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ANALYSIS OF COLOMBIAN PRECIPITATION TO ESTIMATE IRRIGATION REQUIREMENTS

By

James E. Hardee

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PREFACE

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J. E. Christiansen
Project Leader

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James E. Harde

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ABSTRACT

Analysis of Colombian Precipitation to Estimate Irrigation Requirements

by

James E. Hardee, Master of Science

Utah State University, 1971

Major Professor. Dr. H. B. Peterson
Department· Agricultural and Irrigation Engineering

Monthly and annual distributions of precipitation were analyzed for a 103-year record station. A gamma probability distribution with maximum likelihood estimates of the parameters gave the best fit.

For 97 stations throughout Colombia a computer program was written to calculate 13 probability levels of precipitation using the gamma distribution. Potential evapotranspiration was calculated from climatic data at 43 of these stations using the Christiansen and Hargreaves formula. The difference between potential evapotranspiration and five probability levels of precipitation were calculated as an index of irrigation requirements.

(63 pages)

INTRODUCTION

Agricultural development in the Republic of Colombia, South America, is receiving much attention. Through the Colombian Agrarian Reform Institute (INCORA), planning and initial development of approximately 363,000 hectares of irrigated lands has been started. To provide a firm foundation for planning and effective management of these projects, reliable estimates of irrigation water requirements are essential.

Irrigation water requirement is defined as the quantity of water required to maintain the desired soil moisture and salinity level during a crop growing season, in addition to precipitation. To arrive at this requirement two basic parameters need to be determined, effective precipitation and evapotranspiration. The amount of water used by a crop and the amount of water required for leaching are directly proportional to evapotranspiration. Part of this water used is supplied by effective precipitation while the remainder must be supplied by irrigation.

In each project where an irrigation requirement is to be estimated there exists a unique environment. This uniqueness depends on soil characteristics, irrigation water quality, management practices, economic and social environments, geographic location, climate, topography, etc. How these factors affect the relationships between irrigation requirement, evapotranspiration, and effective precipitation are impossible to evaluate on a general, country-wide basis. However, with a general relationship the unique factors for each project can be evaluated and applied as correction factors to the general relationship to estimate each irrigation requirement.

The general relationship proposed in this study is potential irrigation requirement. This is defined as the difference between potential evapotranspiration and dependable precipitation. Potential evapotranspiration is an index of the actual evapotranspiration for a crop, and dependable precipitation is an index of the amount of precipitation that is available for crop use, based on a probability distribution.

The objectives of this study then are to.

1. Estimate dependable and effective precipitation from monthly precipitation data.
2. To relate the dependable precipitation with estimated potential evapotranspiration to determine potential irrigation water requirements.

REVIEW OF LITERATURE

Published information on the evaluation of climatic parameters which affect agriculture is extensive. Due to the development of computers a more rigorous evaluation of greater amounts of data has been made possible. This, along with the increasing need for knowledge in this area accounts for many of the more recent publications

Precipitation Probabilities

Jen-Hu (1968, p. 200) states that, "Since rainfall is the most variable element in the water balance equation, an important first step would be to analyze the rainfall probability " The importance of precipitation probability and its useful application by engineers, scientists, industrial management, farmers, and general meteorologists is discussed by Miller and Weaver (1968), and by Burchinal and Dickerson (1961)

To arrive at probabilities, past records are analyzed to predict the population they represent. These records, however, are only a sample, usually too small and almost always in error, as indicated by Cry (1965). Analysis is therefore designed to minimize the error and smooth the variability of estimation One method of analysis is to increase the sample size, but this is impossible in most cases Another alternative is to use statistical methods to smooth irregularities and errors of estimation

Frequency plot

The basic analysis of collected data begins with a frequency plot Three equations, the Hazen, the California, and the Kimball, have been used. They all differ as to what return period is assumed. According to Linsley, Kohler, and Paulhus (1958), the most generally accepted equation is the Kimball. It takes the form:

$$F = m/(n + 1) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

in which

m = order number assigned to data, ranked in descending order, m = 1, 2, ..., n

n = total number of data points

This equation does not attempt to smooth the variability. Arithmetic and log probability paper was developed to allow the cumulative frequency curves to plot on a straight line.

