5
1957/58	0.0	0.0	36.8	0.0	24.4	230.4	67.0	207.5	42.3	90.2	87.4	75.5	194.9	146.6	656.9	35.3	16.0	0.0	0.0
1958/59	0.0	0.0	0.0	62.1	58.4	0.0	93.6	58.4	20.3	72.0	35.5	13.0	1.8	2.0	70.8	0.0	11.4	58.4	0.0
1959/60	80.2	6.6	0.0	0.0	12.9	75.2	47.1	44.2	98.8	69.9	91.5	114.8	84.1	31.0	22.4	38.6	8.2	4.8	77.8
1960/61	0.0	0.0	0.0	0.0	47.5	29.5	98.7	193.4	62.2	93.7	43.9								
1961/62	0.0	0.0	0.0	0.0	22.1	136.6	149.1	74.2	29.7	20.4	59.1	117.6	116.8	6.1	0.0	51.9	50.8	21.3	18.2
1962/63	1.0	0.0	4.1	279.4	113.8	125.8	3.3	22.3	27.0	29.2	28.1	57.4	0.0	65.0	62.8	63.5	134.4	27.4	4.6
1963/64	3.6	50.5	4.2	8.9	168.9	135.2	13.2	86.4	125.2	160.5	121.5	99.3	211.8	0.5	109.2	66.4	33.2	0.0	20.0
1964/65	1.5	0.0	0.0	51.8	35.6	48.3	47.2	52.8	45.7	77.8	18.5	36.6	2.6	5.0	65.7	0.0	0.0	48.8	0.0
1965/56	0.0	0.0	0.0	177.1	137.2	65.5	38.1	139.7	89.9	8.2	33.5	256.5	33.3	61.3	59.5	2.3	0.0	36.6	10.2
1966/67	82.5	41.7	19.9	128.0	113.8	5.9	53.4	72.4	244.4	65.5	5.6	53.6	31.0	5.1	70.7	64.2	0.0	4.5	11.3
1967/68	1.1	23.0	0.0	0.0	27.4	153.3	104.9	64.6	31.5	39.9	54.5	196.5	153.1	2.3	0.3	6.5	37.3	0.8	1.8
1968/69	19.1	18.5	12.2	0.0	63.8	109.3	85.7	37.4	123.4	142.7					32.9	0.0	6.2	39.6	13.7
1969/70	0.0	0.0	30.7	132.8	53.1	79.4	45.3	4.1	34.5	48.5	23.4	12.2	58.4	47.4	111.9	153.7	44.9	4.7	28.3
1970/71	4.1	6.6	27.4	35.3	79.3	39.4	9.7	13.4	129.5	17.3	103.1	82.1	78.3	52.3	8.7	9.9	103.1	25.6	9.7
1971/72	26.6	30.0	8.7	0.0	0.0	110.9	79.8	63.7	0.0	50.3	6.9	61.5	215.9	87.9	3.8	18.5	0.0	0.0	12.8
1972/73	7.4	25.6	114.0	8.0	145.0	49.8	51.1	88.3	53.3	30.5	21.0	30.5	3.8	28.6	105.1	0.0	0.0	0.0	0.0
1973/74	88.3	3.0	28.9	0.0	99.5	35.7	93.2	25.1	2.8	0.8	45.8	43.0	11.9	47.8	107.1	173.0	0.5	0.0	0.0
1974/75	184.9	16.3	1.5	1.1	0.0	0.0	27.9	8.9	16.8	1.3	71.6	9.4	87.3	0.0	22.4	56.6	0.3	1.0	30.8
1975/76	15.6	34.1	0.0	17.0	25.9	60.5	29.8	15.5	43.5	120.6	27.5	5.3	57.7	68.4	5.8	4.6	3.0	1.1	0.0
1976/77	0.0	0.0	54.8	131.0	106.7	0.5	35.4	110.2	88.4	37.4	60.5	89.0	28.3	48.8	102.1	0.0	88.1	1.8	0.0
1977/78	6.1	72.0	37.8	69.1	152.6	256.7	28.8	41.7	179.2	1.3	50.8	9.9	29.4	63.4	36.9	7.2	7.0	2.0	0.0
1978/79	0.0	1.2	8.1	0.2	5.2	152.0	141.3	176.8	17.5	5.5	354.8	15.8	57.2	4.8	146.1	2.0	0.0	0.0	3.2
1979/80	81.7	1.0	0.0	0.0	104.1	,64.6	122.0	26.9	108.5	86.4	53.9	85.5	22.8	5.2	17.6	1.5	0.0	0.2	0.0
1980/81	0.0	191.5	2.0	13.6	116.3	38.1	9.4	50.5	217.2	76.2	74.0	33.1	44.9	56.4	0.0	52.1	30.5	0.0	0.0
1981/82	34.5	0.0	0.0	0.0	68.1	66.9	51.7	68.8	0.0	2.8	66.4	108.8	0.0	55.7	15.7	1.1	0.0	0.0	0.0
1982/83	42.0	0.0	18.7	119.6	1.8	69.2	56.2	49.0	68.8	47.3	74.6	72.4	25.2	34.1	17.8	0.0	0.0	4.0	0.0
1983/84	18.6	4.7	0.0	0.0	29.5	17.3	76.0	128.9	2.7	15.3	0.0	26.4	91.8	147.9	197.3	42.9	19.3	154.1	4.8
1984/85	0.0	213.3	80.9	2.2	1.3	0.0	90.0	15.8	128.8	72.4	89.2	0.0	99.6	0.0	26.2	40.4	30.7	21.4	1.0
1985/86	0.0	60.8	3.1	7.8	0.0	16.7	153.0	167.1	99.6										

Table B1. Continued. Weeks beginning September 14

Year		September				October				November				December				January	
	14-20	21-27	28-04	05-11	12-18	19-25	26-01	02-08	09-15	16-22	23-29	30-06	07-13	14-20	21-27	28-03	04-10	11-17	18-24
1952/53								8.1	0.0	59.7	4.1	18.9	47.3	5.8	29.7	4.6	5.1	13.8	62.4
1953/54	0.0	0.6	0.0	81.1	186.2	52.6	80.5	0.5	32.0	104.1	74.7	0.0	36.9	17.0	155.5	50.8	30.2	28.0	2.5
1954/55	0.0	0.0	0.8	3.3	145.1	66.1	19.5	58.4	8.9	188.5	11.7	163.7	86.4	80.5	76.1	18.5	49.2	11.9	101.8
1955/56	169.4	47.3	12.4	7.1	6.1	60.4	123.8	22.8	2.5	95.2	47.0	23.7	15.0	0.0	14.2	0.0	32.8	17.3	2.0
1956/57	0.0	0.3	13.8	33.5	22.6	33.5	35.7	17.5	113.3	33.0	19.1	13.0	2.3	6.3	101.7	5.8	18.8	32.3	1.3
1957/58	0.0	0.0	36.8	0.3	58.1	196.4	67.0	207.5	42.3	110.0	101.1	92.3	144.6	201.7	610.9	33.3	8.9	0.0	0.0
1958/59	0.0	0.0	4.6	57.5	58.4	0.0	120.5	31.5	35.8	56.5	36.5	12.0	1.8	2.0	70.8	0.0	11.4	58.4	0.0
1959/60	80.2	6.6	0.0	0.0	12.9	76.5	45.8	67.6	77.2	95.0	113.6	65.8	89.7	35.6	15.0	40.4	6.6	1.8	86.9
1960/61	0.0	0.0	0.0	0.0	47.5	98.1	46.9	197.4	56.1	83.3	41.4								
1961/62	0.0	0.0	0.0	0.0	22.1	136.6	149.4	74.7	30.7	19.6	63.4	192.3	36.8	6.1	0.0	51.9	50.8	21.3	20.5
1962/63	1.0	0.0	9.4	366.0	98.6	49.1	3.3	24.1	25.2	29.2	28.1	57.4	0.0	65.0	116.9	33.5	110.3	27.4	4.6
1963/64	6.1	49.0	3.2	8.9	173.2	140.0	8.9	81.6	126.2	164.8	122.0	123.0	182.3	1.0	109.7	65.4	33.2	0.0	24.1
1964/65	0.0	0.0	0.0	51.8	35.6	48.3	53.6	50.5	41.6	78.3	18.0	36.6	5.6	2.8	64.9	0.0	0.3	48.5	0.0
1965/56	0.0	0.0	0.0	180.7	135.6	71.1	35.6	134.6	89.9	12.5	30.5	281.9	6.6	86.2	35.6	1.3	0.0	36.6	19.6
1966/67	82.5	41.7	24.5	122.4	116.1	3.6	53.4	196.4	164.1	26.4	1.3	70.1	14.2	9.2	66.6	64.2	0.0	4.5	11.3
1967/68	1.4	22.7	0.0	0.0	31.0	149.7	106.9	62.6	31.8	42.1	82.0	312.3	7.3	2.3	1.6	30.3	12.2	0.8	1.8
1968/69	27.7	9.9	12.2	0.0	67.1	106.0	100.2	71.7	79.4	137.9					28.2	0.0	27.5	18.3	13.7
1969/70	0.0	17.0	13.7	132.8	53.6	78.9	45.3	4.1	37.0	46.3	23.1	12.2	58.4	55.3	127.9	129.8	46.2	6.7	25.0
1970/71	4.1	34.0	0.0	35.3	94.3	24.4	11.7	20.0	120.9	17.8	117.6	67.6	77.8	52.6	17.5	17.6	111.4	0.5	24.9
1971/72	26.6	30.0	8.7	0.0	16.8	111.1	63.1	63.4	39.9	10.4	9.4	66.6	212.1	84.1	11.9	10.4	0.0	0.5	12.3
1972/73	7.4	30.4	110.7	25.0	158.3	44.7	87.2	29.3	73.9	6.1	21.0	30.5	4.6	83.9	49.0	0.0	0.0	0.0	0.0
1973/74	85.8	27.9	4.0	0.0	103.8	36.2	88.4	25.6	2.3	0.8	47.3	41.5	11.9	48.8	203.4	75.7	0.5	0.0	0.0
1974/75	36.1	16.3	1.5	1.1	0.0	0.0	27.9	25.7	1.3	8.9	63.5	9.1	86.8	0.0	27.2	51.8	0.3	1.0	45.0
1975/76	16.4	33.3	16.0	1.0	27.2	70.1	26.5	38.9	15.5	125.2	19.9	36.8	26.2	68.4	5.8	4.6	3.8	0.3	0.0
1976/77	0.0	0.0	54.8	140.4	97.3	0.5	60.0	85.6	89.7	36.4	61.2	96.4	19.9	76.7	74.2	0.0	89.9	0.0	0.0
1977/78	6.1	72.0	41.8	65.1	187.2	225.1	25.8	44.1	178.1	1.5	49.3	9.9	29.9	87.5	12.3	14.2	0.0	2.0	16.8
1978/79	0.0	3.4	5.9	0.2	5.8	153.5	160.0	158.3	15.2	32.2	328.1	15.8	58.7	3.3	146.1	2.0	0.0	0.0	9.1
1979/80	79.4	1.0	0.0	15.4	88.7	87.3	100.4	31.6	104.3	112.8	27.9	84.7	26.2	4.8	13.4	1.5	0.0	0.2	0.0
1980/81	0.0	191.5	2.0	23.1	106.8	38.1	9.4	50.5	235.5	60.4	75.8	28.8	44.9	56.4	0.0	82.6	0.0	0.0	0.0
1981/82	34.5	0.0	0.0	0.0	101.9	48.1	50.3	55.2	0.0	2.8	68.9	106.3	0.0	56.1	15.3	1.1	0.0	0.0	0.0
1982/83	42.0	0.0	64.9	73.4	1.8	81.9	75.6	22.6	64.2	48.4	72.4	72.4	25.2	34.1	17.8	0.0	0.0	4.0	1.2
1983/84	18.6	4.7	0.0	21.9	15.7	9.2	142.1	65.5	0.0	15.3	5.5	22.9	123.2	172.0	139.8	43.4	72.0	100.9	4.8
1984/85	0.0	232.2	63.5	0.7	1.3	0.0	90.0	16.1	128.5	74.2	87.4	1.9	97.7	0.0	31.2	60.4	5.7	21.4	1.0
1985/86	0.0	60.8	10.6	0.3	0.5	84.7	89.0	177.6	97.7										

Table B1. Continued. Weeks beginning September 15

Year	September				October				November				December					January	
	15-21	22-28	29-05	06-12	13-19	20-26	27-02	03-09	10-16	17-23	24-30	01-07	08-14	15-21	22-28	29-04	05-11	12-18	19-25
1952/53								3.8	18.3	45.0	3.0	23.8	40.4	8.9	26.1	4.6	5.1	15.8	60.4
1953/54	0.3	0.3	1.5	219.6	46.2	53.1	80.5	0.0	90.4	50.5	69.9	0.0	38.4	15.5	155.5	51.3	54.6	3.1	2.5
1954/55	0.0	0.0	0.8	7.1	162.9	45.5	18.5	58.4	11.4	187.3	16.0	193.2	54.3	81.6	72.0	18.5	51.7	9.4	111.5
1955/56	78.2	59.7	0.0	7.1	58.4	8.1	136.0	10.6	2.5	95.2	52.1	20.1	13.5	0.5	13.7	0.0	45.0	5.1	2.0
1956/57	0.0	0.3	16.6	43.4	9.9	58.1	20.0	15.2	112.8	37.6	8.4	14.0	1.3	6.6	107.2	1.3	22.6	28.5	0.0
1957/58	0.0	0.5	36.3	14.3	54.1	190.0	77.4	195.8	46.4	111.0	94.8	91.5	144.6	285.3	535.9	24.7	8.9	0.0	0.0
1958/59	0.0	0.0	11.5	51.4	57.6	0.0	138.8	13.2	35.8	56.5	36.5	12.0	1.8	2.0	70.8	0.0	11.4	58.4	0.0
1959/60	80.2	6.6	0.0	0.0	51.3	38.6	46.8	116.4	36.6	105.3	140.8	18.9	92.4	32.6	20.8	34.6	6.6	1.8	86.9
1960/61	0.0	0.0	0.0	0.0	55.4	91.0	66.7	195.3	110.8	48.7	17.3								
1961/62	0.0	0.0	0.0	0.0	37.8	164.6	110.3	70.1	34.0	55.9	45.9	172.5	36.3	4.3	0.3	51.6	50.8	21.3	20.5
1962/63	1.0	2.8	6.6	367.5	102.2	44.0	4.3	43.2	5.1	29.2	28.1	57.4	0.3	65.5	117.4	49.0	93.5	27.4	28.7
1963/64	36.3	18.8	3.2	8.9	189.5	123.7	15.8	74.7	131.3	179.8	103.2	143.5	160.5	31.2	90.9	65.4	21.8	0.0	24.1
1964/65	0.0	0.0	0.0	74.2	13.2	48.6	60.2	43.6	83.3	53.1	1.5	38.1	6.1	3.1	62.6	0.0	0.3	48.5	0.0
1965/66	0.0	0.0	0.0	205.3	112.8	88.4	16.5	158.2	66.3	19.6	85.4	220.9	5.6	111.1	12.0	0.0	0.0	36.6	19.6
1966/67	80.5	43.5	24.7	120.4	116.9	2.8	62.0	230.2	121.7	26.4	7.4	66.5	11.7	10.5	65.3	64.2	0.0	6.3	9.5
1967/68	1.4	22.7	0.0	0.0	65.0	115.7	107.2	62.3	31.8	42.4	83.5	312.8	5.0	2.3	2.4	29.5	12.2	0.8	1.8
1968/69	37.6	2.5	9.7	2.3	107.0	70.7	95.6	109.5	75.9	101.3					1.3	0.5	27.0	18.3	13.7
1969/70	0.0	17.0	87.6	75.2	61.2	55.8	44.5	4.1	54.5	28.8	25.6	14.8	53.3	58.9	160.9	93.2	48.5	18.4	11.0
1970/71	4.1	34.0	0.0	46.7	106.5	0.8	11.7	23.0	117.9	17.8	117.6	67.6	77.8	52.6	17.5	60.3	69.2	0.0	24.9
1971/72	32.2	26.4	6.7	0.0	47.0	81.7	82.6	43.1	49.3	1.0	10.2	109.5	202.4	50.1	11.9	10.4	0.0	2.3	10.5
1972/73	0.3	71.0	72.3	25.0	155.8	46.2	99.7	56.4	33.3	5.6	21.0	30.5	4.6	86.9	46.0	0.0	0.0	0.0	0.0
1973/74	24.1	30.4	1.5	0.0	108.6	46.4	73.9	25.1	2.6	0.5	48.1	40.7	28.2	33.0	231.6	47.0	0.5	0.0	0.0
1974/75	8.9	14.3	1.5	1.1	0.0	19.3	8.6	25.7	1.3	23.4	49.0	9.1	86.8	0.0	77.2	2.1	0.0	15.0	43.7
1975/76	42.8	6.6	16.0	1.0	27.2	71.6	27.0	40.7	31.5	116.3	9.0	60.2	20.1	51.1	9.1	1.3	3.8	0.3	0.0
1976/77	0.0	0.0	54.8	144.2	94.0	0.0	103.2	43.2	91.4	44.6	99.8	47.1	20.4	126.7	23.7	0.0	89.9	0.0	0.0
1977/78	6.1	73.5	57.0	79.8	158.6	222.3	25.8	44.1	178.1	3.0	47.8	9.9	29.9	88.6	11.2	14.2	0.0	2.0	17.4
1978/79	0.0	3.4	5.9	0.2	19.1	171.9	222.2	66.8	12.8	317.8	42.5	20.3	54.2	3.3	147.8	0.3	0.0	0.0	9.1
1979/80	0.2	1.0	0.0	55.7	48.8	91.5	95.8	36.1	135.9	78.0	27.9	86.6	23.0	5.0	13.8	0.9	0.0	0.2	0.0
1980/81	1.5	190.0	2.0	34.7	95.2	38.1	35.2	54.1	258.1	13.5	70.7	31.4	43.7	55.0	0.0	82.6	0.0	0.0	0.0
1981/82	33.0	0.0	0.0	3.5	98.4	63.0	78.1	12.5	2.8	0.0	124.5	50.7	5.1	51.0	15.3	1.1	0.0	0.0	0.0
1982/83	42.0	0.0	73.4	64.9	1.8	95.2	65.1	44.8	39.4	89.0	35.2	68.8	25.2	37.5	14.4	0.0	0.0	4.0	1.2
1983/84	16.8	3.7	0.0	21.9	15.7	9.2	148.7	58.9	1.0	14.3	6.1	36.4	109.8	191.5	150.6	19.5	108.9	61.7	0.4
1984/85	56.5	213.0	26.6	1.3	0.3	0.0	90.0	16.1	134.0	77.7	78.4	2.2	97.4	0.0	31.7	64.7	0.9	22.4	0.4
1985/86	0.0	60.8	10.6	0.3	5.0	100.2	122.5	142.5											