Distribution curves

Variability of frequency distribution curves has been smoothed by attempts to approximate the curves through the use of statistical parameters and standard distribution curves. A normal or Gaussian curve with its symmetry about the mean and unbounded at

either end does not fit precipitation, which is often skewed and has a lower bound of zero (Miller and Weaver, 1968). Log-probability transformations by Hazen and Chow, as cited in Burchinal and Dickerson (1961), correct for the skew. The use of this method allows the transformation to assume a normal curve. Tucker (1965) used a square-root transformation to reach the same results. Manning (1950) and Walker (1967) also used a log transformation.

Barger and Thom (1949), in inspecting frequency histograms of precipitation, noted that for daily or weekly precipitation distributions a negative exponential curve was suggested. For precipitation four months or more in length, the distributions approached normal. A Pearsons Type III curve was used in their work since it could take either of these forms. This curve is defined by the equation:

$$G(x) = \int_a^x \frac{p^{(p+1)}}{e^p \Gamma_\infty (p+1)} e^{-\lambda x} ((1 + (x/a))^{\lambda a} dx \quad \ldots\ldots (2)$$

in which

$G(x)$	=	probability of x amount of precipitation
a	=	origin and the mode
p	=	shape parameter
λ	=	scale parameter
$\Gamma_\infty(p+1)$	=	complete gamma distribution evaluated for (p+1)
e	=	naperian logarithmic base

In order to account for the fact that negative precipitation is impossible, Equation (2) was forced through the origin. By substituting x - a for x and the identity $p = \lambda a$, Equation (2) becomes:

$$G(x) = \int_0^x \frac{\lambda^{(p+1)} e^{-\lambda x} x^p}{\Gamma_\infty (p+1)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Thom (1958) defines the complete gamma distribution with its origin at zero as:

$$\Gamma_\infty (p+1) = \int_0^\infty \lambda^{(p+1)} x^p e^{-\lambda x} dx \quad \ldots\ldots\ldots\ldots (4)$$

This represents the total area under a gamma distribution curve. The area under a gamma curve from zero to some precipitation x, is defined as an incomplete gamma curve of the form:

$$\Gamma_x (p+1) = \int_0^x \lambda^{(p+1)} x^p e^{-\lambda x} dx \quad \ldots\ldots\ldots\ldots (5)$$

The cumulative probability distribution, therefore, can be defined as the ratio of the complete to the incomplete gamma curves. It has the form of Equation (3). In the literature, Equation (3) is often called an incomplete gamma distribution, but in this report, it is referred to as a gamma distribution.

Parameter estimators

The major problem with the use of any statistical procedure is the estimation of the parameters. Methods of moments or least squares are two of the more common. As cited in Thom (1958) and Cry (1965), Fisher found that some estimators had more variability than others. Fisher developed a method called maximum likelihood, which gave efficient estimators of statistical parameters. Thom (1958), using methods of maximum likelihood, derived the equations for estimating the parameters of the gamma distribution. These estimators are found by solving the quadratic equation.

$$12\,A\,r^2 - 6\,r - 1 = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

in which

r = (p+1) the shape parameter of the gamma distribution

A = $\ln(\bar{x}) - 1/N \sum_{i=1}^{N} \ln(x_i)$

$\bar{x}$ = mean

x_i – precipitation amounts

N = number of occurrences of precipitation

Solving Equation (6) for the only pertinent root of r with the quadratic formula yields:

$$r = \frac{1 + \sqrt{1 + (4/3)\,A}}{4\,A} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

The maximum likelihood estimate for the scale parameter is:

$$\lambda = r/\bar{x} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

Substituting these estimators into Equation (5), the following gamma distribution is defined:

$$G(x) = \frac{\lambda}{\Gamma(r)} \int_0^x \lambda x^{(r-1)} e^{-\lambda x}\, dx \qquad \ldots\ldots\ldots\ldots \quad (9)$$

Curve evaluations

The complete gamma curve, Equation (4), can be evaluated by numerical procedures (Univac Division Sperry Rand Corporation, 1967) or by the use of tables (Thom, 1967). The incomplete gamma curve, Equation (5), can also be found through the use of tables (Pearson, 1957). Since two variables are needed in these tables they are cumbersome to use.

Equation (9) was solved by Thom, as cited by Miller and Weaver (1968), by a Newton approximation. For a given probability level P, the expected precipitation X is given by:

$$X = x_i / \lambda \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

in which

$$x_i = x_j - (x_j/r)\, S - P \left\lceil_{\infty} (r)\, e^{(x_j)} / x_j^{(r-1)} \right. \quad \ldots\ldots\ldots (11)$$

and

$$j = i - 1 \quad j = i - 1$$

$$S = 1 + \sum_{k=1}^{\infty} (x_j^k / (r + k)!)$$

The computer program by Weaver and Miller (1967) developed an iterative procedure for the solution of Equations (10), (11).

Barger and Thom (1949), Miller and Weaver (1968), Essenwagner (1960), and Cry (1965) have shown that the best fit for precipitation probability is through the use of a gamma distribution. Friedman and Janes as cited by Burchinal and Dickerson (1961) concluded that irregularities in precipitation probability curves obtained from the Kimball Equation (1), based on 30 years of data, are smoothed by the gamma distribution.

Determination of Evapotranspiration

Evapotranspiration as defined by Pair et al. (1969) is the sum of the water evaporated from soil and plant surfaces and the water transpired by the plant. Actual evapotranspiration (ET_a) is referred to as the amount of ET occurring in a crop under existing conditions. Potential evapotranspiration (ET_p) applies to conditions of full vegetative crop cover where soil moisture is not limiting.

Various methods of estimating ET as given by Tanner (1967) are divided into three categories: (1) water balance methods, (2) micrometeorological methods, and (3) empirical methods. The first two approaches are based on measurements of theoretical variables which effect ET. The third method relies on relating empirical factors to actual measurements of ET.

Water balance methods

The general equation for water balance from Tanner (1967) is:

$$ET = P - (D_r + D_e + D_i + \Delta D_w + \Delta D_s)$$

in which

ET = evapotranspiration
P = precipitation or irrigation
D_r = depth of surface or subsurface runoff
D_e = depth of leakage
D_i = depth of intercepted water
ΔD_w = depth of change in groundwater storage
ΔD_s = depth of change in water stored above water table

Equation (12) applies to catchment hydrology methods, soil water depletion methods, and lysimetry methods of handling water balance. Each of these methods either controls the variables or adjusts the boundary conditions to make the variables constant. Therefore, controls or adjustments play a major part in utilizing and interpreting the results

Micrometeorological methods

The most common micrometeorological methods employed are profile methods, energy balance methods, and combinations of these two The profile method and formulas of Penman, Meger, Rowher, and Harbeck are discussed by Christiansen and Mehta (1965). This method utilizes vapor pressure profiles, wind profiles, and temperature profiles to determine the aerodynamic or mass transfer of water vapor over a given distance. The energy balance equation, $LE = R_n - G - H$, is a budgeting equation that equates the energy used to evaporate water to the net radiation minus the energy used to heat the soil and air (Tanner, 1967).

Combinations of the profile and energy balance methods are discussed by Pardo (1968). The major drawback of all these theoretical methods is the need for highly precise instrumentation to collect the needed data. Even though combination methods require less data than the micrometeorological methods, the data needed are not always measured.

Empirical methods

Many formulas have been developed relating measured climatic variables to measured evapotranspiration. These have been developed for purposes of estimating potential evapotranspiration in areas where measurements of evapotranspiration have not been made. The most common climatic variables used in these relationships are radiation, temperature, humidity, and evaporation. Some of the early methods are reviewed by Christiansen and Mehta (1965), and Blaney and Criddle (1962).