Table B1. Continued. beginning September 16

Year		September				October				November				December				January	
	16-22	23-29	30-06	07-13	14-20	21-27	30-03	04-10	11-17	18-24	25-01	02-08	09-15	16-22	23-29	30-05	06-12	13-19	20-26
1952/53								3.8	23.8	39.2	3.0	27.4	39.8	7.4	24.6	35.3	50.3	1.3	2.5
1953/54	0.3	0.3	2.3	235.6	36.8	45.7	80.5	0.0	128.5	50.5	31.8	0.0	38.4	15.5	155.5	57.4	50.3	1.3	2.5
1954/55	0.0	0.0	0.8	21.3	174.4	19.8	18.5	58.4	64.0	134.7	102.1	140.6	20.8	81.6	72.0	18.5	51.7	12.7	112.0
1955/56	22.8	59.7	0.0	7.1	59.9	10.4	137.0	5.8	2.5	106.9	40.4	33.6	0.0	0.5	13.7	0.0	50.1	0.0	2.0
1956/57	0.3	0.0	16.6	43.4	10.4	62.9	19.3	45.4	78.5	37.1	8.4	14.0	1.3	13.5	100.3	1.3	22.6	28.5	0.0
1957/58	0.0	0.5	36.3	14.0	122.2	161.8	44.6	196.3	53.3	96.8	98.1	87.9	145.1	285.8	548.9	16.0	3.6	0.0	3.8
1958/59	0.0	0.0	14.8	94.3	11.4	2.3	149.7	1.5	36.6	56.2	35.0	11.5	3.3	0.5	70.8	0.0	11.4	58.4	0.0
1959/60	80.2	6.6	0.0	0.0	66.0	24.2	46.5	127.8	25.2	113.4	150.2	1.4	92.4	32.6	20.8	34.6	6.6	1.8	86.9
1960/61	0.0	0.0	0.0	47.5	23.4	76.5	90.6	171.4	110.3	49.2									
1961/62	0.0	0.0	0.0	3.6	38.0	162.6	110.5	85.9	23.6	49.0	54.8	163.1	40.6	0.0	5.9	49.3	50.8	18.0	20.5
1962/63	1.0	2.8	7.1	374.9	108.0	30.3	7.6	45.0	0.0	31.7	69.3	13.7	0.3	91.4	91.5	73.4	95.0	6.1	27.4
1963/64	38.8	19.0	1.0	63.0	211.6	47.0	40.7	61.2	225.8	74.9	128.9	265.6	11.7	39.1	84.0	85.7	0.5	0.0	24.1
1964/65	0.0	0.0	0.0	76.5	10.9	48.6	67.6	52.2	81.0	39.4	3.3	36.3	6.1	60.3	5.4	0.0	1.8	47.0	0.5
1965/56	0.0	0.0	0.0	205.3	116.1	88.4	40.1	150.6	47.0	24.4	83.9	221.9	1.3	111.9	11.2	0.0	0.0	36.9	19.3
1966/67	80.2	60.3	14.0	122.9	110.8	1.1	61.5	238.0	113.6	26.4	8.9	75.9	4.4	13.5	86.6	36.3	0.0	7.6	8.2
1967/68	2.2	21.9	0.0	0.0	69.7	111.0	167.7	2.1	31.5	43.9	85.6	309.2	7.3	0.3	2.1	29.5	12.2	0.8	1.8
1968/69	37.6	10.4	1.8	59.2	66.4	54.4	110.1	95.0	76.9	101.3					0.0	0.8	40.4	4.6	13.7
1969/70	0.0	17.0	95.7	87.4	67.3	29.4	44.5	7.4	58.6	21.4	25.6	56.2	11.9	59.2	209.6	44.2	49.3	21.2	7.4
1970/71	4.1	34.0	0.0	89.9	64.1	0.0	11.7	43.6	97.3	21.9	140.2	65.3	61.0	45.0	18.0	62.3	66.7	0.0	53.9
1971/72	39.8	25.2	0.3	0.0	66.1	92.6	69.1	26.6	49.3	3.3	7.9	167.7	151.8	42.5	13.9	8.4	0.0	12.5	0.3
1972/73	3.3	70.0	72.3	58.1	127.8	40.6	101.5	57.2	34.8	0.0	21.0	30.5	11.5	80.3	45.7	0.0	0.0	0.0	0.0
1973/74	3.0	30.4	1.5	0.0	112.4	70.8	57.4	15.7	0.3	16.0	48.6	24.7	31.5	29.7	231.6	47.0	0.5	0.0	0.0
1974/75	20.6	0.8	1.5	1.1	0.0	19.3	8.6	25.7	1.3	38.1	34.3	17.0	78.9	0.5	77.7	1.1	0.0	24.1	35.4
1975/76	30.6	6.6	16.0	26.4	1.8	73.4	26.2	42.0	81.0	66.3	7.2	60.2	31.5	42.7	7.4	1.0	3.1	0.0	0.0
1976/77	0.0	0.0	56.3	156.7	80.0	0.0	105.5	82.0	55.6	45.9	115.6	24.7	20.4	127.5	22.9	5.1	84.8	0.0	0.0
1977/78	6.1	73.5	74.6	63.4	211.2	168.5	40.6	29.3	178.1	13.4	46.0	1.3	29.9	91.1	8.7	14.2	2.0	0.0	17.8
1978/79	0.0	3.4	5.9	0.2	37.6	155.0	239.1	55.5	5.6	356.8	3.5	25.5	49.0	12.7	138.4	0.3	0.0	0.0	9.1
1979/80	0.0	1.0	0.0	95.4	9.1	102.1	92.4	41.4	129.6	80.4	43.4	63.1	22.4	5.0	14.6	0.1	0.0	0.2	0.0
1980/81	36.1	155.4	2.0	83.7	46.2	39.5	33.2	65.9	247.3	63.9	30.5	21.4	42.5	55.0	0.0	82.6	0.0	0.0	0.0
1981/82	32.5	0.0	0.0	50.6	62.1	68.9	61.4	12.5	2.8	0.0	151.4	23.8	17.9	38.2	16.4	0.0	0.0	0.0	0.0
1982/83	42.0	0.0	73.4	64.9	1.8	102.9	66.8	37.9	40.5	86.8	53.9	48.7	35.2	33.2	8.7	0.0	4.0	0.0	1.7
1983/84	17.6	2.9	0.0	21.9	22.5	2.4	164.8	42.8	1.6	13.7	6.1	68.7	84.6	186.4	148.6	22.2	123.4	44.5	0.4
1984/85	71.5	205.8	18.8	1.3	0.3	77.0	22.3	52.7	119.1	53.2	71.9	2.2	97.4	2.4	50.8	44.1	0.0	22.4	0.4
1985/86	5.5	55.8	10.1	0.3	11.5	94.2	124.7	151.8											

Table B2. Weekly pan evaporation data (mm). Weeks beginning September 10

Year		September			October				November				December					January	
	10-16	17-23	24-30	01-06	07-14	15-21	22-28	29-04	05-11	12-18	19-25	26-02	03-09	10-16	17-23	24-30	31-06	07-13	14-20
1952/53									24.8	23.0	26.9	25.1	17.0	18.5	22.8	25.7	23.0	27.0	21.3
1953/54	47.6	47.4	48.7	33.9	36.9	28.6	29.8	19.6	25.5	17.9	18.6	21.9	19.4	26.8	14.7	19.8	17.1	26.8	25.8
1954/55	46.5	41.4	41.8	22.9	39.3	36.4	36.4	26.6	18.7	22.4	21.9	21.0	22.5	21.9	23.5	17.9	24.3	26.6	25.6
1955/56	47.5	51.5	45.4	29.9	35.7	39.4	32.9	21.9	22.5	22.3	23.6	20.6	17.5	21.7	24.6	20.9	26.0	25.8	21.5
1956/57	42.2	42.2	45.4	30.8	32.8	29.5	30.9	25.3	21.1	26.4	17.4	15.2	22.3	18.3	18.5	20.9	27.6	22.4	19.5
1957/58	56.5	64.8	55.2	51.4	51.6	29.1	19.7	20.6	17.3	17.9	11.8	14.8	11.0	15.8	10.4	14.1	19.2	19.6	28.2
1958/59	42.2	42.2	45.4	30.8	32.8	29.5	30.9	23.2	22.4	14.8	21.8	25.0	24.8	26.7	26.4	19.0	28.5	23.8	18.6
1959/60	49.9	37.7	45.2	39.8	53.0	35.0	16.2	24.0	16.9	18.4	13.3	13.7	22.1	15.6	19.4	19.7	20.9	23.9	21.8
1960/61	46.2	54.3	48.5	55.3	50.0	32.5	17.9	21.8	11.2	14.2	17.6	19.0	18.8	21.7	25.1	22.0	19.1	26.8	25.3
1961/62	49.0	46.9	43.3	52.1	51.0	35.5	21.3	25.2	27.8	16.4	14.7	20.2	15.8	17.4	29.7	22.0	19.7	18.7	23.1
1962/63	41.4	48.9	41.1	37.3	21.6	20.7	24.6	26.6	17.7	27.7	20.3	17.0	27.6	28.7	16.4	16.7	11.6	17.1	23.7
1963/64	52.7	45.8	38.7	48.9	41.4	18.0	25.7	22.5	22.4	15.3	15.6	11.6	13.5	22.2	20.1	15.6	7.7	13.1	17.4
1964/65	35.5	49.5	52.4	56.1	38.2	35.8	33.3	17.4	18.6	19.8	18.3	29.4	20.4	26.4	19.0	25.1	24.8	24.6	22.7
1965/56	53.5	53.2	50.9	51.4	30.9	27.3	21.0	23.7	24.7	28.8	18.2	16.0	13.9	28.2	12.8	19.4	26.9	31.3	25.8
1966/67	53.6	44.5	27.4	26.0	31.4	23.1	30.1	21.0	22.3	25.4	24.5	23.8	21.7	26.8	23.8	19.8	19.3	27.9	23.6
1967/68	56.9	48.0	40.9	50.4	45.9	25.2	32.8	30.7	28.5	32.2	18.5	17.7	13.8	17.6	27.2	10.4	14.3	21.2	25.9
1968/69	47.5	51.5	45.4	29.9	35.7	39.4	32.9	21.9	22.5	22.3	23.6	19.4	22.5	21.9	23.5	17.9	24.3	26.6	25.6
1969/70	36.9	38.3	35.9	21.2	28.2	21.4	17.4	17.7	24.9	14.4	21.1	23.8	19.3	20.2	19.0	24.1	31.0	29.2	31.9
1970/71	44.1	44.9	37.6	30.8	34.5	49.4	32.3	29.4	25.6	22.5	21.7	20.2	28.4	19.8	23.6	22.0	22.0	27.8	22.7
1971/72	37.6	34.9	44.1	28.5	31.5	49.4	32.3	30.0	18.7	23.8	18.7	17.8	17.0	19.2	19.1	17.5	31.0	25.5	22.9
1972/73	51.0	45.1	40.2	29.8	44.6	33.0	37.9	31.8	28.0	25.2	24.5	23.1	24.6	21.8	18.1	20.6	24.3	14.8	15.9
1973/74	45.8	44.4	50.4	32.0	19.6	25.6	40.2	24.9	26.0	10.5	13.2	25.3	14.0	12.0	19.4	23.3	23.8	27.0	15.6
1974/75	52.1	50.8	44.9	27.9	36.1	26.2	27.8	28.0	24.1	19.4	16.8	18.3	19.8	18.9	16.5	18.3	23.2	22.7	29.1
1975/76	45.4	52.1	44.7	44.7	32.5	26.1	25.0	30.3	22.3	21.3	28.4	18.3	21.8	28.2	17.2	25.9	28.6	18.0	28.7
1976/77	56.5	49.2	55.4	29.0	28.4	32.1	38.9	20.0	24.0	17.2	11.9	14.6	23.7	27.8	19.8	18.2	31.1	27.7	42.1
1977/78	54.4	53.5	43.4	34.2	21.1	21.9	18.6	30.9	26.3	19.5	28.8	25.1	25.1	21.8	17.8	29.7	17.4	24.6	28.3
1978/79	45.1	52.1	47.2	42.3	52.6	43.4	22.4	25.2	34.3	35.9	33.3	40.2	38.9	37.1	29.0	25.5	36.9	38.2	37.5
1979/80	21.6	35.9	51.9	54.5	51.1	34.9	26.0	23.1	28.7	23.8	21.4	27.7	20.8	24.1	21.1	23.1	28.0	29.9	27.4
1980/81	56.1	54.9	44.4	44.4	37.1	29.1	34.8	35.8	17.4	11.0	19.5	13.7	14.9	21.3	19.0	25.8	20.1	28.9	27.5
1981/82	22.3	27.2	32.4	40.7	27.4	29.7	21.9	20.1	24.1	22.6	17.9	22.7	23.8	34.0	18.1	21.8	24.7	27.3	32.0
1982/83	50.1	41.4	38.6	41.8	27.5	26.9	38.7	19.1	34.4	27.0	25.3	24.9	19.6	18.2	15.4	16.5	22.2	25.6	25.8
1983/84	37.7	30.5	43.2	53.4	48.2	47.7	42.2	38.0	24.4	21.2	22.8	26.6	22.8	24.5	17.1	23.8	18.0	21.3	19.5
1984/85	50.2	44.4	47.1	26.7	40.4	33.0	37.9	33.9	26.2	16.8	17.0	21.4	21.3	28.2	17.2	25.9	25.7	30.4	24.2
1985/86	41.8	44.2	58.0	43.5	39.4	38.4	33.9	28.0	19.5	17.1	22.2								

Table B2. Continued. Weeks beginning September 11

Year		September				October				November				December				January	
	11-17	18-24	25-01	02-08	09-15	16-22	23-29	30-05	06-12	13-19	20-26	27-03	04-10	11-17	18-24	25-31	01-07	08-14	15-21
1952/53									24.5	25.2	28.0	24.4	15.7	19.0	20.6	28.4	23.5	24.5	22.6
1953/54	46.4	50.1	45.4	33.4	41.2	24.1	31.4	14.8	26.4	18.2	20.4	18.9	20.9	24.6	15.4	18.5	18.1	29.1	26.8
1954/55	47.9	41.9	34.6	29.6	36.2	35.5	36.1	24.2	22.3	21.5	24.3	16.0	24.8	20.8	24.4	19.3	22.8	26.7	29.3
1955/56	52.6	46.1	43.3	30.0	42.4	32.4	33.7	19.7	25.0	21.1	24.5	21.1	18.5	22.1	21.5	23.0	25.3	26.9	22.0
1956/57	40.7	45.1	43.2	30.6	29.8	35.1	28.5	23.0	19.0	29.5	14.9	17.1	21.6	17.0	20.9	20.2	28.4	23.6	18.5
1957/58	61.0	64.0	53.5	51.4	53.6	22.5	20.0	20.1	17.0	17.4	11.1	16.3	13.5	11.3	12.1	14.1	19.7	19.1	30.0
1958/59	40.7	45.1	43.2	30.6	29.8	35.1	28.5	21.3	21.2	13.9	23.4	24.0	26.5	26.1	25.1	20.6	28.9	21.2	20.9
1959/60	47.1	35.8	47.7	41.3	53.4	29.6	18.3	20.9	18.0	19.7	11.2	14.3	22.4	15.5	20.6	19.8	20.3	22.2	22.9
1960/61	44.6	55.6	48.5	55.8	47.8	29.7	17.6	21.6	10.8	15.6	16.3	19.3	19.7	23.6	24.0	20.6	18.1	29.1	26.3
1961/62	51.5	46.8	43.1	53.1	47.9	34.2	21.1	26.6	25.5	16.0	15.5	19.6	16.0	18.7	30.0	18.9	19.7	20.0	22.9
1962/63	41.7	48.5	41.8	32.3	25.4	15.8	28.7	25.5	17.4	28.1	19.7	16.6	28.3	27.3	16.0	18.0	9.5	20.0	24.2
1963/64	52.0	45.5	37.3	48.8	38.1	16.8	28.6	21.4	22.3	15.4	14.9	10.9	14.8	23.1	18.3	15.9	7.3	13.6	17.7
1964/65	39.8	49.5	52.9	54.9	38.4	35.0	30.5	16.0	21.0	21.1	18.6	25.4	26.0	24.5	18.3	25.3	24.6	22.0	26.8
1965/66	52.8	54.4	50.2	50.9	26.9	27.2	22.5	22.1	24.3	29.0	18.6	13.5	16.7	28.9	11.3	19.1	28.5	30.8	27.0
1966/67	53.3	40.2	29.5	22.6	34.0	21.6	27.5	24.6	21.5	23.4	26.5	24.8	19.4	26.8	23.8	17.3	22.1	26.9	23.6
1967/68	57.4	47.5	42.7	48.1	42.1	22.7	33.8	32.5	29.7	31.2	16.7	17.0	16.6	18.3	22.9	13.2	14.3	20.7	24.6
1968/69	52.6	46.1	43.3	30.0	42.4	32.4	33.7	19.7	25.0	21.1	24.5	17.3	24.8	20.8	24.4	19.3	22.8	26.7	29.3
1969/70	37.0	36.4	34.9	21.9	26.5	20.1	19.9	18.0	23.9	14.4	21.3	25.1	18.9	19.1	19.5	24.7	31.8	29.3	28.5
1970/71	44.2	43.3	38.6	31.5	32.4	51.5	31.7	25.8	27.8	21.6	19.0	22.3	27.0	22.0	21.8	24.0	21.4	27.0	22.1
1971/72	36.1	35.5	43.6	27.2	33.4	51.5	31.7	28.1	17.6	22.9	16.5	19.3	18.1	20.2	18.8	17.4	32.6	24.6	23.1
1972/73	49.2	46.0	38.1	33.5	43.8	28.7	42.4	29.9	26.9	23.0	24.8	25.2	25.6	20.6	16.7	20.5	24.3	15.9	15.9
1973/74	46.4	45.2	50.3	26.9	18.4	32.3	38.6	23.0	22.8	11.5	13.1	25.5	12.7	12.5	22.6	21.3	23.6	27.8	15.9
1974/75	50.3	53.5	44.2	24.7	34.4	28.1	28.1	24.9	23.4	19.7	17.4	19.2	19.3	16.8	17.2	20.2	23.8	20.9	30.0
1975/76	42.8	54.5	43.8	40.5	31.9	29.4	27.0	24.8	24.6	22.1	28.8	15.0	23.7	27.9	19.4	25.8	27.6	18.0	29.6
1976/77	54.7	51.1	52.3	27.5	30.3	32.0	38.9	19.9	23.0	14.2	11.3	17.9	23.5	27.3	18.7	20.3	29.1	31.3	41.8
1977/78	55.5	52.6	42.1	32.1	21.2	20.3	20.4	30.6	26.8	19.2	26.8	25.7	25.8	21.4	18.8	28.3	17.8	25.2	28.7
1978/79	46.1	50.3	46.6	44.9	52.7	41.5	18.6	27.9	32.7	38.5	32.6	40.9	37.2	37.1	26.9	29.4	36.5	38.4	36.5
1979/80	18.4	40.9	51.9	55.1	48.7	34.2	24.8	24.0	28.4	21.7	23.4	27.0	19.9	24.8	21.5	23.1	29.0	28.3	28.8
1980/81	55.0	52.0	45.6	43.7	34.1	32.8	31.6	38.0	12.2	13.2	18.8	13.3	15.8	22.3	19.0	25.3	22.1	28.5	28.5
1981/82	22.0	31.5	32.4	37.4	28.9	28.2	21.2	18.7	27.1	20.2	19.5	22.1	25.6	31.6	20.3	22.0	24.0	28.1	31.2
1982/83	49.4	42.1	37.5	38.8	28.0	27.9	35.5	21.8	35.9	22.6	28.2	23.9	17.4	20.6	15.7	14.4	24.3	23.0	29.9
1983/84	37.6	30.5	46.4	52.9	48.2	47.1	42.1	35.9	22.9	18.3	26.2	24.1	22.8	24.3	19.3	24.7	17.9	20.6	18.3
1984/85	48.9	47.2	38.8	29.2	43.5	28.7	42.4	30.6	23.2	18.5	19.8	19.5	21.4	27.9	19.4	25.8	22.6	32.5	24.9
1985/86	40.8	45.7	59.2	41.8	36.1	38.8	34.8	26.7	19.8	17.6	23.7								