Blaney-Criddle. One of the most popular formulas in use today is that developed by Blaney and Criddle (1962). This formula, known as the Blaney-Criddle formula, was developed in the arid western United States, relating mean air temperature, mean percentage of day-time hours, and length of growing season to evapotranspiration. The formula is of the form

$$U = K F = \Sigma k f \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (13)$$

in which

U = seasonal water use in inches
K = empirical seasonal coefficient
F = sum of monthly factors (f) for the season
f = Tp
T = mean monthly temperature in °F
p = monthly percentage of annual daytime hours
k = monthly use coefficient

The Soil Conservation Service (USDA - SCS, 1967) modified the Blaney-Criddle k value in two ways for calculating short period evapotranspiration values for arid and semi-arid areas. The modifications are:

$$k = k_t k_c \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (14)$$

in which

k_t = (.0173T - .314) a climatic coefficient related to mean air temperature T
k_c = a crop growth stage coefficient

Jensen and Haise. Jensen and Haise (1968) proposed a formula for estimating potential evapotranspiration as follows:

$$\overline{ET}_p = (.014\ T - .37)\ R_s \quad \ldots\ldots\ldots\ldots\ldots\ldots (15)$$

in which

ET_p = potential evapotranspiration, in inches per day
R_s = solar radiation, in equivalent inches per day of evapotranspiration

R_s, when not measured, is proposed to be calculated using an equation by Angstrom with coefficients developed by S. Fritz and J. H. MacDonald (Jensen and Haise, 1963). This formula has the form:

$$R_s = R_{so}\ (.35 + .61\ S_f) \quad \ldots\ldots\ldots\ldots\ldots\ldots (16)$$

in which

R_s = solar radiation under existing conditions
R_{so} = solar radiation on a cloudless day
S_f = fraction of possible sunshine for the time period

Penman. Penman, as cited by Pair et al. (1969), developed an equation combining the energy balance equation and an experimentally derived aerodynamic equation patterned after Dalton. The resulting equation is:

$$ET_p = \frac{\Delta}{\Delta + \gamma} R_n + \frac{\gamma}{\Delta + \gamma} (.35)\ (1.0 + .01\ W_2)\ (e_a - e_d) \quad \ldots (17)$$

in which

ET_p = potential evaporation in mm per day

R_n = $.75\ R_s - R_L$ where R_s is solar radiation and R_L is net outgoing longwave radiation

Δ = a temperature dependent constant

γ = the constant of the wet-and-dry bulb psychrometric equation

W_2 = mean wind speed at a height of 2 m in miles per day

e_a = saturation vapor pressure at mean air temperature

e_d = saturation vapor pressure at dew point in mm Hg

The Penman equation is reliable when making short period estimates.

Hargreaves (1956) gives a method based on temperature and humidity for estimating Class A pan evaporation. The equation developed is

$$E_v = M\ (T - 32) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (18)$$

in which

E_v = mean monthly evaporation in inches

M = CD, where C is a function of humidity and D is a monthly daytime coefficient.

Christiansen and Hargreaves. Extensive work has been carried out at Utah State University developing formulas for calculating evaporation and evapotranspiration for Latin American countries (Christiansen and Hargreaves, 1970, 1971). Under the direction of Professor J. E. Christiansen, 14 theses and special problem reports have investigated empirical relationships. Continued reanalysis by J. E. Christiansen and George H. Hargreaves of the data has yielded formulas which they feel give satisfactory results (Christiansen, 1971). The formulas take the form

$$ETCH = K\ R\ C_t\ C_w\ C_h\ C_s\ C_e \quad \ldots\ldots\ldots\ldots\ldots (19)$$

in which

ETCH = potential evapotranspiration, in mm

K = constant

R = extraterrestrial radiation expressed as equivalent depth of evaporation, in mm

and the coefficients expressed in dimensionless form are:

$$C_t = 0.50 + 0.40\ (T_m/25) + .10\ (T_m/25)^2$$

$$C_w = 0.65 + 0.35\ (W_{10}/8)$$

$$C_h = (1.0 - H_m \cdot 3)^{.25}$$

$$C_s = 0.48 + 0.66\ (S/.5) - .14\ (S/.5)^2$$

$$C_e = 1.0 + .06\ (E/1000)$$

in which

T_m = mean temperature in °C
W_{10} = mean wind velocity in kilometers per hour measured at 10 meters
H_m = mean relative humidity expressed as a decimal
E = elevation in meters

This equation takes into account as many parameters as are measured at the station in question. When a parameter is not measured the coefficient is set equal to 1.0, or an estimated value, which is designed to represent the average conditions.