Table B2. Continued. Weeks beginning September 12

Year		September				October				November				December				January	
	12-18	19-25	26-02	03-09	10-16	17-23	24-30	31-06	07-13	14-20	21-27	28-04	05-11	12-18	19-25	26-01	02-08	09-15	16-22
1952/53									27.9	25.1	25.3	24.8	17.9	18.8	21.5	28.3	23.4	22.8	26.3
1953/54	46.9	46.5	45.0	30.3	42.4	23.8	31.1	17.3	23.3	17.5	20.8	20.0	20.8	23.7	13.7	19.6	22.5	26.9	26.4
1954/55	51.8	38.5	34.9	27.7	34.6	39.0	35.1	20.1	22.9	19.5	26.6	17.1	23.5	21.6	24.0	18.1	22.9	31.1	24.6
1955/56	46.9	49.7	39.5	35.3	34.8	37.1	28.3	22.9	23.7	21.9	24.1	18.7	22.0	21.2	23.9	20.9	25.0	30.3	19.0
1956/57	41.7	42.2	40.4	35.0	28.8	29.2	32.4	21.3	20.6	27.2	15.6	14.9	25.2	17.8	18.5	21.2	29.5	23.3	19.3
1957/58	61.3	62.2	54.5	52.7	48.3	23.0	17.7	18.8	18.0	17.7	9.8	15.1	14.2	12.6	12.2	15.3	18.4	20.6	30.0
1958/59	41.7	42.2	40.4	35.0	28.8	29.2	32.4	21.0	19.2	14.3	25.0	24.1	25.9	27.2	22.0	23.2	29.0	19.1	23.0
1959/60	45.0	36.2	47.5	43.1	51.9	26.6	18.8	20.2	19.0	17.2	11.9	15.3	21.9	15.4	20.1	19.9	21.7	22.5	20.7
1960/61	45.0	54.9	49.5	55.8	45.4	27.4	19.0	19.1	11.5	15.7	16.8	18.5	19.3	25.0	24.0	18.1	22.5	26.9	25.9
1961/62	52.3	44.1	46.3	52.8	46.9	30.8	21.3	28.4	23.6	15.9	16.2	28.4	16.2	20.3	30.4	17.2	18.3	22.3	20.4
1962/63	41.6	46.5	43.4	29.0	26.2	16.6	29.0	24.5	17.4	26.2	19.3	19.2	28.6	24.1	17.4	19.1	7.9	21.9	24.5
1963/64	53.1	43.3	38.8	48.9	34.0	14.9	31.9	19.1	23.1	14.7	14.1	11.0	15.8	24.0	16.1	15.9	7.0	14.6	16.5
1964/65	41.3	48.2	56.4	53.4	35.6	33.8	29.7	16.8	22.5	20.8	18.1	24.7	27.0	24.3	16.2	25.6	24.6	20.5	31.3
1965/66	53.5	53.4	50.0	46.8	27.5	26.8	23.1	21.8	22.8	32.0	17.9	9.7	20.2	26.6	13.4	19.6	29.2	26.3	30.0
1966/67	52.0	35.6	31.6	22.0	32.6	23.1	24.9	25.1	23.4	22.6	27.0	23.0	21.4	26.1	23.5	14.5	25.4	25.4	24.9
1967/68	56.6	45.0	46.0	47.8	38.8	23.2	36.9	29.7	30.4	27.9	19.2	13.5	15.9	22.1	19.8	13.7	13.6	24.2	25.9
1968/69	46.9	49.7	39.5	35.3	34.8	37.0	28.3	22.9	23.7	21.9	24.1	18.2	23.5	21.6	24.0	18.1	22.9	31.1	24.6
1969/70	34.2	38.7	32.1	23.7	25.7	18.6	18.9	19.2	22.2	17.7	20.5	24.1	18.9	20.6	20.2	25.6	30.7	27.1	29.8
1970/71	43.6	40.7	38.9	31.6	34.6	48.9	32.8	23.6	28.8	20.7	19.1	23.0	27.0	21.0	19.8	28.9	19.3	25.9	20.4
1971/72	34.0	36.5	44.1	27.1	34.6	48.9	32.8	28.2	15.5	21.7	17.6	17.0	21.3	19.4	16.0	21.2	29.8	26.9	22.6
1972/73	47.2	45.9	37.6	34.7	44.4	27.6	41.1	28.9	28.8	22.1	23.7	24.7	24.2	21.3	17.5	22.6	20.9	15.1	20.3
1973/74	49.3	43.4	50.7	22.4	19.8	37.2	36.6	22.4	20.6	11.0	11.9	26.9	10.9	13.1	24.9	21.6	23.7	24.5	18.4
1974/75	50.4	49.6	44.3	27.2	30.5	30.4	27.7	24.9	21.8	19.9	15.9	20.2	19.6	17.4	18.2	17.3	25.5	23.6	27.0
1975/76	45.7	53.9	42.6	38.7	30.4	28.7	32.6	20.8	21.5	24.2	28.4	15.7	24.2	24.7	21.9	26.5	25.4	20.0	30.4
1976/77	52.5	53.2	47.2	28.5	29.4	34.6	34.7	22.3	20.9	12.9	12.5	16.2	29.6	24.7	16.6	22.8	28.2	34.5	40.4
1977/78	56.4	50.0	39.2	32.6	22.4	17.7	22.8	29.8	25.9	21.1	24.9	27.1	25.9	20.4	20.2	26.9	20.3	23.5	30.1
1978/79	47.5	49.7	44.9	47.9	52.6	39.1	14.9	33.2	31.3	37.9	33.0	40.9	36.0	36.5	24.6	33.2	36.8	38.2	35.2
1979/80	16.3	45.8	52.2	55.5	45.5	32.6	25.1	23.8	28.1	21.2	25.2	25.5	19.6	25.2	22.3	22.8	30.3	26.5	30.0
1980/81	55.4	49.6	46.4	43.0	30.9	35.9	29.6	35.8	11.2	15.2	17.7	13.6	17.2	19.4	22.1	24.6	23.1	28.3	28.5
1981/82	19.8	35.8	32.4	34.2	30.0	26.4	20.5	20.2	26.3	17.9	21.0	22.7	27.6	27.9	23.9	20.0	25.4	30.1	29.2
1982/83	47.6	40.4	37.9	39.4	27.9	27.9	31.0	23.8	36.4	24.9	22.6	29.9	14.3	19.9	15.8	17.0	22.7	27.1	25.8
1983/84	37.6	32.5	49.0	51.4	48.8	47.5	40.5	32.4	23.9	18.4	27.1	24.1	22.0	25.1	17.5	24.8	17.5	20.9	20.6
1984/85	52.4	44.4	35.2	33.7	44.4	27.6	41.1	28.5	21.6	21.5	19.7	21.0	20.2	24.7	21.9	25.2	25.0	32.1	21.9
1985/86	40.7	46.7	56.6	44.8	34.7	37.1	34.8	22.3	20.4	18.2	24.9								

Table B2. Continued. Weeks beginning September 13

Year		September				October				November				December				January	
	13-19	20-26	27-03	04-10	11-17	18-24	25-31	01-07	08-14	15-21	22-28	29-05	06-12	13-19	20-26	27-02	03-09	10-16	17-23
1952/53								20.6	25.6	26.7	22.1	25.4	17.0	21.3	22.5	25.7	26.3	22.1	22.2
1953/54	45.9	49.2	38.5	32.7	38.9	24.8	29.2	19.7	21.1	18.7	20.2	22.1	19.1	22.9	14.9	21.8	21.3	25.8	28.7
1954/55	52.7	38.3	35.8	29.2	35.2	34.2	36.3	16.4	23.0	22.1	25.8	19.6	20.5	23.4	24.2	17.1	26.4	26.2	27.6
1955/56	45.5	50.7	34.6	38.9	33.1	38.4	30.5	20.9	20.6	23.7	24.4	16.8	22.6	19.3	26.1	21.4	22.9	31.1	18.8
1956/57	42.0	44.3	37.0	33.9	26.8	32.2	32.1	18.8	20.5	26.2	14.0	17.1	26.1	18.0	20.3	19.9	28.2	21.8	23.6
1957/58	62.3	60.7	52.8	54.7	43.2	22.7	18.0	16.8	19.5	17.2	11.6	12.8	12.7	14.5	12.1	19.0	15.1	23.2	30.0
1958/59	42.0	44.3	37.0	33.9	26.8	32.2	32.1	18.9	18.4	16.7	23.5	23.2	27.2	27.9	19.3	25.2	27.2	18.7	25.0
1959/60	43.1	36.9	46.1	46.1	49.3	24.6	19.1	20.1	18.7	15.5	11.9	17.5	19.5	16.2	22.0	17.8	23.7	22.6	19.6
1960/61	48.5	53.8	50.4	55.5	43.4	24.1	20.6	16.1	12.3	17.2	17.3	16.6	19.7	26.8	24.0	19.2	21.3	25.8	28.2
1961/62	52.4	40.7	49.9	52.8	47.0	25.3	22.0	29.8	21.4	16.8	18.0	16.9	14.5	23.3	29.3	17.4	18.0	22.7	17.5
1962/63	44.4	45.2	44.3	25.6	26.2	16.6	30.7	21.2	19.7	23.7	21.3	20.1	28.5	22.4	16.4	19.6	8.4	22.8	25.6
1963/64	51.9	42.0	41.1	48.5	30.1	15.6	33.4	17.5	20.8	15.7	12.9	10.8	18.2	25.0	13.8	14.3	7.8	15.3	15.1
1964/65	42.8	48.6	58.1	49.6	33.5	36.6	25.7	18.0	23.1	19.0	21.1	20.9	28.8	25.1	15.6	26.9	25.1	19.8	30.8
1965/66	54.0	53.6	48.3	44.3	27.4	25.3	24.4	23.0	23.6	27.9	18.7	9.2	23.2	22.6	13.6	22.7	30.2	25.3	26.9
1966/67	51.5	32.6	33.6	20.2	31.8	26.2	21.1	26.8	22.4	23.4	26.2	21.8	24.4	24.6	21.7	15.5	27.2	25.2	22.8
1967/68	56.1	39.9	50.6	49.3	36.5	24.0	35.7	28.1	31.9	23.4	22.0	13.9	13.4	23.9	21.6	10.6	14.6	27.3	24.1
1968/69	45.5	50.7	34.6	38.9	33.1	38.3	30.5	20.9	20.6	23.7	24.4	19.1	20.5	23.4	24.2	17.1	26.4	26.2	27.6
1969/70	33.8	40.1	30.1	27.5	21.0	18.4	15.9	22.5	20.4	17.7	21.3	24.6	18.4	21.9	20.2	26.2	32.7	26.2	27.7
1970/71	44.0	41.4	38.5	30.8	36.8	44.9	34.9	20.9	26.1	23.0	18.6	23.6	26.4	23.2	20.6	25.6	21.0	25.5	17.5
1971/72	34.8	37.2	42.8	27.9	36.8	44.9	35.9	24.8	17.1	19.2	19.1	16.8	21.3	18.3	17.7	22.9	28.7	25.9	22.1
1972/73	46.1	42.8	35.5	37.6	44.0	30.9	40.9	24.3	27.4	24.3	21.9	26.5	22.5	21.3	17.0	25.2	17.9	16.0	23.6
1973/74	48.4	44.6	47.2	20.5	26.8	35.8	33.6	20.7	20.0	12.2	11.9	25.0	11.9	13.0	25.8	22.3	23.9	23.1	20.5
1974/75	47.8	50.0	41.6	28.9	31.9	30.0	27.6	23.7	20.5	23.1	11.4	21.3	19.8	15.9	20.3	15.7	28.4	23.5	24.8
1975/76	46.7	54.3	40.6	40.2	28.7	26.4	32.5	20.5	21.8	24.7	25.1	17.7	25.9	20.7	23.9	27.9	23.4	23.0	28.7
1976/77	50.7	54.2	44.4	27.9	28.1	37.5	32.7	23.5	18.5	11.0	12.6	17.3	31.2	22.7	18.6	23.1	27.5	37.0	39.3
1977/78	56.5	47.5	40.9	27.9	22.8	16.1	25.6	29.5	24.6	23.7	22.1	27.6	27.1	17.5	23.1	25.4	21.3	24.4	31.1
1978/79	49.3	49.1	43.6	50.6	50.4	35.2	15.1	36.8	30.6	38.4	33.1	40.7	36.1	36.4	22.8	35.3	36.4	38.3	34.7
1979/80	18.3	49.0	52.7	55.9	41.4	31.1	26.2	24.6	26.9	21.3	26.5	23.6	20.8	24.5	22.7	22.9	31.2	26.8	30.2
1980/81	56.4	47.1	46.3	43.2	27.1	38.5	29.2	33.1	10.3	17.4	16.1	14.4	17.9	19.7	22.4	24.0	23.9	28.3	30.5
1981/82	20.9	39.4	32.4	30.0	32.1	24.5	20.0	22.6	26.2	16.8	22.0	20.5	30.8	22.4	26.4	19.1	27.4	30.8	28.2
1982/83	48.7	37.9	40.7	36.2	24.2	33.1	29.4	22.7	39.6	18.3	25.1	28.3	12.7	21.9	13.8	20.1	22.7	28.4	25.0
1983/84	40.2	30.9	51.1	51.4	48.1	47.7	40.0	27.5	27.7	16.0	29.5	22.6	20.0	24.9	19.6	23.4	19.5	17.3	23.7
1984/85	51.5	41.7	36.3	33.9	44.0	30.9	40.9	25.3	20.1	21.9	19.6	19.6	22.8	20.7	23.9	26.5	25.8	32.5	21.2
1985/86	41.3	48.5	53.0	42.6	38.1	34.2	36.7	21.1	17.1	20.4	27.0								

Table B2. Continued. Weeks beginning September 14

Year	September				October				November				December				January	
	14-20	21-27	28-04	05-11	12-18	19-25	26-01	02-08	09-15	16-22	23-29	30-06	07-13	14-20	21-27	28-03	04-10	11-17	18-24
1952/53								19.8	20.3	30.3	18.5	22.9	17.5	21.3	24.2	25.7	25.5	20.8	20.1
1953/54	43.6	51.9	36.0	32.7	37.4	22.1	32.7	19.6	19.1	22.4	18.7	21.5	21.7	17.6	17.7	23.0	22.3	26.2	25.6
1954/55	50.0	39.1	31.9	34.7	33.8	37.8	30.3	14.5	25.2	23.2	23.4	18.9	22.6	21.3	25.4	15.9	28.8	25.1	28.5
1955/56	47.4	49.3	34.3	36.9	34.4	37.7	27.3	20.4	22.8	21.5	25.6	14.7	22.8	21.7	25.4	21.7	24.4	28.8	17.9
1956/57	41.2	44.7	32.3	39.4	28.1	28.5	30.9	20.8	19.2	25.3	15.3	18.9	23.1	17.3	20.7	23.9	23.9	21.0	27.7
1957/58	63.3	61.5	49.3	54.7	38.8	22.7	19.8	16.6	20.2	13.2	13.2	11.3	14.7	12.5	13.3	18.5	17.7	23.4	29.2
1958/59	41.2	44.7	32.3	39.4	28.1	28.5	30.7	20.7	17.1	18.4	22.4	24.1	28.1	27.9	17.4	27.2	25.9	17.8	26.6
1959/60	41.3	38.0	42.6	50.5	47.2	20.3	22.3	18.7	17.7	15.1	13.1	17.8	17.9	16.1	23.3	16.6	26.0	22.1	17.8
1960/61	52.7	52.4	51.1	55.7	40.1	21.9	20.1	14.3	13.9	18.2	16.9	19.2	18.0	26.7	22.6	21.9	22.3	26.2	25.1
1961/62	50.6	41.2	51.3	53.4	42.8	24.7	22.4	30.2	19.5	17.3	17.3	16.6	14.8	26.0	28.8	17.8	19.7	20.4	14.9
1962/63	45.8	44.4	45.0	21.4	25.8	18.1	30.7	18.4	22.5	22.9	20.1	21.6	28.4	22.5	14.6	19.2	9.4	23.4	26.1
1963/64	50.3	39.2	45.1	48.0	25.3	18.2	32.7	18.0	17.6	17.1	11.7	10.4	20.4	24.9	13.8	11.7	9.3	16.1	16.1
1964/65	46.8	47.1	58.6	48.6	32.5	36.6	23.6	17.0	24.7	16.4	25.7	19.1	27.5	23.4	18.6	26.9	26.6	18.8	31.1
1965/66	54.2	51.3	50.1	41.3	27.6	22.5	24.9	25.8	22.9	25.6	18.4	9.2	25.5	20.5	14.7	22.9	31.3	24.5	24.1
1966/67	49.8	33.6	29.8	24.0	28.2	29.3	19.0	27.0	22.8	23.9	23.6	24.4	26.6	23.6	19.7	16.5	27.2	26.2	21.8
1967/68	53.6	38.6	53.1	48.3	34.7	24.5	35.2	29.4	29.4	22.8	22.2	12.0	14.4	25.9	17.3	10.6	18.7	27.5	23.6
1968/69	47.4	49.3	34.3	36.9	34.4	37.6	27.3	20.4	22.8	21.5	25.6	17.9	22.6	21.3	25.4	15.9	28.8	25.1	28.5
1969/70	34.0	39.1	29.9	25.9	19.8	18.1	16.4	25.1	18.3	17.7	21.8	24.9	18.1	20.2	22.2	26.7	31.3	28.4	26.8
1970/71	44.2	39.6	37.7	30.8	38.6	43.3	35.5	22.1	24.9	22.0	18.2	26.4	24.9	25.4	18.4	24.6	22.1	25.9	14.9
1971/72	33.7	35.4	40.8	28.8	38.6	43.3	34.4	23.2	18.2	20.2	18.8	15.1	23.6	18.7	13.4	27.5	29.7	24.7	20.7
1972/73	45.0	43.0	34.2	38.4	39.0	34.8	41.0	23.0	27.3	23.3	19.8	30.3	21.5	18.8	17.9	25.7	16.7	16.5	26.8
1973/74	47.1	46.5	44.3	17.8	27.6	39.5	30.4	22.1	16.7	11.3	16.4	23.7	10.8	12.0	25.6	25.4	23.4	20.9	21.3
1974/75	46.7	48.7	36.2	33.8	30.7	25.6	31.1	21.6	19.8	23.8	11.8	21.0	22.9	11.5	21.6	16.8	28.8	23.4	22.8
1975/76	49.0	54.1	39.0	37.9	29.9	27.6	31.7	20.2	20.8	26.4	21.0	20.8	26.3	20.0	25.0	27.4	23.2	23.2	28.5
1976/77	49.8	54.6	42.3	24.6	30.8	38.8	30.3	21.4	18.3	12.0	12.3	20.7	30.7	21.5	16.3	26.4	28.4	36.8	39.0
1977/78	55.2	46.2	41.4	23.9	21.9	17.1	27.6	28.0	24.0	28.5	21.3	26.0	26.9	15.3	25.2	23.8	21.7	27.2	28.4
1978/79	50.5	48.3	42.6	50.6	50.9	31.3	17.9	35.8	32.0	36.0	36.4	40.4	35.9	36.1	21.3	36.8	36.3	38.6	34.6
1979/80	20.3	52.2	53.0	56.3	35.7	31.6	26.7	24.5	28.5	19.8	27.8	22.0	21.8	24.0	21.7	23.8	32.1	26.6	31.2
1980/81	57.5	44.3	46.5	43.1	24.5	39.8	30.3	28.3	11.4	18.4	14.7	15.1	17.7	18.4	25.4	22.7	25.6	27.9	31.9
1981/82	24.1	39.6	32.4	29.3	30.8	23.6	20.3	23.2	23.2	18.5	23.4	19.0	32.8	20.3	27.1	18.5	29.4	31.3	28.4
1982/83	44.0	40.5	38.7	37.0	22.6	38.6	23.6	23.3	39.9	20.0	23.4	26.0	16.2	19.4	14.3	20.1	24.2	27.9	25.6
1983/84	38.2	32.8	52.2	51.9	46.8	47.2	42.2	24.4	25.8	16.0	31.5	19.6	20.0	24.8	18.9	25.4	18.7	15.9	27.2
1984/85	51.4	40.4	37.1	32.1	39.0	34.8	39.6	24.1	22.6	17.9	22.6	15.9	26.1	20.0	25.0	23.9	27.7	32.2	23.4
1985/86	42.0	49.8	52.8	42.5	36.6	31.1	38.7	18.5	17.4	23.3	27.8								

Table B2. Continued. Weeks beginning September 15

Year		September				October				November				December				January	
	15-21	22-28	29-05	06-12	13-19	20-26	27-02	03-09	10-16	17-23	24-30	01-07	08-14	15-21	22-28	29-04	05-11	12-18	19-25
1952/53								21.9	24.3	27.4	24.3	20.5	16.7	20.6	25.6	23.1	29.1	21.7	22.3
1953/54	46.6	51.1	36.0	30.8	36.1	23.9	29.4	22.6	18.4	18.6	21.1	21.9	22.8	18.1	18.7	19.1	22.3	25.3	28.0
1954/55	48.8	36.9	32.8	35.7	30.8	41.3	25.7	19.0	23.0	22.8	23.7	18.9	22.5	25.0	20.8	19.1	27.5	25.9	28.8
1955/56	49.6	49.5	34.5	32.3	37.1	38.1	24.9	18.9	22.8	25.3	20.9	14.4	25.0	22.7	23.1	22.7	24.3	27.8	16.0
1956/57	42.7	44.0	30.0	40.8	28.6	31.2	23.5	23.3	21.8	19.9	18.1	19.6	21.0	18.5	20.1	23.9	23.4	20.2	24.3
1957/58	62.8	61.8	48.8	53.4	35.7	22.0	20.0	17.9	17.4	13.5	13.3	11.8	16.0	12.7	10.8	20.5	18.3	24.9	26.4
1958/59	42.7	44.0	30.0	40.8	28.6	31.2	24.4	21.7	17.0	21.0	21.1	24.7	28.7	27.4	16.6	27.5	25.7	18.0	26.6
1959/60	38.1	40.9	40.5	52.7	44.7	17.1	23.3	17.7	17.5	14.2	14.5	18.7	16.5	16.9	22.1	18.9	26.2	22.0	17.1
1960/61	53.1	51.8	52.1	55.0	37.1	19.9	19.2	13.8	13.5	18.9	16.8	20.1	19.5	26.3	20.9	21.9	25.9	25.3	27.5
1961/62	49.6	41.3	52.2	53.7	39.0	24.0	21.6	32.0	16.8	17.0	17.2	16.7	15.4	28.8	26.5	19.4	19.1	20.5	12.5
1962/63	46.6	43.1	43.8	21.5	23.2	21.0	29.5	16.8	24.5	22.5	18.6	23.2	28.3	22.3	13.0	18.6	11.4	23.6	24.3
1963/64	47.4	40.8	46.1	47.2	21.2	20.9	28.6	20.8	15.2	16.9	12.5	10.8	20.9	23.5	13.9	11.3	10.3	16.1	16.1
1964/65	48.6	46.3	60.6	44.1	34.5	36.3	20.8	18.3	22.5	15.4	29.2	19.3	25.7	25.5	18.8	26.7	26.1	18.5	31.6
1965/66	54.7	49.5	52.1	36.0	29.6	21.3	25.6	23.0	26.5	22.6	17.1	11.2	26.5	17.6	16.1	24.9	31.1	25.2	22.3
1966/67	49.3	33.3	25.2	28.4	24.6	31.6	17.2	28.1	20.1	25.5	27.4	19.3	28.4	23.6	20.2	16.0	26.4	25.7	23.9
1967/68	53.1	36.8	52.4	49.0	28.9	29.8	32.4	29.9	28.9	20.5	22.6	11.9	15.1	27.9	12.5	12.1	20.8	27.7	24.1
1968/69	49.6	49.5	34.5	32.3	37.0	38.1	24.9	18.9	22.8	25.3	20.9	18.9	22.5	25.0	20.8	19.1	27.5	25.9	28.8
1969/70	35.8	37.8	28.2	24.2	22.7	18.6	15.1	24.6	17.9	17.6	21.5	24.2	19.6	19.4	23.8	27.4	31.3	27.4	24.7
1970/71	47.9	34.3	37.0	32.2	41.7	36.9	33.6	26.2	25.8	20.9	16.7	27.6	22.7	24.4	21.7	22.5	25.4	24.6	12.5
1971/72	35.6	35.1	36.0	32.2	41.7	36.9	36.2	20.5	21.5	19.4	15.9	17.5	22.8	16.6	17.4	27.1	28.2	25.5	21.5
1972/73	47.7	42.4	32.5	41.0	32.8	37.8	41.4	22.1	26.7	25.6	20.6	28.4	20.6	19.0	15.7	28.0	14.9	17.0	29.2
1973/74	44.1	50.1	37.9	19.3	27.5	40.8	28.0	24.2	13.7	12.2	19.6	20.2	11.9	12.0	25.5	25.4	23.7	21.5	22.3
1974/75	49.3	46.5	34.8	33.8	29.0	28.2	30.3	21.3	19.8	20.5	14.4	19.6	23.6	11.9	19.6	21.9	24.9	26.5	22.1
1975/76	49.6	50.3	41.4	35.4	29.8	26.9	31.3	20.9	21.1	26.8	20.3	18.7	28.3	20.7	23.8	28.5	21.4	23.0	28.5
1976/77	48.9	55.9	38.0	26.7	28.3	40.2	27.3	21.0	20.5	9.5	14.5	21.2	28.9	22.6	14.9	29.0	26.1	39.1	39.4
1977/78	54.1	45.9	38.7	24.0	20.4	17.5	30.7	25.9	24.1	28.4	21.4	24.7	25.1	16.3	26.7	21.6	23.5	28.1	28.0
1978/79	51.3	47.7	43.9	50.6	48.8	27.6	19.8	36.9	32.5	33.2	40.1	39.9	35.6	35.9	20.3	36.5	37.6	39.0	34.3
1979/80	25.3	52.0	53.5	55.4	33.2	31.8	24.1	26.7	26.2	20.5	28.9	21.2	22.7	22.3	21.8	25.7	32.2	26.1	32.1
1980/81	58.4	42.7	45.8	41.6	24.9	38.6	32.5	27.1	8.1	20.0	13.6	15.0	19.1	18.5	25.8	21.2	27.0	28.0	33.0
1981/82	24.8	40.8	32.4	27.6	30.6	22.4	20.1	23.2	21.6	21.5	22.8	19.7	33.0	18.9	26.9	20.6	28.0	31.3	30.1
1982/83	40.3	42.7	41.5	29.3	25.4	39.5	20.9	31.8	31.6	22.6	22.4	28.1	11.6	20.9	12.3	21.1	25.2	28.9	24.6
1983/84	35.2	36.8	53.3	50.7	46.8	46.0	40.5	23.5	26.2	17.5	28.8	22.3	21.0	21.9	19.2	24.4	18.9	18.0	26.5
1984/85	47.9	42.4	34.7	36.2	32.8	37.8	36.9	27.1	20.2	19.5	21.9	16.9	25.6	20.7	23.8	25.2	28.3	28.9	26.0
1985/86	44.7	52.1	49.2	42.6	40.1	32.2	31.4	20.5	18.0	20.0	32.0								

Table B2. Continued. Weeks beginning September 16

Year		September				October				November				December				January	
	16-22	23-29	30-06	07-13	14-20	21-27	28-03	04-10	11-17	18-24	25-01	02-08	09-15	16-22	23-29	30-05	06-12	13-19	20-26
1952/53								23.7	22.1	28.8	23.4	20.6	18.1	23.8	24.6	21.8	30.0	22.0	24.1
1953/54	47.9	48.2	35.2	34.8	27.9	28.2	28.1	21.9	17.0	21.1	20.7	21.4	26.1	14.9	20.0	17.4	26.6	23.3	30.3
1954/55	47.8	38.4	27.4	35.9	34.7	40.1	26.4	17.7	22.0	25.1	20.5	19.0	26.8	20.5	21.3	22.8	24.5	27.7	27.7
1955/56	47.1	50.9	30.8	35.6	33.8	39.9	22.1	19.0	27.3	20.5	20.1	18.7	22.8	22.3	23.5	24.5	23.1	26.9	17.2
1956/57	47.1	42.1	30.6	36.1	27.6	31.8	25.6	21.4	23.0	20.4	17.1	19.5	19.0	22.2	18.5	25.7	22.4	19.5	36.3
1957/58	63.8	59.3	49.1	54.9	29.3	21.8	20.5	18.1	17.4	12.8	14.3	12.3	15.0	10.4	11.6	21.0	19.3	26.2	27.4
1958/59	47.1	42.1	30.6	36.1	27.6	31.8	23.6	23.5	15.3	21.3	23.1	24.7	28.2	28.0	16.5	27.9	25.1	17.9	26.7
1959/60	37.8	41.8	39.4	53.7	39.7	16.7	24.8	16.0	18.4	13.3	14.5	20.7	16.0	17.9	20.7	19.4	26.0	21.9	18.5
1960/61	54.0	49.2	54.6	52.5	34.8	19.3	19.8	12.0	14.1	18.5	18.3	19.3	20.1	26.2	21.4	21.3	26.6	23.3	29.8
1961/62	47.8	42.7	52.0	53.0	37.6	21.3	23.0	30.3	16.6	16.3	19.5	15.4	14.5	30.8	24.2	20.8	18.5	21.5	11.6
1962/63	48.2	41.2	41.6	21.2	21.8	23.4	28.0	16.0	27.4	21.0	18.0	25.5	28.1	19.3	15.0	15.2	12.9	24.9	22.5
1963/64	46.6	39.7	47.7	45.8	17.3	23.6	25.8	23.4	13.7	17.0	11.4	12.1	21.6	21.3	14.6	9.5	12.1	17.1	15.1
1964/65	49.3	50.6	55.1	42.5	36.3	34.5	19.0	17.1	21.3	18.9	28.4	19.3	25.7	22.5	22.3	25.9	25.6	20.6	32.6
1965/66	54.2	49.7	53.4	32.9	30.1	18.0	24.9	23.2	29.1	20.8	16.6	11.7	27.3	14.8	18.9	25.4	30.8	20.0	23.3
1966/67	48.8	28.7	25.5	30.9	24.1	31.1	18.7	24.1	22.9	25.2	26.4	20.9	17.6	25.1	14.7	12.1	21.9	23.6	26.5
1967/68	48.0	40.9	52.4	49.0	22.3	23.6	32.4	29.1	29.7	20.5	19.0	12.8	17.6	25.1	14.7	12.1	21.9	26.9	25.9
1968/69	47.1	50.9	30.8	35.6	33.7	39.9	22.1	19.0	27.3	20.5	21.1	19.0	26.8	20.5	21.3	22.8	24.5	27.7	27.7
1969/70	36.8	37.6	24.3	26.9	20.2	17.9	16.9	25.1	16.5	18.8	23.5	21.5	20.3	18.3	23.7	28.7	30.7	29.7	22.4
1970/71	48.8	34.6	35.4	34.5	42.9	35.6	30.9	25.2	24.2	21.7	19.1	26.5	20.6	24.7	22.2	23.2	25.5	24.3	11.6
1971/72	34.2	40.2	30.4	36.5	42.9	35.6	31.9	20.5	21.5	18.3	19.9	15.4	21.7	17.6	17.8	28.2	26.5	25.5	20.9
1972/73	46.5	41.9	33.4	41.5	31.8	39.7	35.6	25.3	25.1	27.9	19.1	25.7	22.8	18.5	17.0	25.4	15.9	16.9	30.1
1973/74	45.3	50.6	36.1	17.6	25.9	40.4	27.9	24.2	12.4	12.7	23.0	16.9	11.1	16.3	24.5	24.4	23.9	20.0	24.4
1974/75	48.1	44.1	33.1	37.3	29.6	21.5	33.1	21.5	19.9	19.1	16.5	19.7	20.3	14.4	20.8	23.2	23.5	25.5	20.8
1975/76	51.7	45.5	45.0	34.0	25.8	28.4	30.1	22.3	18.8	28.9	19.2	21.1	27.8	17.9	26.7	27.2	20.4	25.9	27.4
1976/77	49.1	55.4	34.8	27.1	30.2	39.0	24.0	20.6	20.5	10.4	15.7	20.4	29.5	21.2	16.8	29.2	26.0	41.1	38.3
1977/78	53.1	45.9	36.1	21.8	22.4	17.3	30.8	25.9	22.1	28.3	22.4	27.3	22.2	16.4	29.7	18.5	24.4	27.4	25.7
1978/79	51.3	47.7	44.3	50.5	46.3	24.8	23.0	36.4	32.8	33.3	40.1	39.4	36.6	32.8	21.9	37.1	37.9	38.1	35.4
1979/80	30.9	52.0	54.0	53.3	33.8	29.1	23.8	27.5	24.5	21.3	27.8	21.4	23.6	21.6	22.5	26.9	31.1	27.0	33.0
1980/81	57.2	43.4	45.1	39.8	26.1	36.5	34.9	22.2	9.2	20.0	12.4	15.4	20.0	18.9	25.7	19.8	28.9	27.5	34.5
1981/82	24.2	37.4	37.5	27.1	29.8	21.4	19.8	25.3	20.1	21.9	21.7	22.1	32.8	18.7	25.2	22.0	28.0	31.3	30.1
1982/83	41.9	40.1	42.3	28.5	24.9	40.2	17.9	32.6	29.0	27.5	19.1	26.0	16.2	16.6	12.5	23.7	25.7	26.9	26.6
1983/84	34.4	39.9	53.8	48.1	47.9	43.5	39.8	23.6	23.1	22.2	26.8	23.9	20.5	20.6	24.8	16.3	20.4	20.8	23.1
1984/85	46.1	45.8	28.4	41.3	31.8	39.7	33.4	26.3	17.9	18.8	22.5	18.5	27.6	17.9	26.7	24.4	30.0	24.9	27.9
1985/86	48.0	53.1	47.2	39.3	43.5	28.8	30.6	18.9	17.2	21.3	29.0								

Appendix C
Computer Program for Power Transforamtion and SMEMAX Transformation

```
   COMMON/NUM/X(100),Y(100)
   DIMENSION L5(20)
   INTEGER R4(20),P2
   READ (10,10) N
   READ (10,12) (X(I),I=1,N)
 10 FORMAT (I5)
 12 FORMAT (32X,F6.1)
   N1=N
   L5(1)=1
   R4(1)=N1
   P2=1
216 IF(L5(P2).LT.R4(P2)) GO TO 219
   P2=P2-1
   GO TO 254
219 I=L5(P2)
   J=R4(P2)
   P1=X(J)
   M4=(I+J)/2
   IF (J-I.LT.6) GO TO 232
   IF ((P1.GT.X(I)).AND.(P1.LT.X(M4))) GO TO 232
   IF ((P1.LT.X(I)).AND.(P1.GT.X(M4))) GO TO 232
   IF ((X(I).LT.X(M4)).AND.(X(I).GT.P1)) GO TO 230
   IF ((X(I).GT.X(M4)).AND.(X(I).LT.P1)) GO TO 230
   H1=X(J)
   X(J)=X(M4)
   X(M4)=H1
   GO TO 231
230 H1=X(J)
   X(J)=X(I)
   X(I)=H1
231 P1=X(J)
232 IF(I.GE.J) GO TO 243
233 IF(X(I).GE.P1) GO TO 236
   I=I+1
   GO TO 233
236 J=J-1
237 IF (.NOT.((I.LT.J).AND.(P1.LT.X(J)))) GO TO 240
   J=J-1
   GO TO 237
240 IF (I.GE.J) GO TO 242
   H1=X(J)
   X(J)=X(I)
   X(I)=H1
242 GO TO 232
243 J=R4(P2)
   H1=X(J)
   X(J)=X(I)
   X(I)=H1
```

```
      IF(I-L5(P2).GE.R4(P2)-I) GO TO 250
      L5(P2+1)=L5(P2)
      R4(P2+1)=I-1
      L5(P2)=I+1
      GO TO 253
  250 L5(P2+1)=I+1
      R4(P2+1)=R4(P2)
      R4(P2)=I-1
  253 P2=P2+1
  254 IF (P2.GT.0) GO TO 216
      DO 14 I=1,N
      Y(I)=X(I)
   14 CONTINUE
      CALL POWER (N,JFLAG,CSY,CKY,CSYYY,CKYY,GG)
C      CALL SMEMAX (N,JFLAG,CSY,CKY,CSYY,CKYY)
      RETURN
      END
C
C
C
      SUBROUTINE POWER (N,JFLAG,CSY,CKY,CSYYY,CKYY,GG)
      COMMON/NUM/X(100),Y(100)
      DIMENSION YY(3,100),SUMYY(3),CSYY(3),G(10),QY(10),QYY(10),ZZ(6)
      REAL MEANY,M2YY(3),M3YY(3),MEANYY(3),M2Y,M3Y,M4Y,M4YY
      IJK=1
      WRITE (20,40)
      ZZ(1)=0.000
      ZZ(2)=0.84162
      ZZ(3)=1.28155
      ZZ(4)=1.75069
      ZZ(5)=2.05375
      ZZ(6)=2.32635
      G(1)=-3.00
      G(3)=4.00
      DO 6 I=1,50
      G(2)=0.5*(G(1)+G(3))
      IF (I.EQ.1) J=0
    1 IF (I.EQ.1) J=J+1
      SUMYY(J)=0.0
      DO 2 K=1,N
      IF (Y(K).LE.0) THEN
         YY(J,K)=-1.0/G(J)
         GO TO 2
      END IF
      YY(J,K)=((Y(K)**G(J))-1.0)/G(J)
    2 SUMYY(J)=SUMYY(J)+YY(J,K)
      MEANYY(J)=SUMYY(J)/FLOAT(N)
      M2YY(J)=0.0
      M3YY(J)=0.0
      DO 3 K=1,N
      TEMP1=(YY(J,K)-MEANYY(J))**2
      TEMP2=(YY(J,K)-MEANYY(J))**3
      M2YY(J)=M2YY(J)+TEMP1
      M3YY(J)=M3YY(J)+TEMP2
    3 CONTINUE
      M2YY(J)=M2YY(J)/FLOAT(N)
      M3YY(J)=M3YY(J)/FLOAT(N)
      CSYY(J)=M3YY(J)/(M2YY(J)**1.5)
      IF (I.EQ.1.AND.J.LT.3) GO TO 1
      IF ((G(3)-G(1)).LT.0.00005) GO TO 7
      IF (CSYY(1)*CSYY(2).LE.0.0) GO TO 4
      IF (CSYY(2)*CSYY(3).LE.0.0) GO TO 5
      WRITE (20,80)
      JFLAG=1
      RETURN
    4 CSYY(3)=CSYY(2)
      SUMYY(3)=SUMYY(2)
      MEANYY(3)=MEANYY(2)
      M2YY(3)=M2YY(2)
      M3YY(3)=M3YY(2)
      G(3)=G(2)
      J=2
```

```
      GO TO 6
    5 CSYY(1)=CSYY(2)
      SUMYY(1)=SUMYY(2)
      MEANYY(1)=MEANYY(2)
      M2YY(1)=M2YY(2)
      M3YY(1)=M3YY(2)
      G(1)=G(2)
      J=2
    6 CONTINUE
    7 IF (I.EQ.50) WRITE (20,90)
      IF (I.EQ.50) JFLAG=1
      WRITE (20,100)
      DO 8 I=1,N
      Q1(I)=(YY(2,I)-MEANYY(2))/SQRT(M2YY(2)*FLOAT(N)/FLOAT(N-1))
      IF (ABS(YY(2,I)-MEANYY(2)).NE.0.01) WRITE (20,110) I,Y(I),YY(2,I)
    8 CONTINUE
      SUMY=0.0
      DO 9 I=1,N
    9 SUMY=SUMY+Y(I)
      MEANY=SUMY/FLOAT(N)
      WRITE (20,130) MEANY,MEANYY(2)
      M2Y=0.0
      M3Y=0.0
      M4Y=0.0
      M4YY=0.0
      DO 11 I=1,N
      M2Y=M2Y+(Y(I)-MEANY)**2
      M3Y=M3Y+(Y(I)-MEANY)**3
      M4Y=M4Y+(Y(I)-MEANY)**4
   11 M4YY=M4YY+(YY(2,I)-MEANYY(2))**4
      M2Y=M2Y/FLOAT(N)
      M3Y=M3Y/FLOAT(N)
      M4Y=M4Y/FLOAT(N)
      WRITE (6,25)M2Y,M3Y,M4Y
   25 FORMAT (F6.2,5X,F6.2,5X,F6.2)
      M4YY=M4YY/FLOAT(N)
      SY=SQRT(M2Y*FLOAT(N)/FLOAT(N-1))
      SYY=SQRT(M2YY(2)*FLOAT(N)/FLOAT(N-1))
      CSY=M3Y/(M2Y**1.5)
      CKY=M4Y/(M2Y**2)
      CKYY=M4YY/(M2YY(2)**2)
      WRITE (20,140) SY,SYY
      WRITE (20,170) CSY,CSYY
      WRITE (20,180) CKY,CKYY
      I=0
   12 I=I+1
      QYY(I)=MEANYY(2)-SYY*ZZ(I)
      IF (QYY(I).LT.0.0001) QYY(I)=0.0001
      QY(I)=(G(2)*QYY(I)+1.0)**(1.0/G(2))
      IF (QYY(I).LT.0.001) QY(I)=0.0001
      IF (QYY(I).GT.MEANYY(2)) WRITE (20,190)
      IF (QYY(I).GT.MEANYY(2)) JFLAG=1
      CSYYY=ABS(CSYY(2))
      GG=G(2)
      WRITE (20,60) G(1),CSYY(1),G(2),CSYY(2),G(3),CSYY(3)
   40 FORMAT (//,5X,36H****** THIS PART OF THE PROGRAM USES,
     132H THE POWER TRANSFORMATION ******,//)
   60 FORMAT (21X,7HLAMDA =,F10.5,5X,4HCS =,F10.5)
   80 FORMAT (5X,39HERROR - ALL THIRD MOMENTS HAVE THE SAME,
     130H SIGN.  PROGRAM WAS TERMINATED)
   90 FORMAT (/,13X,36HERROR - THE METHOD DID NOT CONVERGE ,
     116HIN 50 ITERATIONS)
  100 FORMAT (/,22X,4HRANK,5X,8HMEASURED,5X,11HTRANSFORMED)
  110 FORMAT (20X,I5,5X,F9.3,6X,F10.2)
  130 FORMAT (22X,4HMEAN,4X,F12.2,4X,F12.2)
  140 FORMAT (24X,1HS,5X,F9.3,6X,F9.3)
  170 FORMAT (23X,2HCS,5X,F9.3,3X,E12.3)
  180 FORMAT (23X,2HCK,5X,F9.3,6X,F9.3,/)
  190 FORMAT (12X,36HERROR - THE WRONG INVERSE TRANSFORMA,
     118HTION HAS BEEN USED)
      RETURN
```

```
      END
C
C
C
      SUBROUTINE SMEMAX (N,JFLAG,CSY,CKY,CSYY,CKYY)
      DIMENSION YY(100),QYY(10),QY(10),ZZ(10),Q1(100),Q2(100),Q3(100)
      REAL MIN,MED,MAX,MEANY,MEANYY
      REAL M2Y,M2YY,M3Y,M3YY,M4Y,M4YY
      COMMON/NUM/X(100),Y(100)
      IJK=2
      ZZ(1)=0.000
      ZZ(2)=0.84162
      ZZ(3)=1.28155
      ZZ(4)=1.75069
      ZZ(5)=2.05375
      ZZ(6)=2.32635
      WRITE (20,10)
      MIN=Y(1)
      MAX=Y(N)
      KFLAG=0
      ND2=N/2
      IF (N.EQ.2*ND2) KFLAG=1
      JPOINT=(N+1)/2
      MED=Y(JPOINT)
      IF (KFLAG.EQ.0) GO TO 1
      JP1=JPOINT+1
      MED=0.5*(Y(JPOINT)+Y(JP1))
    1 WRITE (20,20) MIN,MED,MAX
      A=ATAN((MAX-MED)/(MED-MIN))
      WRITE (20,30)
      DO 2 I=1,JPOINT
      YY(I)=(Y(I)-MIN)/(2.0*COS(A))
    2 WRITE (20,40) I,Y(I),YY(I)
      JP1=JPOINT+1
      DO 3 I=JP1,N
      YY(I)=((MED-MIN)+((Y(I)-MED)/TAN(A)))/(2.0*COS(A))
    3 WRITE (20,40) I,Y(I),YY(I)
      SUMY=0.0
      SUMYY=0.0
      DO 4 I=1,N
    4 SUMY=SUMY+Y(I)
      MEANY=SUMY/FLOAT(N)
      MEANYY=SUMYY/FLOAT(N)
      WRITE (20,60) MEANY,MEANYY
      M2Y=0.0
      M2YY=0.0
      M3Y=0.0
      M3YY=0.0
      M4Y=0.0
      M4YY=0.0
      DO 5 I=1,N
      M2Y=M2Y+(Y(I)-MEANY)**2
      M2YY=M2YY+(YY(I)-MEANYY)**2
      M3Y=M3Y+(Y(I)-MEANY)**3
      M3YY=M3YY+(YY(I)-MEANYY)**3
      M4Y=M4Y+(Y(I)-MEANY)**4
    5 M4YY=M4YY+(YY(I)-MEANYY)**4
      M2Y=M2Y/FLOAT(N)
      M2YY=M2YY/FLOAT(N)
      M3Y=M3Y/FLOAT(N)
      M3YY=M3YY/FLOAT(N)
      M4Y=M4Y/FLOAT(N)
      M4YY=M4YY/FLOAT(N)
      SY=SQRT(M2Y*FLOAT(N)/FLOAT(N-1))
      SYY=SQRT(M2YY*FLOAT(N)/FLOAT(N-1))
      CSY=M3Y/(M2Y**1.5)
      CSYY=M3YY/(M2YY**1.5)
      CKY=M4Y/(M2Y**2)
      CKYY=M4YY/(M2YY**2)
      WRITE (20,70) SY,SYY
      WRITE (20,80) CSY,CSYY
      WRITE (20,90) CKY,CKYY
```

```
      DO 6 I=1,N
    6 Q2(I)=(YY(I)-MEANYY)/SYY
      I=0
    7 I=I+1
      QYY(I)=MEANYY-SYY*ZZ(I)
      IF (QYY(I).GT.MEANYY) WRITE (20,100)
      IF (QYY(I).GT.MEANYY) JFLAG=1
      QY(I)=QYY(I)*2.0*COS(A)+MIN
      IF (QY(I).LT.0.0001) QY(I)=0.0001
   10 FORMAT (//,5X,36H***** THIS PART OF THE PROGRAM USES ,
     132HTHE SMEMAX TRANSFORMATION ******,//)
   20 FORMAT (17X,22HFOR THE LOW FLOW DATA:,5X,9HMINIMUM =,
     1F8.2,/,44X,9HMEDIAN  =,F8.2,/,44X,9HMAXIMUM =,F8.2,/)
   30 FORMAT (/,22X,4HRANK,5X,8HMEASURED,5X,11HTRANSFORMED)
   40 FORMAT (20X,I5,5X,F9.3,6X,F9.3)
   60 FORMAT (22X,4HMEAN,4X,F9.3,6X,F9.3)
   70 FORMAT (24X,1HS,4X,F9.3,6X,F9.3)
   80 FORMAT (23X,2HCS,5X,F9.3,6X,F9.3)
   90 FORMAT (23X,2HCK,5X,F9.3,6X,F9.3/)
  100 FORMAT (12X,36HERROR - THE WRONG INVERSE TRANFORMA,
     118HTION HAS BEEN USED)
      STOP
      END
```