When R, the extraterrestrial radiation, is not measured, it is calculated using a method developed by Christiansen (Pardo, 1968) using an equation given by Frank and Lee (1966). This equation can be written:

$$R = 120\,[DL \sin(LA) \sin(DE) + 7.6394 \cos(LA) \cos(DE) \sin(OM)]/ES \quad \ldots\ldots (20)$$

in which

$$OM = \text{Arctan} \frac{\sqrt{1 - \tan^2(LA) \tan^2(DE)}}{\text{Abs}\,[\tan(LA) \tan(DE)]}$$

and

R = extraterrestrial radiation, in Langleys per day
DL = day length (theoretical sunshine), in hours
LA = latitude, in radians
DE = mean monthly declination of the sun, in radians
ES = square of the monthly relative value of the distance from the earth to the sun, dimensionless

The radiation may be expressed as an equivalent depth of evaporation, in cm., by dividing the radiation by the heat of vaporization of water in calories/gm. The heat of vaporization is computed from:

$$HV = 595.9 - 0.55\,T_m$$

in which

HV = heat of vaporization, in calories/gm.

Irrigation Requirement

Irrigation water requirement is defined as the amount of water exclusive of precipitation needed to maintain a desired soil moisture and salinity level during a crop season (Pair et al., 1969). This definition contains the unique environments existing for each crop, in each soil, locality, soil moisture level, cultural environment, and stage of growth which make irrigation requirements unique also.

Irrigation water requirements have been estimated by many authors (Thornthwaite, 1948, Blaney, 1951, Allred and Chen, 1953, von Bavel, 1953, Mather, 1954, Hershfield, 1964, Wiser, 1965) through the use of the water balance Equation (12). Irrigation water requirements are calculated as drought indexes, deficits, or number of irrigations. Several basic assumptions were made in using Equation (12) These basic assumptions were that when a minimum soil moisture level existed, an irrigation water requirement equal to the amount of water needed to fill the soil to its maximum water holding capacity was required. Water use rate (ET) was calculated from empirical equations on a monthly basis and assumed to be equally distributed throughout the month Precipitation was taken as daily values from past records and assumed effective if there was a storage capacity in the soil, and as excess if the maximum water holding capacity was reached.

Christiansen and Hargreaves (1970, 1971) proposed, as an index of actual irrigation water requirement, the term potential irrigation requirement, where potential irrigation requirement on a monthly basis is potential evapotranspiration less dependable precipitation. Dependable precipitation is the mean amount of precipitation equaled or exceeded 75 percent of the time, based on a ranking distribution

PROCEDURE

The first step in this study was to collect, tabulate, and keypunch all available data on Colombian precipitation. Professor J. E. Christiansen, Kern Stutler, and George Hargreaves supplied the writer with data they had collected in recent years. The writer and Dr. E C. Olsen, on a recent trip to Bogota, Colombia, were able to collect additional data through the offices of INCORA, the Agency for International Development Mission in Bogota, and the Colombian Meteorology and Hydrology Service (SCHM) Appendix A, Table 4, lists the 54 stations for which precipitation data were collected Climatic data collected by Pardo (1968), for 20 stations, supplemented with precipitation data, appear in Appendix A, Table 5. Appendix A, Table 6, lists stations that have climatic data collected by Stutler (1970) in addition to the precipitation data collected by the writer Figure 1 shows the location of these stations.

The precipitation data used consisted of monthly totals for 97 stations, for a sum of 14,106 months of data. The climatic data collected by Stutler (1970) and Pardo (1968) consisted of 1,604 months of mean climatic data.

Based on the review of literature, it was hypothesized that an index to the amount of effective precipitation would be the amount of precipitation expected at a given probability level. This is an extension of the criterion proposed by Christiansen and Hargreaves (1970, 1971) which limited dependable precipitation to the 75 percent probability level Based on this hypothesis, a probability distribution of precipitation was needed.

Station number 52145, Observatorio Meteorologico Nacional (OMN), with 103 years of precipitation records, was used to analyze the fit of standard distribution curves. A computer program was written to rank the data according to Equation (1) and to calculate the parameters for a normal, log-normal, and gamma distribution From these parameters the curves were computed and plotted on logarithmic probability paper for each month, and for the annual distribution, for visual comparison Next, a chi-square goodness of fit test was used to analyze the normal and gamma distributions

Computer program 700 (Table 1) was written to read the basic precipitation data, probability levels, and control parameters. The yearly sums and the monthly and annual means are calculated. The data used and their computer symbols are defined in comment statements at the beginning of the program, Appendix B.