Appendix D
Sample Data Input for EXTRAN and Program Output

Sample Data Input for EXTRAN

```
FLOW ROUTING IN LEFT BANK MAIN CANAL OF KALAWEWA IRRIGATION SCHEME
VARIABLE INFLOW AT ENTRY
 918050.  0.   11   10    0    0   180  180    1    30  0.05
    1000        1301       2301        3301        4301        5301        6301        5302
    1302        2302       3302
     100         105        110         115         120         125         130         135
     140         145
  1001000 1301   6         10.  10.  2354.          .10   1.5  1.5
  1051301 2301   6         10.  10.  1351.          .10   1.5  1.5
  1102301 3301   6         10.  10.  4781.          .10   1.5  1.5
  1153301 4301   6         10.  10.  1559.          .10   1.5  1.5
  1204301 5301   6         10.  10.  1975.          .10   1.5  1.5
  1255301 6301   6         10.  10.  6236.          .10   1.5  1.5
  1306301 5302   6         10.  10.  5509.          .10   1.5  1.5
  1355302 1302   6         10.  10.  1351.          .10   1.5  1.5
  1401302 2302   6         10.  10.  2262.          .10   1.5  1.5
  1452302 3302   6         10.  10.  2079.          .10   1.5  1.5
99999
 100060.  39.72
 130159.  38.94
 230158.  38.54
 330157.  36.92
 430156.  36.41
 530156.  35.75
 630154.  33.64
 530252.  31.87
 130251.  31.43
 230251.  30.68
 330250.  30.00
99999
99999
 23013302   1  0.92 0.95  0.
 43013302   1  0.94 0.95  0.
 63013302   1  0.96 0.95  0.
 13023302   1  1.03 0.95  0.
99999
99999
99999
 3302
99999
99999
    1
99999
```

1000	
0.0	200.0
36.0	200.0
36.1	190.0
60.0	190.0
60.1	180.0
84.0	180.0
84.1	170.0
108.0	170.0
108.1	160.0
140.0	160.0

Program Output

ENTRY MADE TO EXTENDED TRANSPORT MODEL

UPDATED BY CAMP DRESSER AND MCKEE INC APR. 1981

UPDATED BY THE UNIVERSITY OF FLORIDA, MARCH 1983

1---

ENVIRONMENTAL PROTECTION AGENCY ^^^^ EXTENDED TRANSPORT PROGRAM ^^^^ WATER RESOURCES DIVISION
WASHINGTON, D.C. ^^^^ ^^^^ CAMP DRESSER & MCKEE INC.
^^^^ ANALYSIS MODULE ^^^^ ANNANDALE, VIRGINIA
FLOW ROUTING IN LEFT BANK MAIN CANAL OF KALAWEWA IRRIGATION SCHEME
VARIABLE INFLOW AT ENTRY

0INTEGRATION CYCLES 9180
0LENGTH OF INTEGRATION STEP IS 50. SECONDS
0PRINTING STARTS IN CYCLE 180 AND PRINTS AT INTERVALS OF 180 CYCLES
0INITIAL TIME 0.0 HOURS
0SURCHARGE VARIABLES: ITMAX... 30
SURTOL... 0.050
0PRINTED OUTPUT AT THE FOLLOWING 11 JUNCTIONS

1000 1301 2301 3301 4301 5301 6301 5302 1302
2302 3302

AND FOR THE FOLLOWING 10 CONDUITS

100 105 110 115 120 125 130 135 140
145

1---

ENVIRONMENTAL PROTECTION AGENCY ^^^^ EXTENDED TRANSPORT PROGRAM ^^^^ WATER RESOURCES DIVISION
WASHINGTON, D.C. ^^^^ ^^^^ CAMP DRESSER & MCKEE INC.
^^^^ ANALYSIS MODULE ^^^^ ANNANDALE, VIRGINIA
FLOW ROUTING IN LEFT BANK MAIN CANAL OF KALAWEWA IRRIGATION SCHEME
VARIABLE INFLOW AT ENTRY

	CONDUIT NUMBER	LENGTH (FT)	CLASS	AREA SQ FT)	MANNING COEF.	MAX WIDTH (FT)	DEPTH (FT)	JUNCTIONS AT ENDS	INVERT HEIGHT ABOVE JUNCTIONS	TRAPEZOID SIDE SLOPE
1	100	2354.	6	250.00	0.100	10.00	10.00	1000	1301	1.50 1.50
2	105	1351.	6	250.00	0.100	10.00	10.00	1301	2301	1.50 1.50
3	110	4781.	6	250.00	0.100	10.00	10.00	2301	3301	1.50 1.50
4	115	1559.	6	250.00	0.100	10.00	10.00	3301	4301	1.50 1.50
5	120	1975.	6	250.00	0.100	10.00	10.00	4301	5301	1.50 1.50
6	125	6236.	6	250.00	0.100	10.00	10.00	5301	6301	1.50 1.50
7	130	5509.	6	250.00	0.100	10.00	10.00	6301	5302	1.50 1.50
8	135	1351.	6	250.00	0.100	10.00	10.00	5302	1302	1.50 1.50
9	140	2262.	6	250.00	0.100	10.00	10.00	1302	2302	1.50 1.50
10	145	2079.	6	250.00	0.100	10.00	10.00	2302	3302	1.50 1.50

1---

ENVIRONMENTAL PROTECTION AGENCY ^^^^ EXTENDED TRANSPORT PROGRAM ^^^^ WATER RESOURCES DIVISION
WASHINGTON, D.C. ^^^^ ^^^^ CAMP DRESSER & MCKEE INC.
^^^^ ANALYSIS MODULE ^^^^ ANNANDALE, VIRGINIA
FLOW ROUTING IN LEFT BANK MAIN CANAL OF KALAWEWA IRRIGATION SCHEME
VARIABLE INFLOW AT ENTRY

	JUNCTION NUMBER	GROUND ELEV.	CROWN ELEV.	INVERT ELEV.	QINST (CFS)	CONNECTING CONDUITS	
1	1000	60.00	49.72	39.72	0.0	100	
2	1301	59.00	48.94	38.94	0.0	100	105
3	2301	58.00	48.54	38.54	0.0	105	110
4	3301	57.00	46.92	36.92	0.0	110	115
5	4301	56.00	46.41	36.41	0.0	115	120
6	5301	56.00	45.75	35.75	0.0	120	125
7	6301	54.00	43.64	33.64	0.0	125	130
8	5302	52.00	41.87	31.87	0.0	130	135
9	1302	51.00	41.43	31.43	0.0	135	140
10	2302	51.00	40.68	30.68	0.0	140	145
11	3302	50.00	50.00	30.00	0.0	145	

0- ORIFICE DATA -

JUNCTION FROM	TO	TYPE (FT2)	AREA COEFF.	DISCHARGE JUNCTION	HEIGHT ABOVE
2301	3302	1	0.92	0.9500	0.0
4301	3302	1	0.94	0.9500	0.0
6301	3302	1	0.96	0.9500	0.0
1302	3302	1	1.03	0.9500	0.0

0- FREE OUTFALL DATA -

FREE OUTFLOW AT JUNCTIONS 3302

1---

ENVIRONMENTAL PROTECTION AGENCY ^^^^ EXTENDED TRANSPORT PROGRAM ^^^^ WATER RESOURCES DIVISION
WASHINGTON, D.C. ^^^^ ^^^^ CAMP DRESSER & MCKEE INC.
^^^^ ANALYSIS MODULE ^^^^ ANNANDALE, VIRGINIA

```
FLOW ROUTING IN LEFT BANK MAIN CANAL OF KALAWEWA IRRIGATION SCHEME
VARIABLE INFLOW AT ENTRY


0---------------------- INTERNAL CONNECTIVITY INFORMATION ----------------------

        CONDUIT          JUNCTION          JUNCTION

         90011             2301              3302
         90012             4301              3302
         90013             6301              3302
         90014             1302              3302
         90015             3302                 0
1------------------------------------------------------------------------------------------
ENVIRONMENTAL PROTECTION AGENCY        ****  EXTENDED TRANSPORT PROGRAM  ****     WATER RESOURCES DIVISION
WASHINGTON, D.C.                  ****                               ****    CAMP DRESSER & MCKEE INC.
                              ****      ANALYSIS MODULE      ****     ANNANDALE, VIRGINIA
FLOW ROUTING IN LEFT BANK MAIN CANAL OF KALAWEWA IRRIGATION SCHEME
VARIABLE INFLOW AT ENTRY

------------------- SUMMARY OF INITIAL HEADS, FLOWS AND VELOCITIES ----------


INITIAL HEADS, FLOWS AND VELOCITIES ARE ZERO
1------------------------------------------------------------------------------------------
ENVIRONMENTAL PROTECTION AGENCY        ****  EXTENDED TRANSPORT PROGRAM  ****     WATER RESOURCES DIVISION
WASHINGTON, D.C.                  ****                               ****    CAMP DRESSER & MCKEE INC.
                              ****      ANALYSIS MODULE      ****     ANNANDALE, VIRGINIA
FLOW ROUTING IN LEFT BANK MAIN CANAL OF KALAWEWA IRRIGATION SCHEME
VARIABLE INFLOW AT ENTRY

0****** SYSTEM INFLOWS (CARDS) AT    0.0 HOURS FOR    1 JUNCTIONS

  1000/ 200.00
0****** SYSTEM INFLOWS (CARDS) AT   36.00 HOURS    ( JUNCTION / INFLOW,CFS )

  1000/ 200.00
-------------------------------------------------------------

CYCLE   180     TIME    2 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

  1000/  8.96301/  8.52            2301/  8.12             3301/  5.85   4301/  4.55   5301/  0.83   6301/  0.01   5302/  0.00
  1302/  0.02302/  0.0             3302/  0.0

CONDUITS / FLOWS

  100/ 196.74   105/ 188.74     110/ 155.27     115/ 102.20     120/  42.13     125/   0.75     130/   0.00      135/   0.0
  140/   0.0    145/   0.0      90011/  18.76   90012/  13.42   90013/   0.00   90014/   0.0    90015/   0.0
-------------------------------------------------------------

CYCLE   360     TIME    5 HRS -  0.0  MIN

JUNCTIONS / DEPTHS

  1000/  9.26   1301/  8.99     2301/  8.73     3301/  8.03     4301/  7.70     5301/  7.53     6301/  3.61      5302/  0.70
  1302/  0.04   2302/  0.00     3302/  0.00

CONDUITS / FLOWS

  100/ 199.23   105/ 197.31     110/ 173.63     115/ 160.39     120/ 132.44     125/ 109.10     130/  17.47      135/   0.79
  140/   0.00   145/   0.00     90011/  19.55   90012/  18.57   90013/  11.76   90014/   0.00   90015/   0.00
-------------------------------------------------------------

CYCLE   540     TIME    7 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

  1000/  9.38   1301/  9.17     2301/  8.95     3301/  8.56     4301/  8.32     5301/  8.19     6301/  6.96      5302/  5.09
  1302/  4.27   2302/  2.64     3302/  0.31

CONDUITS / FLOWS

  100/ 199.67   105/ 198.90     110/ 177.52     115/ 174.59     120/ 153.25     125/ 148.24     130/ 103.64      135/  74.48
  140/  44.77   145/  11.57     90011/  19.83   90012/  19.43   90013/  17.88   90014/  14.08   90015/  11.57
-------------------------------------------------------------

CYCLE   720     TIME   10 HRS -  0.0  MIN

JUNCTIONS / DEPTHS
```

1000/ 9.42	1301/ 9.23	2301/ 9.03	3301/ 8.71	4301/ 8.51	5301/ 8.42	6301/ 7.67	5302/ 6.78
1302/ 6.42	2302/ 6.16	3302/ 1.22					

CONDUITS / FLOWS

100/ 199.88	105/ 199.58	110/ 179.06	115/ 177.83	120/ 157.31	125/ 154.98	130/ 127.75	135/ 117.08
140/ 92.53	145/ 84.97	90011/ 19.93	90012/ 19.68	90013/ 18.93	90014/ 18.22	90015/ 84.97	

CYCLE 900 TIME 12 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

1000/ 9.43	1301/ 9.26	2301/ 9.06	3301/ 8.77	4301/ 8.59	5301/ 8.52	6301/ 7.93	5302/ 7.31
1302/ 7.03	2302/ 6.79	3302/ 1.42					

CONDUITS / FLOWS

100/ 199.94	105/ 199.81	110/ 179.57	115/ 179.01	120/ 158.84	125/ 157.76	130/ 134.93	135/ 131.48
140/ 110.32	145/ 108.16	90011/ 19.97	90012/ 19.79	90013/ 19.29	90014/ 19.23	90015/ 108.16	

CYCLE 1080 TIME 15 HRS - 0.0 MIN

JUNCTIONS / DEPTHS

1000/ 9.44	1301/ 9.27	2301/ 9.08	3301/ 8.80	4301/ 8.63	5301/ 8.56	6301/ 8.04	5302/ 7.48
1302/ 7.22	2302/ 6.98	3302/ 1.48					

CONDUITS / FLOWS

100/ 199.97	105/ 199.91	110/ 179.80	115/ 179.54	120/ 159.53	125/ 159.04	130/ 138.12	135/ 136.85
140/ 116.63	145/ 115.87	90011/ 19.99	90012/ 19.83	90013/ 19.44	90014/ 19.53	90015/ 115.87	

CYCLE 1260 TIME 17 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

1000/ 9.44	1301/ 9.28	2301/ 9.08	3301/ 8.82	4301/ 8.65	5301/ 8.59	6301/ 8.08	5302/ 7.54
1302/ 7.29	2302/ 7.05	3302/ 1.50					

CONDUITS / FLOWS

100/ 199.99	105/ 199.96	110/ 179.90	115/ 179.78	120/ 159.85	125/ 159.63	130/ 139.50	135/ 139.00
140/ 119.07	145/ 118.78	90011/ 20.00	90012/ 19.86	90013/ 19.50	90014/ 19.65	90015/ 118.78	

CYCLE 1440 TIME 20 HRS - 0.0 MIN

JUNCTIONS / DEPTHS

1000/ 9.45	1301/ 9.28	2301/ 9.09	3301/ 8.83	4301/ 8.65	5301/ 8.59	6301/ 8.10	5302/ 7.57
1302/ 7.32	2302/ 7.08	3302/ 1.51					

CONDUITS / FLOWS

100/ 199.99	105/ 199.98	110/ 179.95	115/ 179.90	120/ 160.00	125/ 159.90	130/ 140.10	135/ 139.89
140/ 120.08	145/ 119.96	90011/ 20.00	90012/ 19.87	90013/ 19.52	90014/ 19.69	90015/ 119.96	

CYCLE 1620 TIME 22 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

1000/ 9.45	1301/ 9.28	2301/ 9.09	3301/ 8.83	4301/ 8.66	5301/ 8.60	6301/ 8.11	5302/ 7.58
1302/ 7.33	2302/ 7.09	3302/ 1.52					