Subroutine program 701 (Appendix B) was written to calculate the gamma distribution of precipitation data on a monthly and annual basis The data used are supplied by program 700. The computer symbols are defined in program 700 and additional variables are defined in program 701 Program 701 was used to compute the distribution parameters by the method of maximum likelihood estimators Evaluation of the complete gamma function is accomplished using subroutine gamma, program 704 The amount of precipitation based on the gamma distribution at 13 probability levels is approximated using a Newton procedure.

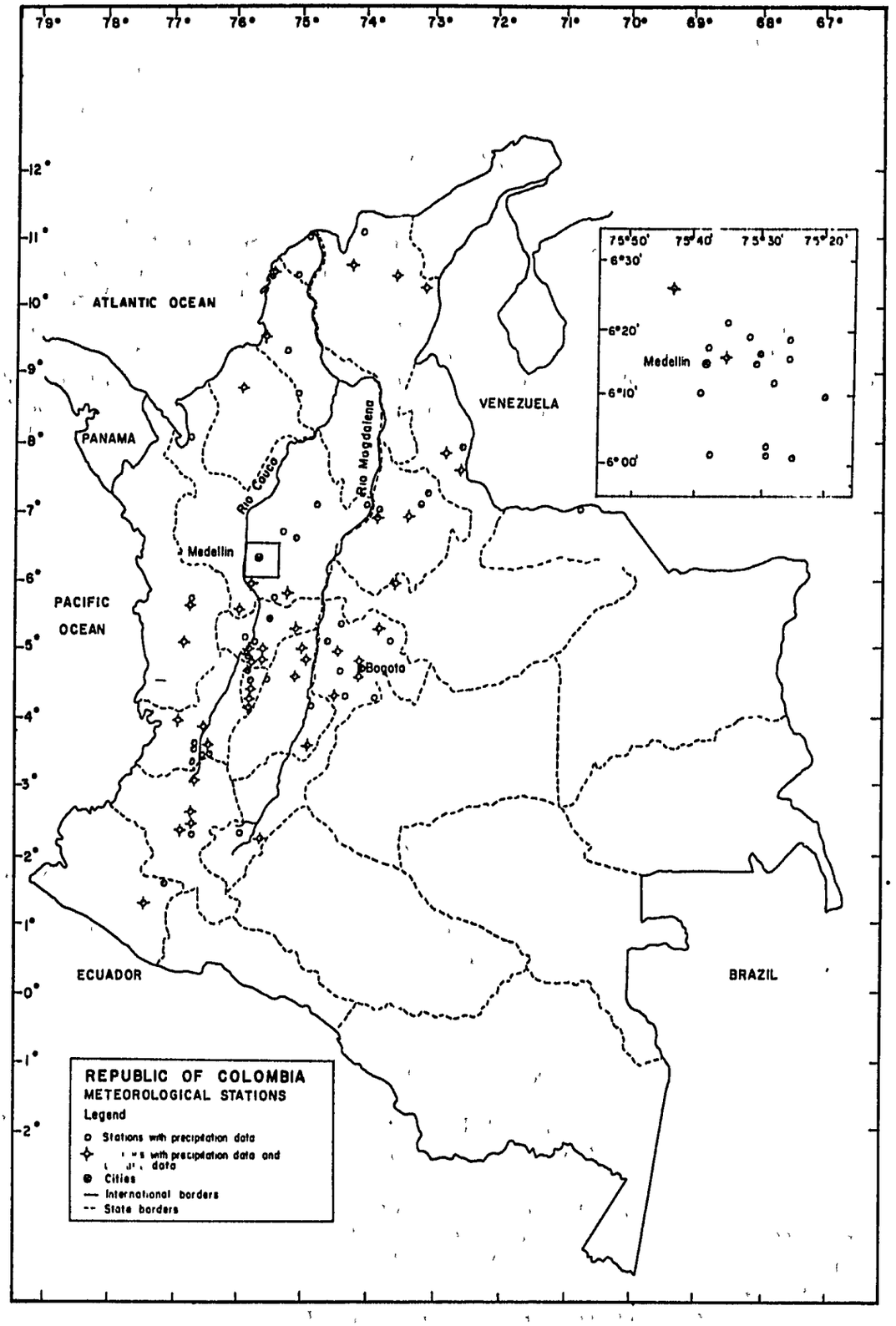

Figure 1. Geographical location of the stations with precipitation and climatic data.