CONDUITS / FLOWS

100/ 200.00	105/ 199.99	110/ 179.98	115/ 179.95	120/ 160.07	125/ 160.02	130/ 140.37	135/ 140.27
140/ 120.51	145/ 120.46	90011/ 20.00	90012/ 19.87	90013/ 19.54	90014/ 19.71	90015/ 120.46	

CYCLE 1800 TIME 25 HRS - 0.0 MIN

JUNCTIONS / DEPTHS

1000/ 9.45	1301/ 9.28	2301/ 9.09	3301/ 8.83	4301/ 8.66	5301/ 8.60	6301/ 8.11	5302/ 7.59
1302/ 7.33	2302/ 7.10	3302/ 1.52					

CONDUITS / FLOWS

100/ 200.00	105/ 200.00	110/ 179.99	115/ 179.98	120/ 160.09	125/ 160.07	130/ 140.48	135/ 140.44
140/ 120.70	145/ 120.68	90011/ 20.00	90012/ 19.87	90013/ 19.54	90014/ 19.72	90015/ 120.68	

CYCLE 1980 TIME 27 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

1000/ 9.45	1301/ 9.28	2301/ 9.09	3301/ 8.83	4301/ 8.66	5301/ 8.60	6301/ 8.11	5302/ 7.59
1302/ 7.34	2302/ 7.10	3302/ 1.52					

CONDUITS / FLOWS

100/ 200.00	105/ 200.00	110/ 179.99	115/ 179.99	120/ 160.11	125/ 160.10	130/ 140.53	135/ 140.51
140/ 120.78	145/ 120.77	90011/ 20.00	90012/ 19.87	90013/ 19.54	90014/ 19.72	90015/ 120.77	

- -

CYCLE 2160 TIME 30 HRS - 0.0 MIN

JUNCTIONS / DEPTHS

1000/ 9.45	1301/ 9.28	2301/ 9.09	3301/ 8.83	4301/ 8.66	5301/ 8.60	6301/ 8.11	5302/ 7.59
1302/ 7.34	2302/ 7.10	3302/ 1.52					

CONDUITS / FLOWS

100/ 200.00	105/ 200.00	110/ 179.99	115/ 179.99	120/ 160.11	125/ 160.11	130/ 140.55	135/ 140.54
140/ 120.82	145/ 120.81	90011/ 20.00	90012/ 19.87	90013/ 19.54	90014/ 19.72	90015/ 120.81	

- -

CYCLE 2340 TIME 32 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

1000/ 9.45	1301/ 9.28	2301/ 9.09	3301/ 8.83	4301/ 8.66	5301/ 8.60	6301/ 8.11	5302/ 7.59
1302/ 7.34	2302/ 7.10	3302/ 1.52					

CONDUITS / FLOWS

100/ 200.00	105/ 200.00	110/ 179.99	115/ 179.99	120/ 160.12	125/ 160.11	130/ 140.56	135/ 140.56
140/ 120.83	145/ 120.83	90011/ 20.00	90012/ 19.87	90013/ 19.54	90014/ 19.72	90015/ 120.83	

- -

CYCLE 2520 TIME 35 HRS - 0.0 MIN

JUNCTIONS / DEPTHS

1000/ 9.45	1301/ 9.28	2301/ 9.09	3301/ 8.83	4301/ 8.66	5301/ 8.60	6301/ 8.11	5302/ 7.59
1302/ 7.34	2302/ 7.10	3302/ 1.52					

CONDUITS / FLOWS

100/ 200.00	105/ 200.00	110/ 179.99	115/ 179.99	120/ 160.12	125/ 160.12	130/ 140.57	135/ 140.56
140/ 120.84	145/ 120.84	90011/ 20.00	90012/ 19.87	90013/ 19.54	90014/ 19.72	90015/ 120.84	

- -

0****** SYSTEM INFLOWS (CARDS) AT 36.10 HOURS (JUNCTION / INFLOW,CFS)

1000/ 190.00

- -

0****** SYSTEM INFLOWS (CARDS) AT 60.00 HOURS (JUNCTION / INFLOW,CFS)

1000/ 190.00

- -

CYCLE 2700 TIME 37 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

1000/ 9.28	1301/ 9.14	2301/ 8.96	3301/ 8.76	4301/ 8.61	5301/ 8.57	6301/ 8.10	5302/ 7.59
1302/ 7.33	2302/ 7.10	3302/ 1.52					

CONDUITS / FLOWS

100/ 190.41	105/ 191.33	110/ 173.22	115/ 175.11	120/ 156.31	125/ 158.36	130/ 140.09	135/ 140.36
140/ 120.73	145/ 120.80	90011/ 19.85	90012/ 19.80	90013/ 19.53	90014/ 19.72	90015/ 120.80	

- -

CYCLE 2880 TIME 40 HRS - 0.0 MIN

JUNCTIONS / DEPTHS

1000/ 9.24	1301/ 9.08	2301/ 8.89	3301/ 8.66	4301/ 8.50	5301/ 8.46	6301/ 8.01	5302/ 7.53
1302/ 7.28	2302/ 7.06	3302/ 1.51					

CONDUITS / FLOWS

100/ 190.09 105/ 190.31 110/ 170.99 115/ 171.75 120/ 152.57 125/ 153.81 130/ 136.45 135/ 137.50
140/ 118.39 145/ 118.89 90011/ 19.76 90012/ 19.66 90013/ 19.41 90014/ 19.64 90015/ 118.89

- -

CYCLE 3060 TIME 42 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

1000/ 9.23 1301/ 9.06 2301/ 8.87 3301/ 8.62 4301/ 8.45 5301/ 8.40 6301/ 7.94 5302/ 7.45
1302/ 7.20 2302/ 6.99 3302/ 1.48

CONDUITS / FLOWS

100/ 190.03 105/ 190.11 110/ 170.54 115/ 170.84 120/ 151.44 125/ 151.97 130/ 133.85 135/ 134.63
140/ 115.52 145/ 115.95 90011/ 19.73 90012/ 19.60 90013/ 19.31 90014/ 19.51 90015/ 115.95

- -

CYCLE 3240 TIME 45 HRS - 0.0 MIN

JUNCTIONS / DEPTHS

1000/ 9.22 1301/ 9.05 2301/ 8.86 3301/ 8.60 4301/ 8.43 5301/ 8.38 6301/ 7.90 5302/ 7.40
1302/ 7.15 2302/ 6.94 3302/ 1.46

CONDUITS / FLOWS

100/ 190.01 105/ 190.04 110/ 170.39 115/ 170.51 120/ 151.02 125/ 151.25 130/ 132.57 135/ 132.99
140/ 113.77 145/ 114.01 90011/ 19.72 90012/ 19.58 90013/ 19.25 90014/ 19.44 90015/ 114.01

- -

CYCLE 3420 TIME 47 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

1000/ 9.22 1301/ 9.05 2301/ 8.86 3301/ 8.60 4301/ 8.43 5301/ 8.37 6301/ 7.89 5302/ 7.38
1302/ 7.13 2302/ 6.91 3302/ 1.46

CONDUITS / FLOWS

100/ 190.01 105/ 190.02 110/ 170.33 115/ 170.38 120/ 150.85 125/ 150.95 130/ 131.99 135/ 132.19
140/ 112.90 145/ 113.01 90011/ 19.71 90012/ 19.57 90013/ 19.23 90014/ 19.39 90015/ 113.01

- -

CYCLE 3600 TIME 50 HRS - 0.0 MIN

JUNCTIONS / DEPTHS

1000/ 9.22 1301/ 9.05 2301/ 8.86 3301/ 8.59 4301/ 8.42 5301/ 8.37 6301/ 7.88 5302/ 7.37
1302/ 7.12 2302/ 6.90 3302/ 1.45

CONDUITS / FLOWS

100/ 190.00 105/ 190.01 110/ 170.30 115/ 170.33 120/ 150.78 125/ 150.82 130/ 131.72 135/ 131.81
140/ 112.49 145/ 112.54 90011/ 19.71 90012/ 19.56 90013/ 19.21 90014/ 19.38 90015/ 112.54

- -

CYCLE 3780 TIME 52 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

1000/ 9.22 1301/ 9.05 2301/ 8.86 3301/ 8.59 4301/ 8.42 5301/ 8.36 6301/ 7.87 5302/ 7.36
1302/ 7.11 2302/ 6.90 3302/ 1.45

CONDUITS / FLOWS

100/ 190.00 105/ 190.00 110/ 170.30 115/ 170.30 120/ 150.75 125/ 150.77 130/ 131.61 135/ 131.65
140/ 112.31 145/ 112.33 90011/ 19.71 90012/ 19.56 90013/ 19.21 90014/ 19.37 90015/ 112.33

- -

CYCLE 3960 TIME 55 HRS - 0.0 MIN

JUNCTIONS / DEPTHS

1000/ 9.22 1301/ 9.05 2301/ 8.86 3301/ 8.59 4301/ 8.42 5301/ 8.36 6301/ 7.87 5302/ 7.36
1302/ 7.11 2302/ 6.89 3302/ 1.45

CONDUITS / FLOWS

100/ 190.00 105/ 190.00 110/ 170.29 115/ 170.29 120/ 150.74 125/ 150.74 130/ 131.56 135/ 131.58
140/ 112.22 145/ 112.23 90011/ 19.71 90012/ 19.56 90013/ 19.21 90014/ 19.36 90015/ 112.23

- -

CYCLE 4140 TIME 57 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

1000/ 9.22 1301/ 9.05 2301/ 8.85 3301/ 8.59 4301/ 8.42 5301/ 8.36 6301/ 7.87 5302/ 7.36
1302/ 7.11 2302/ 6.89 3302/ 1.45

```
CONDUITS / FLOWS

  100/ 190.00    105/ 190.00     110/ 170.29     115/ 170.29     120/ 150.73     125/ 150.73     130/ 131.54     135/ 131.54
  140/ 112.19    145/ 112.19     90011/  19.71   90012/  19.56   90013/  19.21   90014/  19.36   90015/ 112.19
------------------------------------------------------------------

0****** SYSTEM INFLOWS (CARDS) AT   60.10 HOURS    ( JUNCTION / INFLOW,CFS )

  1000/ 180.00


------------------------------------------------------------------

CYCLE  4320      TIME   60 HRS -  0.0  MIN

JUNCTIONS / DEPTHS

 1000/   9.22    1301/   9.05    2301/   8.85    3301/   8.59    4301/   8.42    5301/   8.36    6301/   7.87    5302/   7.36
 1302/   7.11    2302/   6.89    3302/   1.45

CONDUITS / FLOWS

  100/ 190.00    105/ 190.00     110/ 170.29     115/ 170.29     120/ 150.73     125/ 150.73     130/ 131.53     135/ 131.53
  140/ 112.17    145/ 112.17     90011/  19.71   90012/  19.56   90013/  19.21   90014/  19.36   90015/ 112.17
------------------------------------------------------------------

0****** SYSTEM INFLOWS (CARDS) AT   84.00 HOURS    ( JUNCTION / INFLOW,CFS )

  1000/ 180.00


------------------------------------------------------------------

CYCLE  4500      TIME   62 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

 1000/   9.02    1301/   8.87    2301/   8.68    3301/   8.47    4301/   8.31    5301/   8.27    6301/   7.83    5302/   7.34
 1302/   7.09    2302/   6.88    3302/   1.45

CONDUITS / FLOWS

  100/ 180.21    105/ 180.69     110/ 162.14     115/ 163.51     120/ 144.91     125/ 146.85     130/ 129.79     135/ 130.51
  140/ 111.49    145/ 111.76     90011/  19.49   90012/  19.42   90013/  19.15   90014/  19.34   90015/ 111.76
------------------------------------------------------------------

CYCLE  4680      TIME   65 HRS -  0.0  MIN

JUNCTIONS / DEPTHS

 1000/   9.00    1301/   8.83    2301/   8.64    3301/   8.40    4301/   8.23    5301/   8.18    6301/   7.73    5302/   7.26
 1302/   7.02    2302/   6.82    3302/   1.42

CONDUITS / FLOWS

  100/ 180.06    105/ 180.20     110/ 161.05     115/ 161.59     120/ 142.63     125/ 143.54     130/ 126.28     135/ 127.29
  140/ 108.60    145/ 109.12     90011/  19.44   90012/  19.31   90013/  19.01   90014/  19.22   90015/ 109.12
------------------------------------------------------------------

CYCLE  4860      TIME   67 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

 1000/   8.99    1301/   8.82    2301/   8.62    3301/   8.37    4301/   8.20    5301/   8.14    6301/   7.67    5302/   7.19
 1302/   6.94    2302/   6.75    3302/   1.40

CONDUITS / FLOWS

  100/ 180.02    105/ 180.08     110/ 160.77     115/ 160.98     120/ 141.86     125/ 142.26     130/ 124.26     135/ 124.90
  140/ 106.15    145/ 106.51     90011/  19.42   90012/  19.26   90013/  18.93   90014/  19.10   90015/ 106.51
------------------------------------------------------------------

CYCLE  5040      TIME   70 HRS -  0.0  MIN

JUNCTIONS / DEPTHS

 1000/   8.99    1301/   8.81    2301/   8.62    3301/   8.36    4301/   8.18    5301/   8.13    6301/   7.64    5302/   7.15
 1302/   6.90    2302/   6.71    3302/   1.39

CONDUITS / FLOWS

  100/ 180.01    105/ 180.03     110/ 160.66     115/ 160.75     120/ 141.57     125/ 141.74     130/ 123.30     135/ 123.63
  140/ 104.77    145/ 104.96     90011/  19.41   90012/  19.24   90013/  18.88   90014/  19.03   90015/ 104.96
```

```
--------------------------------------------------------------

CYCLE 5220   TIME  72 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

 1000/  8.99   1301/  8.81   2301/  8.61   3301/  8.35   4301/  8.17   5301/  8.12   6301/  7.63   5302/  7.13
 1302/  6.88   2302/  6.69   3302/  1.38

CONDUITS / FLOWS

 100/ 180.00   105/ 180.01   110/ 160.62   115/ 160.66   120/ 141.45   125/ 141.52   130/ 122.86   135/ 123.02
 140/ 104.10   145/ 104.19   90011/ 19.41  90012/ 19.23  90013/ 18.86  90014/ 19.00  90015/ 104.19
--------------------------------------------------------------

CYCLE 5400   TIME  75 HRS -  0.0 MIN

JUNCTIONS / DEPTHS

 1000/  8.98   1301/  8.81   2301/  8.61   3301/  8.35   4301/  8.17   5301/  8.12   6301/  7.62   5302/  7.12
 1302/  6.87   2302/  6.68   3302/  1.38

CONDUITS / FLOWS

 100/ 180.00   105/ 180.00   110/ 160.60   115/ 160.62   120/ 141.40   125/ 141.43   130/ 122.67   135/ 122.74
 140/ 103.79   145/ 103.83   90011/ 19.41  90012/ 19.23  90013/ 18.85  90014/ 18.98  90015/ 103.83
--------------------------------------------------------------

CYCLE 5580   TIME  77 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

 1000/  8.98   1301/  8.81   2301/  8.61   3301/  8.35   4301/  8.17   5301/  8.12   6301/  7.62   5302/  7.12
 1302/  6.87   2302/  6.68   3302/  1.38

CONDUITS / FLOWS

 100/ 180.00   105/ 180.00   110/ 160.60   115/ 160.61   120/ 141.38   125/ 141.39   130/ 122.58   135/ 122.61
 140/ 103.65   145/ 103.67   90011/ 19.41  90012/ 19.23  90013/ 18.85  90014/ 18.98  90015/ 103.67
--------------------------------------------------------------

CYCLE 5760   TIME  80 HRS -  0.0 MIN

JUNCTIONS / DEPTHS

 1000/  8.98   1301/  8.81   2301/  8.61   3301/  8.35   4301/  8.17   5301/  8.12   6301/  7.62   5302/  7.12
 1302/  6.87   2302/  6.68   3302/  1.38

CONDUITS / FLOWS

 100/ 180.00   105/ 180.00   110/ 160.59   115/ 160.60   120/ 141.37   125/ 141.37   130/ 122.54   135/ 122.56
 140/ 103.59   145/ 103.60   90011/ 19.41  90012/ 19.23  90013/ 18.85  90014/ 18.97  90015/ 103.60
--------------------------------------------------------------

CYCLE 5940   TIME  82 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

 1000/  8.98   1301/  8.81   2301/  8.61   3301/  8.35   4301/  8.17   5301/  8.11   6301/  7.62   5302/  7.12
 1302/  6.87   2302/  6.68   3302/  1.38

CONDUITS / FLOWS

 100/ 180.00   105/ 180.00   110/ 160.59   115/ 160.59   120/ 141.37   125/ 141.37   130/ 122.53   135/ 122.53
 140/ 103.56   145/ 103.57   90011/ 19.41  90012/ 19.23  90013/ 18.85  90014/ 18.97  90015/ 103.57
--------------------------------------------------------------

0****** SYSTEM INFLOWS (CARDS) AT   84.10 HOURS   ( JUNCTION / INFLOW,CFS )

  1000/ 170.00


--------------------------------------------------------------

0****** SYSTEM INFLOWS (CARDS) AT  108.00 HOURS   ( JUNCTION / INFLOW,CFS )

  1000/ 170.00


--------------------------------------------------------------

CYCLE 6120   TIME  85 HRS -  0.0 MIN

JUNCTIONS / DEPTHS
```

1000/ 8.83	1301/ 8.69	2301/ 8.52	3301/ 8.31	4301/ 8.14	5301/ 8.10	6301/ 7.61	5302/ 7.12
1302/ 6.87	2302/ 6.68	3302/ 1.38					

CONDUITS / FLOWS

100/ 170.65	105/ 172.10	110/ 155.47	115/ 157.57	120/ 139.31	125/ 140.79	130/ 122.43	135/ 122.49
140/ 103.54	145/ 103.55	90011/ 19.28	90012/ 19.19	90013/ 18.84	90014/ 18.97	90015/ 103.55	

CYCLE 6300 TIME 87 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

1000/ 8.77	1301/ 8.60	2301/ 8.41	3301/ 8.18	4301/ 8.02	5301/ 7.98	6301/ 7.53	5302/ 7.07
1302/ 6.83	2302/ 6.64	3302/ 1.37					

CONDUITS / FLOWS

100/ 170.12	105/ 170.40	110/ 151.83	115/ 152.79	120/ 134.38	125/ 135.90	130/ 119.38	135/ 120.37
140/ 101.94	145/ 102.38	90011/ 19.15	90012/ 19.02	90013/ 18.73	90014/ 18.91	90015/ 102.38	

CYCLE 6480 TIME 90 HRS - 0.0 MIN

JUNCTIONS / DEPTHS

1000/ 8.75	1301/ 8.58	2301/ 8.38	3301/ 8.13	4301/ 7.96	5301/ 7.91	6301/ 7.45	5302/ 6.98
1302/ 6.74	2302/ 6.57	3302/ 1.35					

CONDUITS / FLOWS

100/ 170.04	105/ 170.13	110/ 151.22	115/ 151.60	120/ 132.91	125/ 133.58	130/ 116.42	135/ 117.32
140/ 99.03	145/ 99.52	90011/ 19.11	90012/ 18.94	90013/ 18.60	90014/ 18.77	90015/ 99.52	

CYCLE 6660 TIME 92 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

1000/ 8.75	1301/ 8.57	2301/ 8.37	3301/ 8.11	4301/ 7.93	5301/ 7.88	6301/ 7.40	5302/ 6.92
1302/ 6.68	2302/ 6.51	3302/ 1.33					

CONDUITS / FLOWS

100/ 170.01	105/ 170.05	110/ 151.03	115/ 151.19	120/ 132.39	125/ 132.67	130/ 114.87	135/ 115.40
140/ 97.01	145/ 97.32	90011/ 19.10	90012/ 18.90	90013/ 18.53	90014/ 18.66	90015/ 97.32	

CYCLE 6840 TIME 95 HRS - 0.0 MIN

JUNCTIONS / DEPTHS

1000/ 8.74	1301/ 8.57	2301/ 8.37	3301/ 8.10	4301/ 7.92	5301/ 7.87	6301/ 7.37	5302/ 6.89
1302/ 6.64	2302/ 6.48	3302/ 1.32					