Table 1. Computer programs used in the study and given in Appendix B.

Program Number	Purpose	Data
700	Reads in basic control parameters and precipitation data	97 stations
701	Calculates gamma distribution curve of precipitation data at given probability levels	Supplied by program 700
702	Calculates potential evapotranspiration using Christiansen and Hargreaves formula and potential irrigation requirements	Pardo (1968)
703	Calculates extraterrestrial radiation, potential evapotranspiration from Christiansen and Hargreaves formula and potential irrigation requirements	Stutler (1970)
704	Univac 1108 library Math-Pack to evaluate the complete gamma function	Parameter from program 701

Subroutine program 702 (Appendix B) was written to calculate potential evapotranspiration using the Christiansen and Hargreaves formula from data collected by Pardo (1968). Potential irrigation requirements at five probability levels are also calculated. The data and symbols used are defined in program 700 and as comment statements in this program.

For the data collected by Stutler (1970), subroutine program 703 (Appendix B) was written. The data and symbols are defined in program 700 and as comments in this program. Since data collected by Stutler do not contain extraterrestrial radiation data, Equation (20) is used for calculation. Potential evapotranspiration and irrigation requirements are then calculated for five probability levels

Subroutine program 704 (Appendix B) is a listing for the Univac 1108 Math-Pack library subroutine gamma (Univac Division of Sperry Rand Corporation, 1967). This program is used to evaluate the complete gamma function for use in program 701. The data and procedure used are defined as comments within the program.

RESULTS AND DISCUSSION

Analysis of Station Observatorio Meteorologico Nacional

Typical results obtained from plotting the ranked precipitation data with the normal, log-normal, and gamma distribution curves are shown in Figures 2, 3, and 4, respectively. These curves represent March precipitation data. As plotted on the log-probability paper, the ranked data show a slight curvature in their distribution. The normal curve consistently underestimates the extreme probabilities and overestimates the middle values. This can be expected for the high probability levels or low precipitation since the curve is not bounded by zero on this end The log-normal again deviates from the ranked curve at the extreme probabilities but fits nicely over the middle range The best fit is obtained with the gamma distribution curve which follows the ranked data even at the extreme probability levels. Because of its versatility in fitting many distributions, the annual distribution, which approaches a log-normal, fits equally well.