CONDUITS / FLOWS

100/ 170.01	105/ 170.02	110/ 150.96	115/ 151.03	120/ 132.18	125/ 132.30	130/ 114.15	135/ 114.41
140/ 95.94	145/ 96.10	90011/ 19.09	90012/ 18.89	90013/ 18.49	90014/ 18.61	90015/ 96.10	

CYCLE 7020 TIME 97 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

1000/ 8.74	1301/ 8.57	2301/ 8.36	3301/ 8.10	4301/ 7.91	5301/ 7.86	6301/ 7.36	5302/ 6.88
1302/ 6.63	2302/ 6.46	3302/ 1.31					

CONDUITS / FLOWS

100/ 170.00	105/ 170.01	110/ 150.93	115/ 150.96	120/ 132.10	125/ 132.15	130/ 113.82	135/ 113.94
140/ 95.43	145/ 95.50	90011/ 19.09	90012/ 18.88	90013/ 18.48	90014/ 18.58	90015/ 95.50	

CYCLE 7200 TIME 100 HRS - 0.0 MIN

JUNCTIONS / DEPTHS

1000/ 8.74	1301/ 8.57	2301/ 8.36	3301/ 8.09	4301/ 7.91	5301/ 7.86	6301/ 7.36	5302/ 6.87
1302/ 6.62	2302/ 6.45	3302/ 1.31					

CONDUITS / FLOWS

100/ 170.00	105/ 170.00	110/ 150.92	115/ 150.93	120/ 132.06	125/ 132.08	130/ 113.68	135/ 113.73
140/ 95.20	145/ 95.23	90011/ 19.09	90012/ 18.88	90013/ 18.47	90014/ 18.57	0015/ 95.23	

CYCLE 7380 TIME 102 HRS - 30.00 MIN

```
JUNCTIONS / DEPTHS

 1000/  8.74   1301/  8.57      2301/  8.36     3301/  8.09     4301/  7.91     5301/  7.86     6301/  7.35     5302/  6.87
 1302/  6.62   2302/  6.45      3302/  1.31

CONDUITS / FLOWS

  100/ 170.00   105/ 170.00     110/ 150.92     115/ 150.92     120/ 132.04     125/ 132.05     130/ 113.61     135/ 113.64
  140/  95.09   145/  95.10     90011/  19.09   90012/  18.88   90013/  18.47   90014/  18.56   90015/  95.10

-------------------------------------------------------------

CYCLE  7560      TIME  105 HRS -  0.0  MIN

JUNCTIONS / DEPTHS

 1000/  8.74   1301/  8.57      2301/  8.36     3301/  8.09     4301/  7.91     5301/  7.86     6301/  7.35     5302/  6.86
 1302/  6.61   2302/  6.45      3302/  1.31

CONDUITS / FLOWS

  100/ 170.00   105/ 170.00     110/ 150.91     115/ 150.92     120/ 132.04     125/ 132.04     130/ 113.59     135/ 113.60
  140/  95.04   145/  95.05     90011/  19.09   90012/  18.88   90013/  18.47   90014/  18.56   90015/  95.05

-------------------------------------------------------------

CYCLE  7740      TIME  107 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

 1000/  8.74   1301/  8.57      2301/  8.36     3301/  8.09     4301/  7.91     5301/  7.86     6301/  7.35     5302/  6.86
 1302/  6.61   2302/  6.45      3302/  1.31

CONDUITS / FLOWS

  100/ 170.00   105/ 170.00     110/ 150.91     115/ 150.91     120/ 132.04     125/ 132.04     130/ 113.57     135/ 113.58
  140/  95.02   145/  95.03     90011/  19.09   90012/  18.88   90013/  18.47   90014/  18.56   90015/  95.03

-------------------------------------------------------------

0****** SYSTEM INFLOWS (CARDS) AT  108.10 HOURS    ( JUNCTION / INFLOW,CFS )

  1000/ 160.00


-------------------------------------------------------------

0****** SYSTEM INFLOWS (CARDS) AT  140.00 HOURS    ( JUNCTION / INFLOW,CFS )

  1000/ 160.00


-------------------------------------------------------------

CYCLE  7920      TIME  110 HRS -  0.0  MIN

JUNCTIONS / DEPTHS

 1000/  8.54   1301/  8.39      2301/  8.20     3301/  7.99     4301/  7.82     5301/  7.79     6301/  7.33     5302/  6.85
 1302/  6.61   2302/  6.44      3302/  1.31

CONDUITS / FLOWS

  100/ 160.30   105/ 160.98     110/ 143.45     115/ 145.14     120/ 127.33     125/ 129.46     130/ 112.70     135/ 113.14
  140/  94.77   145/  94.90     90011/  18.87   90012/  18.76   90013/  18.43   90014/  18.55   90015/  94.90

-------------------------------------------------------------

CYCLE  8100      TIME  112 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

 1000/  8.51   1301/  8.34      2301/  8.14     3301/  7.89     4301/  7.72     5301/  7.68     6301/  7.23     5302/  6.78
 1302/  6.54   2302/  6.39      3302/  1.29

CONDUITS / FLOWS

  100/ 160.08   105/ 160.26     110/ 141.83     115/ 142.51     120/ 124.33     125/ 125.48     130/ 109.20     135/ 110.26
  140/  92.36   145/  92.89     90011/  18.79   90012/  18.62   90013/  18.29   90014/  18.43   90015/  92.89

-------------------------------------------------------------

CYCLE  8280      TIME  115 HRS -  0.0  MIN

JUNCTIONS / DEPTHS

 1000/  8.50   1301/  8.32      2301/  8.12     3301/  7.86     4301/  7.68     5301/  7.63     6301/  7.15     5302/  6.70
 1302/  6.46   2302/  6.31      3302/  1.27

CONDUITS / FLOWS
```

```
  100/ 160.03   105/ 160.09    110/ 141.46    115/ 141.73    120/ 123.36    125/ 123.85    130/ 106.83    135/ 107.61
  140/  89.73   145/  90.17  90011/  18.76  90012/  18.55  90013/  18.17  90014/  18.29  90015/  90.17
-----------------------------------------------------------------

CYCLE 8460     TIME  117 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

 1000/   8.49  1301/   8.31   2301/   8.11   3301/   7.84   4301/   7.66   5301/   7.61   6301/   7.11   5302/   6.65
 1302/   6.40  2302/   6.26   3302/   1.25

CONDUITS / FLOWS

  100/ 160.01   105/ 160.03    110/ 141.33    115/ 141.44    120/ 122.99    125/ 123.20    130/ 105.65    135/ 106.08
  140/  89.11   145/  88.36  90011/  18.75  90012/  18.53  90013/  18.11  90014/  18.20  90015/  88.36
-----------------------------------------------------------------

CYCLE 8640     TIME  120 HRS -  0.0 MIN

JUNCTIONS / DEPTHS

 1000/   8.49  1301/   8.31   2301/   8.11   3301/   7.84   4301/   7.65   5301/   7.60   6301/   7.09   5302/   6.62
 1302/   6.37  2302/   6.23   3302/   1.24

CONDUITS / FLOWS

  100/ 160.00   105/ 160.01    110/ 141.28    115/ 141.33    120/ 122.85    125/ 122.94    130/ 105.11    135/ 105.32
  140/  87.28   145/  87.40  90011/  18.75  90012/  18.52  90013/  18.08  90014/  18.15  90015/  87.40
-----------------------------------------------------------------

CYCLE 8820     TIME  122 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

 1000/   8.49  1301/   8.31   2301/   8.10   3301/   7.83   4301/   7.65   5301/   7.59   6301/   7.08   5302/   6.61
 1302/   6.36  2302/   6.22   3302/   1.24

CONDUITS / FLOWS

  100/ 160.00   105/ 160.00    110/ 141.27    115/ 141.28    120/ 122.79    125/ 122.82    130/ 104.87    135/ 104.96
  140/  86.89   145/  86.95  90011/  18.75  90012/  18.51  90013/  18.07  90014/  18.13  90015/  86.95
-----------------------------------------------------------------

CYCLE 9000     TIME  125 HRS -  0.0 MIN

JUNCTIONS / DEPTHS

 1000/   8.49  1301/   8.31   2301/   8.10   3301/   7.83   4301/   7.64   5301/   7.59   6301/   7.08   5302/   6.60
 1302/   6.35  2302/   6.21   3302/   1.24

CONDUITS / FLOWS

  100/ 160.00   105/ 160.00    110/ 141.26    115/ 141.26    120/ 122.76    125/ 122.78    130/ 104.76    135/ 104.80
  140/  86.71   145/  86.74  90011/  18.75  90012/  18.51  90013/  18.06  90014/  18.12  90015/  86.74
-----------------------------------------------------------------

CYCLE 9180     TIME  127 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

 1000/   8.49  1301/   8.31   2301/   8.10   3301/   7.83   4301/   7.64   5301/   7.59   6301/   7.08   5302/   6.60
 1302/   6.35  2302/   6.21   3302/   1.24

CONDUITS / FLOWS

  100/ 160.00   105/ 160.00    110/ 141.25    115/ 141.26    120/ 122.75    125/ 122.76    130/ 104.71    135/ 104.73
  140/  86.63   145/  86.64  90011/  18.75  90012/  18.51  90013/  18.06  90014/  18.11  90015/  86.64
1---------------------- CONTINUITY BALANCE AT END OF RUN ----------------------

TOTAL SYSTEM INFLOW VOLUME =   83933664. CU FT

JUNCTION OUTFLOWS AND
STREET FLOODING

  JUNCTION  OUTFLOW, FT3

     3302    45297936.
            --------------
        TOTAL         45297936. CU FT

VOLUME LEFT IN SYSTEM =        4426637. CU FT

ERROR IN CONTINUITY, PERCENT = 40.76
1-----------------------------------------------------------------------------------------------
ENVIRONMENTAL PROTECTION AGENCY        ^^^^  EXTENDED TRANSPORT PROGRAM  ^^^^     WATER RESOURCES DIVISION
WASHINGTON, D.C.                 ^^^^                        ^^^^       CAMP DRESSER & MCKEE INC.
                           ^^^^      ANALYSIS MODULE      ^^^^       ANNANDALE, VIRGINIA
FLOW ROUTING IN LEFT BANK MAIN CANAL OF KALAWEWA IRRIGATION SCHEME
VARIABLE INFLOW AT ENTRY
```

0 ********************** TIME HISTORY OF H. G. L. **********************
(VALUES IN FEET)

0	JUNCTION 1000		JUNCTION 1301		JUNCTION 2301		JUNCTION 3301		JUNCTION 4301		JUNCTION 5301	
TIME	GRND 60.00		GRND 59.00		GRND 58.00		GRND 57.00		GRND 56.00		GRND 56.00	
HR . MIN	ELEV	DEPTH	ELEV	DEPTH	ELEV	DEPTH	ELEV	DEPTH	ELEV	DEPTH	ELEV	DEPTH
2.30	48.68	8.96	47.46	8.52	46.66	8.12	42.77	5.85	40.96	4.55	36.58	0.83
5. 0	48.98	9.26	47.93	8.99	47.26	8.73	44.95	8.03	44.11	7.70	43.28	7.53
7.30	49.10	9.38	48.11	9.17	47.49	8.95	45.48	8.56	44.73	8.32	43.94	8.19
10. 0	49.14	9.42	48.17	9.23	47.57	9.03	45.63	8.71	44.92	8.51	44.17	8.42
12.30	49.15	9.43	48.20	9.26	47.60	9.06	45.69	8.77	45.00	8.59	44.27	8.52
15. 0	49.16	9.44	48.21	9.27	47.62	9.08	45.72	8.80	45.04	8.63	44.31	8.56
17.30	49.16	9.44	48.22	9.28	47.62	9.08	45.74	8.82	45.06	8.65	44.34	8.59
20. 0	49.17	9.45	48.22	9.28	47.63	9.09	45.75	8.83	45.06	8.65	44.34	8.59
22.30	49.17	9.45	48.22	9.28	47.63	9.09	45.75	8.83	45.07	8.66	44.35	8.60
25. 0	49.17	9.45	48.22	9.28	47.63	9.09	45.75	8.83	45.07	8.66	44.35	8.60
27.30	49.17	9.45	48.22	9.28	47.63	9.09	45.75	8.83	45.07	8.66	44.35	8.60
30. 0	49.17	9.45	48.22	9.28	47.63	9.09	45.75	8.83	45.07	8.66	44.35	8.60
32.30	49.17	9.45	48.22	9.28	47.63	9.09	45.75	8.83	45.07	8.66	44.35	8.60
35. 0	49.17	9.45	48.22	9.28	47.63	9.09	45.75	8.83	45.07	8.66	44.35	8.60
37.30	49.00	9.28	48.08	9.14	47.50	8.96	45.68	8.76	45.02	8.61	44.32	8.57
40. 0	48.96	9.24	48.02	9.08	47.43	8.89	45.58	8.66	44.91	8.50	44.21	8.46
42.30	48.95	9.23	48.00	9.06	47.41	8.87	45.54	8.62	44.86	8.45	44.15	8.40
45. 0	48.94	9.22	47.99	9.05	47.40	8.86	45.52	8.60	44.84	8.43	44.13	8.38
47.30	48.94	9.22	47.99	9.05	47.40	8.86	45.52	8.60	44.84	8.43	44.12	8.37
50. 0	48.94	9.22	47.99	9.05	47.40	8.86	45.51	8.59	44.83	8.42	44.12	8.37
52.30	48.94	9.22	47.99	9.05	47.40	8.86	45.51	8.59	44.83	8.42	44.11	8.36
55. 0	48.94	9.22	47.99	9.05	47.40	8.86	45.51	8.59	44.83	8.42	44.11	8.36
57.30	48.94	9.22	47.99	9.05	47.39	8.85	45.51	8.59	44.83	8.42	44.11	8.36
60. 0	48.94	9.22	47.99	9.05	47.39	8.85	45.51	8.59	44.83	8.42	44.11	8.36
62.30	48.74	9.02	47.81	8.87	47.22	8.68	45.39	8.47	44.72	8.31	44.02	8.27
65. 0	48.72	9.00	47.77	8.83	47.18	8.64	45.32	8.40	44.64	8.23	43.93	8.18
67.30	48.71	8.99	47.76	8.82	47.16	8.62	45.29	8.37	44.61	8.20	43.89	8.14
70. 0	48.71	8.99	47.75	8.81	47.16	8.62	45.28	8.36	44.59	8.18	43.88	8.13
72.30	48.71	8.99	47.75	8.81	47.15	8.61	45.27	8.35	44.58	8.17	43.87	8.12
75. 0	48.70	8.98	47.75	8.81	47.15	8.61	45.27	8.35	44.58	8.17	43.87	8.12
77.30	48.70	8.98	47.75	8.81	47.15	8.61	45.27	8.35	44.58	8.17	43.87	8.12
80. 0	48.70	8.98	47.75	8.81	47.15	8.61	45.27	8.35	44.58	8.17	43.87	8.12
82.30	48.70	8.98	47.75	8.81	47.15	8.61	45.27	8.35	44.58	8.17	43.86	8.11
85. 0	48.55	8.83	47.63	8.69	47.06	8.52	45.23	8.31	44.55	8.14	43.85	8.10
87.30	48.49	8.77	47.54	8.60	46.95	8.41	45.10	8.18	44.43	8.02	43.73	7.98
90. 0	48.47	8.75	47.52	8.58	46.92	8.38	45.05	8.13	44.37	7.96	43.66	7.91
92.30	48.47	8.75	47.51	8.57	46.91	8.37	45.03	8.11	44.34	7.93	43.63	7.88
95. 0	48.46	8.74	47.51	8.57	46.91	8.37	45.02	8.10	44.33	7.92	43.62	7.87
97.30	48.46	8.74	47.51	8.57	46.90	8.36	45.02	8.10	44.32	7.91	43.61	7.86
100. 0	48.46	8.74	47.51	8.57	46.90	8.36	45.01	8.09	44.32	7.91	43.61	7.86
102.30	48.46	8.74	47.51	8.57	46.90	8.36	45.01	8.09	44.32	7.91	43.61	7.86
105. 0	48.46	8.74	47.51	8.57	46.90	8.36	45.01	8.09	44.32	7.91	43.61	7.86
107.30	48.46	8.74	47.51	8.57	46.90	8.36	45.01	8.09	44.32	7.91	43.61	7.86
110. 0	48.26	8.54	47.33	8.39	46.74	8.20	44.91	7.99	44.23	7.82	43.54	7.79
112.30	48.23	8.51	47.28	8.34	46.68	8.14	44.81	7.89	44.13	7.72	43.43	7.68
115. 0	48.22	8.50	47.26	8.32	46.66	8.12	44.78	7.86	44.09	7.68	43.38	7.63
117.30	48.21	8.49	47.25	8.31	46.65	8.11	44.76	7.84	44.07	7.66	43.36	7.61
120. 0	48.21	8.49	47.25	8.31	46.65	8.11	44.76	7.84	44.06	7.65	43.35	7.60
122.30	48.21	8.49	47.25	8.31	46.64	8.10	44.75	7.83	44.06	7.65	43.34	7.59
125. 0	48.21	8.49	47.25	8.31	46.64	8.10	44.75	7.83	44.05	7.64	43.34	7.59
127.30	48.21	8.49	47.25	8.31	46.64	8.10	44.75	7.83	44.05	7.64	43.34	7.59

1--

ENVIRONMENTAL PROTECTION AGENCY **** EXTENDED TRANSPORT PROGRAM **** WATER RESOURCES DIVISION
WASHINGTON, D.C. **** **** CAMP DRESSER & MCKEE INC.
**** ANALYSIS MODULE **** ANNANDALE, VIRGINIA
FLOW ROUTING IN LEFT BANK MAIN CANAL OF KALAWEWA IRRIGATION SCHEME
VARIABLE INFLOW AT ENTRY

0 ********************** TIME HISTORY OF H. G. L. **********************
(VALUES IN FEET)

0	JUNCTION 6301		JUNCTION 5302		JUNCTION 1302		JUNCTION 2302		JUNCTION 3302		JUNCTION	
TIME	GRND 54.00		GRND 52.00		GRND 51.00		GRND 51.00		GRND 50.00		GRND	
2.30	33.65	0.01	31.87	0.00	31.43	0.0	30.68	0.0	30.00	0.0		
5. 0	37.25	3.61	32.57	0.70	31.47	0.04	30.68	0.00	30.00	0.00		
7.30	40.60	6.96	36.96	5.09	35.70	4.27	33.32	2.64	30.31	0.31		
10. 0	41.31	7.67	38.65	6.78	37.85	6.42	36.84	6.16	31.22	1.22		
12.30	41.57	7.93	39.18	7.31	38.46	7.03	37.47	6.79	31.42	1.42		
15. 0	41.68	8.04	39.35	7.48	38.65	7.22	37.66	6.98	31.48	1.48		
17.30	41.72	8.08	39.41	7.54	38.72	7.29	37.73	7.05	31.50	1.50		
20. 0	41.74	8.10	39.44	7.57	38.75	7.32	37.76	7.08	31.51	1.51		
22.30	41.75	8.11	39.45	7.58	38.76	7.33	37.77	7.09	31.52	1.52		
25. 0	41.75	8.11	39.46	7.59	38.76	7.33	37.78	7.10	31.52	1.52		
27.30	41.75	8.11	39.46	7.59	38.77	7.34	37.78	7.10	31.52	1.52		
30. 0	41.75	8.11	39.46	7.59	38.77	7.34	37.78	7.10	31.52	1.52		
32.30	41.75	8.11	39.46	7.59	38.77	7.34	37.78	7.10	31.52	1.52		
35. 0	41.75	8.11	39.46	7.59	38.77	7.34	37.78	7.10	31.52	1.52		
37.30	41.74	8.10	39.46	7.59	38.76	7.33	37.78	7.10	31.52	1.52		
40. 0	41.65	8.01	39.40	7.53	38.71	7.28	37.74	7.06	31.51	1.51		
42.30	41.58	7.94	39.32	7.45	38.63	7.20	37.67	6.99	31.48	1.48		
45. 0	41.54	7.90	39.27	7.40	38.58	7.15	37.62	6.94	31.46	1.46		
47.30	41.53	7.89	39.25	7.38	38.56	7.13	37.59	6.91	31.46	1.46		
50. 0	41.52	7.88	39.24	7.37	38.55	7.12	37.58	6.90	31.45	1.45		
52.30	41.51	7.87	39.23	7.36	38.54	7.11	37.58	6.90	31.45	1.45		
55. 0	41.51	7.87	39.23	7.36	38.54	7.11	37.57	6.89	31.45	1.45		
57.30	41.51	7.87	39.23	7.36	38.54	7.11	37.57	6.89	31.45	1.45		
60. 0	41.51	7.87	39.23	7.36	38.54	7.11	37.57	6.89	31.45	1.45		
62.30	41.47	7.83	39.21	7.34	38.52	7.09	37.56	6.88	31.45	1.45		
65. 0	41.37	7.73	39.13	7.26	38.45	7.02	37.50	6.82	31.42	1.42		

67.30	41.31	7.67	39.06	7.19	38.37	6.94	37.43	6.75	31.40	1.40
70. 0	41.28	7.64	39.02	7.15	38.33	6.90	37.39	6.71	31.39	1.39
72.30	41.27	7.63	39.00	7.13	38.31	6.88	37.37	6.69	31.38	1.38
75. 0	41.26	7.62	38.99	7.12	38.30	6.87	37.36	6.68	31.38	1.38
77.30	41.26	7.62	38.99	7.12	38.30	6.87	37.36	6.68	31.38	1.38
80. 0	41.26	7.62	38.99	7.12	38.30	6.87	37.36	6.68	31.38	1.38
82.30	41.26	7.62	38.99	7.12	38.30	6.87	37.36	6.68	31.38	1.38
85. 0	41.25	7.61	38.99	7.12	38.30	6.87	37.36	6.68	31.38	1.38
87.30	41.17	7.53	38.94	7.07	38.26	6.83	37.32	6.64	31.37	1.37
90. 0	41.09	7.45	38.85	6.98	38.17	6.74	37.25	6.57	31.35	1.35
92.30	41.04	7.40	38.79	6.92	38.11	6.68	37.19	6.51	31.33	1.33
95. 0	41.01	7.37	38.76	6.89	38.07	6.64	37.16	6.48	31.32	1.32
97.30	41.00	7.36	38.75	6.88	38.06	6.63	37.14	6.46	31.31	1.31
100. 0	41.00	7.36	38.74	6.87	38.05	6.62	37.13	6.45	31.31	1.31
102.30	40.99	7.35	38.74	6.87	38.05	6.62	37.13	6.45	31.31	1.31
105. 0	40.99	7.35	38.73	6.86	38.04	6.61	37.13	6.45	31.31	1.31
107.30	40.99	7.35	38.73	6.86	38.04	6.61	37.13	6.45	31.31	1.31
110. 0	40.97	7.33	38.72	6.85	38.04	6.61	37.12	6.44	31.31	1.31
112.30	40.87	7.23	38.65	6.78	37.97	6.54	37.07	6.39	31.29	1.29
115. 0	40.79	7.15	38.57	6.70	37.89	6.46	36.99	6.31	31.27	1.27
117.30	40.75	7.11	38.52	6.65	37.83	6.40	36.94	6.26	31.25	1.25
120. 0	40.73	7.09	38.49	6.62	37.80	6.37	36.91	6.23	31.24	1.24
122.30	40.72	7.08	38.48	6.61	37.79	6.36	36.90	6.22	31.24	1.24
125. 0	40.72	7.08	38.47	6.60	37.78	6.35	36.89	6.21	31.24	1.24
127.30	40.72	7.08	38.47	6.60	37.78	6.35	36.89	6.21	31.24	1.24

1--

ENVIRONMENTAL PROTECTION AGENCY ^^^^ EXTENDED TRANSPORT PROGRAM ^^^^ WATER RESOURCES DIVISION
WASHINGTON, D.C. ^^^^ ^^^^ CAMP DRESSER & MCKEE INC.
^^^^ ANALYSIS MODULE ^^^^ ANNANDALE, VIRGINIA
FLOW ROUTING IN LEFT BANK MAIN CANAL OF KALAWEWA IRRIGATION SCHEME
VARIABLE INFLOW AT ENTRY

''''''''''''''' SUMMARY STATISTICS FOR JUNCTIONS '''''''''''''''

JUNCTION NUMBER	GROUND ELEVATION (FT)	UPPERMOST PIPE CROWN ELEVATION (FT)	MAXIMUM COMPUTED DEPTH (FT)	TIME OF OCCURENCE HR.	MIN.	FEET OF SURCHARGE AT MAX. DEPTH	FEET MAX. DEPTH IS BELOW GROUND ELEVATION	LENGTH OF SURCHARGE (MIN)
1000	60.00	49.72	9.45	32	28	0.0	10.83	0.0
1301	59.00	48.94	9.28	32	53	0.0	10.78	0.0
2301	58.00	48.54	9.09	32	53	0.0	10.37	0.0
3301	57.00	46.92	8.83	33	47	0.0	11.25	0.0
4301	56.00	46.41	8.66	34	13	0.0	10.93	0.0
5301	56.00	45.75	8.60	34	1	0.0	11.65	0.0
6301	54.00	43.64	8.11	34	42	0.0	12.25	0.0
5302	52.00	41.87	7.59	35	57	0.0	12.54	0.0
1302	51.00	41.43	7.34	36	0	0.0	12.23	0.0
2302	51.00	40.68	7.10	36	9	0.0	13.22	0.0
3302	50.00	40.00	1.52	36	10	0.0	18.48	0.0

1--

ENVIRONMENTAL PROTECTION AGENCY ^^^^ EXTENDED TRANSPORT PROGRAM ^^^^ WATER RESOURCES DIVISION
WASHINGTON, D.C. ^^^^ ^^^^ CAMP DRESSER & MCKEE INC.
^^^^ ANALYSIS MODULE ^^^^ ANNANDALE, VIRGINIA
FLOW ROUTING IN LEFT BANK MAIN CANAL OF KALAWEWA IRRIGATION SCHEME
VARIABLE INFLOW AT ENTRY

0 *************** TIME HISTORY OF FLOW AND VELOCITY ***************

Q(CFS), VEL(FPS)

0 TIME HR . MIN	CONDUIT 100 FLOW	VEL	CONDUIT 105 FLOW	VEL	CONDUIT 110 FLOW	VEL	CONDUIT 115 FLOW	VEL	CONDUIT 120 FLOW	VEL	CONDUIT 125 FLOW	VEL
2.30	196.74	1.0	188.74	1.0	155.27	1.1	102.20	1.1	42.13	1.0	0.75	0.2
5. 0	199.23	0.9	197.31	1.0	173.63	0.9	160.39	0.9	132.44	0.8	109.10	1.0
7.30	199.67	0.9	198.90	0.9	177.52	0.9	174.59	0.9	153.25	0.8	148.24	0.9
10. 0	199.88	0.9	199.58	0.9	179.06	0.9	177.83	0.9	157.31	0.8	154.98	0.9
12.30	199.94	0.9	199.81	0.9	179.57	0.9	179.01	0.9	158.84	0.8	157.76	0.9
15. 0	199.97	0.9	199.91	0.9	179.80	0.9	179.54	0.9	159.53	0.8	159.04	0.9
17.30	199.99	0.9	199.96	0.9	179.90	0.9	179.78	0.9	159.85	0.8	159.63	0.9
20. 0	199.99	0.9	199.98	0.9	179.95	0.9	179.90	0.9	160.00	0.8	159.90	0.9
22.30	200.00	0.9	199.99	0.9	179.98	0.9	179.95	0.9	160.07	0.8	160.02	0.8
25. 0	200.00	0.9	200.00	0.9	179.99	0.9	179.98	0.9	160.09	0.8	160.07	0.8
27.30	200.00	0.9	200.00	0.9	179.99	0.9	179.99	0.9	160.11	0.8	160.10	0.8
30. 0	200.00	0.9	200.00	0.9	179.99	0.9	179.99	0.9	160.11	0.8	160.11	0.8
32.30	200.00	0.9	200.00	0.9	179.99	0.9	179.99	0.9	160.12	0.8	160.11	0.8
35. 0	200.00	0.9	200.00	0.9	179.99	0.9	179.99	0.9	160.12	0.8	160.12	0.8
37.30	190.41	0.9	191.33	0.9	173.22	0.8	175.11	0.9	156.31	0.8	158.36	0.8
40. 0	190.09	0.9	190.31	0.9	170.99	0.8	171.75	0.9	152.57	0.8	153.81	0.8
42.30	190.03	0.9	190.11	0.9	170.54	0.8	170.84	0.9	151.44	0.8	151.97	0.8
45. 0	190.01	0.9	190.04	0.9	170.39	0.8	170.51	0.9	151.02	0.8	151.25	0.8
47.30	190.01	0.9	190.02	0.9	170.33	0.8	170.38	0.9	150.85	0.8	150.95	0.8
50. 0	190.00	0.9	190.01	0.9	170.30	0.8	170.33	0.9	150.78	0.8	150.82	0.8
52.30	190.00	0.9	190.00	0.9	170.30	0.8	170.30	0.9	150.75	0.8	150.77	0.8
55. 0	190.00	0.9	190.00	0.9	170.29	0.8	170.29	0.9	150.74	0.8	150.74	0.8
57.30	190.00	0.9	190.00	0.9	170.29	0.8	170.29	0.9	150.73	0.8	150.73	0.8
60. 0	190.00	0.9	190.00	0.9	170.29	0.8	170.29	0.9	150.73	0.8	150.73	0.8
62.30	180.21	0.9	180.69	0.9	162.14	0.8	163.51	0.9	144.91	0.8	146.85	0.8
65. 0	180.06	0.9	180.20	0.9	161.05	0.8	161.59	0.9	142.63	0.8	143.54	0.8
67.30	180.02	0.9	180.08	0.9	160.77	0.8	160.98	0.9	141.86	0.8	142.26	0.8
70. 0	180.01	0.9	180.03	0.9	160.66	0.8	160.75	0.9	141.57	0.8	141.74	0.8
72.30	180.00	0.9	180.01	0.9	160.62	0.8	160.66	0.9	141.45	0.8	141.52	0.8

75. 0	180.00 0.9	180.00 0.9	160.60 0.8	160.62 0.9	141.40 0.8	141.43 0.8
77.30	180.00 0.9	180.00 0.9	160.60 0.8	160.61 0.9	141.38 0.8	141.39 0.8
80. 0	180.00 0.9	180.00 0.9	160.59 0.8	160.60 0.9	141.37 0.8	141.37 0.8
82.30	180.00 0.9	180.00 0.9	160.59 0.8	160.59 0.9	141.37 0.8	141.37 0.8
85. 0	170.65 0.8	172.10 0.9	155.47 0.8	157.57 0.9	139.31 0.8	140.79 0.8
87.30	170.12 0.9	170.40 0.9	151.83 0.8	152.79 0.9	134.38 0.8	135.90 0.8
90. 0	170.04 0.9	170.13 0.9	151.22 0.8	151.60 0.9	132.91 0.8	133.58 0.8
92.30	170.01 0.9	170.05 0.9	151.03 0.8	151.19 0.9	132.39 0.8	132.67 0.8
95. 0	170.01 0.9	170.02 0.9	150.96 0.8	151.03 0.9	132.18 0.8	132.30 0.8
97.30	170.00 0.9	170.01 0.9	150.93 0.8	150.96 0.9	132.10 0.8	132.15 0.8
100. 0	170.00 0.9	170.00 0.9	150.92 0.8	150.93 0.9	132.06 0.8	132.08 0.8
102.30	170.00 0.9	170.00 0.9	150.92 0.8	150.92 0.9	132.04 0.8	132.05 0.8
105. 0	170.00 0.9	170.00 0.9	150.91 0.8	150.92 0.9	132.04 0.8	132.04 0.8
107.30	170.00 0.9	170.00 0.9	150.91 0.8	150.91 0.9	132.04 0.8	132.04 0.8
110. 0	160.30 0.8	160.98 0.9	143.45 0.8	145.14 0.8	127.33 0.8	129.46 0.8
112.30	160.08 0.8	160.26 0.9	141.83 0.8	142.51 0.8	124.33 0.7	125.48 0.8
115. 0	160.03 0.8	160.09 0.9	141.46 0.8	141.73 0.8	123.36 0.8	123.85 0.8
117.30	160.01 0.8	160.03 0.9	141.33 0.8	141.44 0.8	122.99 0.8	123.20 0.8
120. 0	160.00 0.8	160.01 0.9	141.28 0.8	141.33 0.8	122.85 0.8	122.94 0.8
122.30	160.00 0.8	160.00 0.9	141.27 0.8	141.28 0.8	122.79 0.8	122.82 0.8
125. 0	160.00 0.8	160.00 0.9	141.26 0.8	141.26 0.8	122.76 0.8	122.78 0.8
127.30	160.00 0.8	160.00 0.9	141.25 0.8	141.26 0.8	122.75 0.8	122.76 0.8

1---

ENVIRONMENTAL PROTECTION AGENCY ^^^^ EXTENDED TRANSPORT PROGRAM ^^^^ WATER RESOURCES DIVISION
WASHINGTON, D.C. ^^^^ ^^^^ CAMP DRESSER & MCKEE INC.
^^^^ ANALYSIS MODULE ^^^^ ANNANDALE, VIRGINIA
FLOW ROUTING IN LEFT BANK MAIN CANAL OF KALAWEWA IRRIGATION SCHEME
VARIABLE INFLOW AT ENTRY

0 *************** T I M E H I S T O R Y O F F L O W A N D V E L O C I T Y ***************

Q(CFS), VEL(FPS)

0 TIME	CONDUIT 130	CONDUIT 135	CONDUIT 140	CONDUIT 145	CONDUIT
2.30	0.00 0.0	0.0 0.0	0.0 0.0	0.0 0.0	
5. 0	17.47 0.6	0.79 0.2	0.00 0.0	0.00 0.0	
7.30	103.64 0.9	74.48 0.9	44.77 0.8	11.57 0.6	
10. 0	127.75 0.8	117.08 0.9	92.53 0.8	84.97 1.4	
12.30	134.93 0.8	131.48 0.9	110.32 0.8	108.16 1.5	
15. 0	138.12 0.8	136.85 0.9	116.63 0.8	115.87 1.5	
17.30	139.50 0.8	139.00 0.9	119.07 0.8	118.78 1.6	
20. 0	140.10 0.8	139.89 0.9	120.08 0.8	119.96 1.6	
22.30	140.37 0.8	140.27 0.9	120.51 0.8	120.46 1.6	
25. 0	140.48 0.8	140.44 0.9	120.70 0.8	120.68 1.6	
27.30	140.53 0.8	140.51 0.9	120.78 0.8	120.77 1.6	
30. 0	140.55 0.8	140.54 0.9	120.82 0.8	120.81 1.6	
32.30	140.56 0.8	140.56 0.9	120.83 0.8	120.83 1.6	
35. 0	140.57 0.8	140.56 0.9	120.84 0.8	120.84 1.6	
37.30	140.09 0.8	140.36 0.9	120.73 0.8	120.80 1.6	
40. 0	136.45 0.8	137.50 0.9	118.39 0.8	118.89 1.6	
42.30	133.85 0.8	134.63 0.9	115.52 0.8	115.95 1.5	
45. 0	132.57 0.8	132.99 0.9	113.77 0.8	114.01 1.5	
47.30	131.99 0.8	132.19 0.9	112.90 0.8	113.01 1.5	
50. 0	131.72 0.8	131.81 0.9	112.49 0.8	112.54 1.5	
52.30	131.61 0.8	131.65 0.9	112.31 0.8	112.33 1.5	
55. 0	131.56 0.8	131.58 0.9	112.22 0.8	112.23 1.5	
57.30	131.54 0.8	131.54 0.9	112.19 0.8	112.19 1.5	
60. 0	131.53 0.8	131.53 0.9	112.17 0.8	112.17 1.5	
62.30	129.79 0.8	130.51 0.9	111.49 0.8	111.76 1.5	
65. 0	126.28 0.8	127.29 0.9	108.60 0.8	109.12 1.5	
67.30	124.26 0.8	124.90 0.9	106.15 0.8	106.51 1.5	
70. 0	123.30 0.8	123.63 0.9	104.77 0.8	104.96 1.5	
72.30	122.86 0.8	123.02 0.9	104.10 0.8	104.19 1.5	
75. 0	122.67 0.8	122.74 0.9	103.79 0.8	103.83 1.5	
77.30	122.58 0.8	122.61 0.9	103.65 0.8	103.67 1.5	
80. 0	122.54 0.8	122.56 0.9	103.59 0.8	103.60 1.5	
82.30	122.53 0.8	122.53 0.9	103.56 0.8	103.57 1.5	
85. 0	122.43 0.8	122.49 0.9	103.54 0.8	103.55 1.5	
87.30	119.38 0.8	120.37 0.8	101.94 0.8	102.38 1.5	
90. 0	116.42 0.8	117.32 0.8	99.03 0.7	99.52 1.5	
92.30	114.87 0.8	115.40 0.8	97.01 0.7	97.32 1.4	
95. 0	114.15 0.8	114.41 0.8	95.94 0.7	96.10 1.4	
97.30	113.82 0.8	113.94 0.8	95.43 0.7	95.50 1.4	
100. 0	113.68 0.8	113.73 0.8	95.20 0.7	95.23 1.4	
102.30	113.61 0.8	113.64 0.8	95.09 0.7	95.10 1.4	
105. 0	113.59 0.8	113.60 0.8	95.04 0.7	95.05 1.4	
107.30	113.57 0.8	113.58 0.8	95.02 0.7	95.03 1.4	
110. 0	112.70 0.8	113.14 0.8	94.77 0.7	94.90 1.4	
112.30	109.20 0.8	110.26 0.8	92.36 0.7	92.89 1.4	
115. 0	106.83 0.8	107.61 0.8	89.73 0.7	90.17 1.4	
117.30	105.65 0.8	106.08 0.8	88.11 0.7	88.36 1.4	
120. 0	105.11 0.8	105.32 0.8	87.28 0.7	87.40 1.4	
122.30	104.87 0.8	104.96 0.8	86.89 0.7	86.95 1.4	
125. 0	104.76 0.8	104.80 0.8	86.71 0.7	86.74 1.4	
127.30	104.71 0.8	104.73 0.8	86.63 0.7	86.64 1.4	

1---

ENVIRONMENTAL PROTECTION AGENCY ^^^^ EXTENDED TRANSPORT PROGRAM ^^^^ WATER RESOURCES DIVISION
WASHINGTON, D.C. ^^^^ ^^^^ CAMP DRESSER & MCKEE INC.
^^^^ ANALYSIS MODULE ^^^^ ANNANDALE, VIRGINIA
FLOW ROUTING IN LEFT BANK MAIN CANAL OF KALAWEWA IRRIGATION SCHEME
VARIABLE INFLOW AT ENTRY

''''''''''''''''' S U M M A R Y S T A T I S T I C S F O R C O N D U I T S ''''''''''''''''

CONDUIT NUMBER	DESIGN FLOW (CFS)	DESIGN VELOCITY (FPS)	CONDUIT VERTICAL DEPTH (IN)	MAXIMUM COMPUTED FLOW (CFS)	TIME OF OCCURENCE HR.	MIN.	MAXIMUM COMPUTED VELOCITY (FPS)	TIME OF OCCURENCE HR.	MIN.	RATIO OF MAX. TO DESIGN FLOW	MAXIMUM DEPTH ABOVE INVERT AT CONDUIT ENDS UPSTREAM (FT)	DOWNSTREAM (FT)
100	208.9	0.8	120.0	200.0	27	6	1.6	0	24	1.0	9.45	9.28
105	197.4	0.8	120.0	200.0	30	7	1.7	0	51	1.0	9.28	9.09
110	211.2	0.8	120.0	180.0	32	56	1.1	1	52	0.9	9.09	8.83
115	207.5	0.8	120.0	180.0	32	26	1.2	2	15	0.9	8.83	8.66
120	209.7	0.8	120.0	160.1	33	51	1.3	3	2	0.8	8.66	8.60
125	211.1	0.8	120.0	160.1	34	3	1.0	5	6	0.8	8.60	8.11
130	205.7	0.8	120.0	140.6	34	45	0.9	7	16	0.7	8.11	7.59
135	207.1	0.8	120.0	140.6	35	59	0.9	7	58	0.7	7.59	7.34
140	208.9	0.8	120.0	120.8	35	58	0.8	7	31	0.6	7.34	7.10
145	207.5	0.8	120.0	120.8	36	10	1.6	36	11	0.6	7.10	1.52

***** EXTENDED TRANSPORT MODEL SIMULATION ENDED *****

The vita has been removed from the scanned document