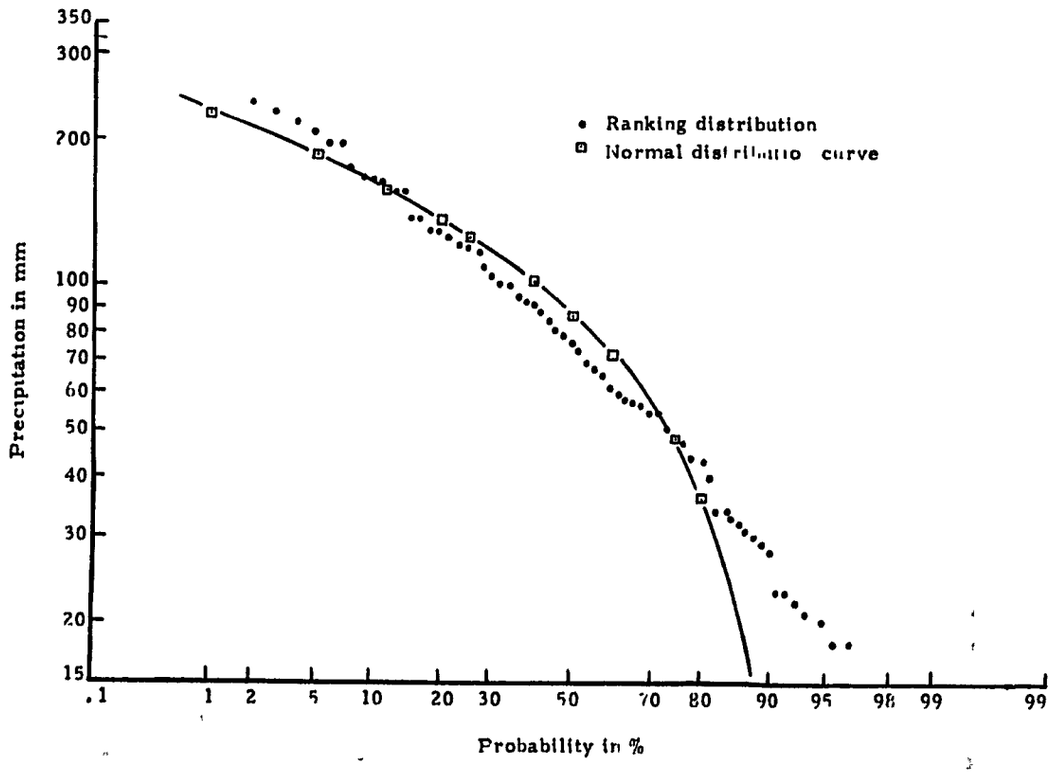

Figure 2. Ranking and normal distribution curves for March at station Observatorio Meteorologico Nacional.

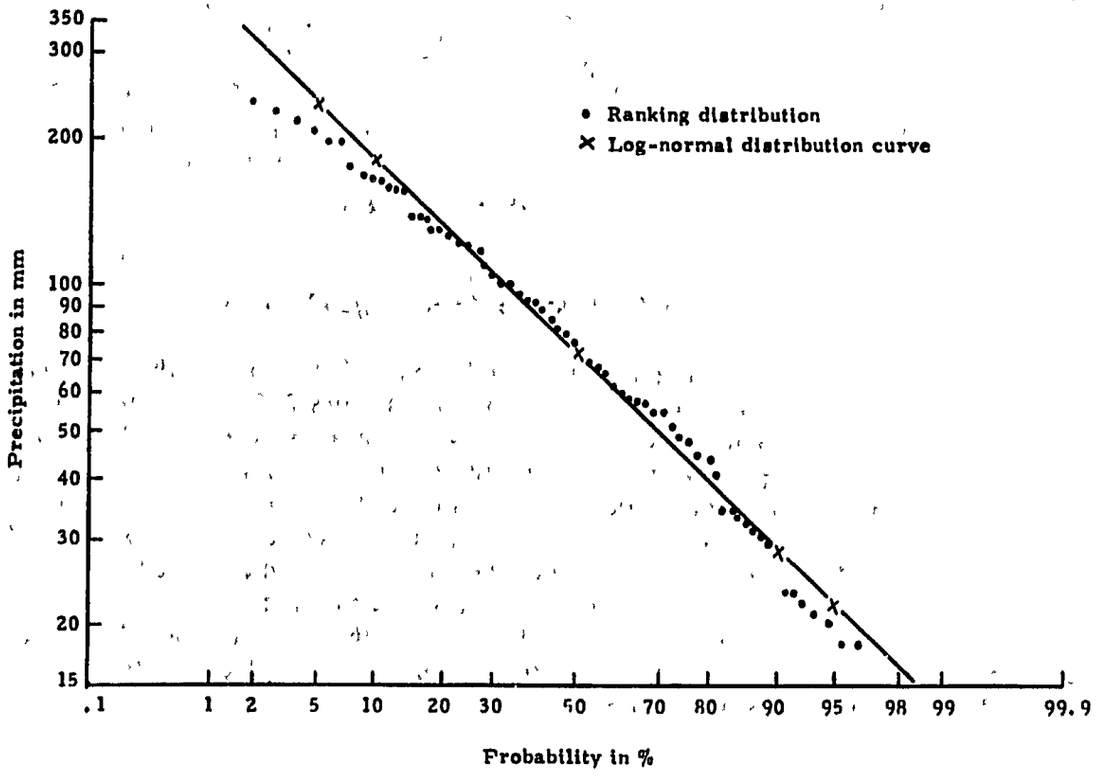

Figure 3. Ranking and log-normal distribution curves for March at station Observatorio Meteorologico Nacional.

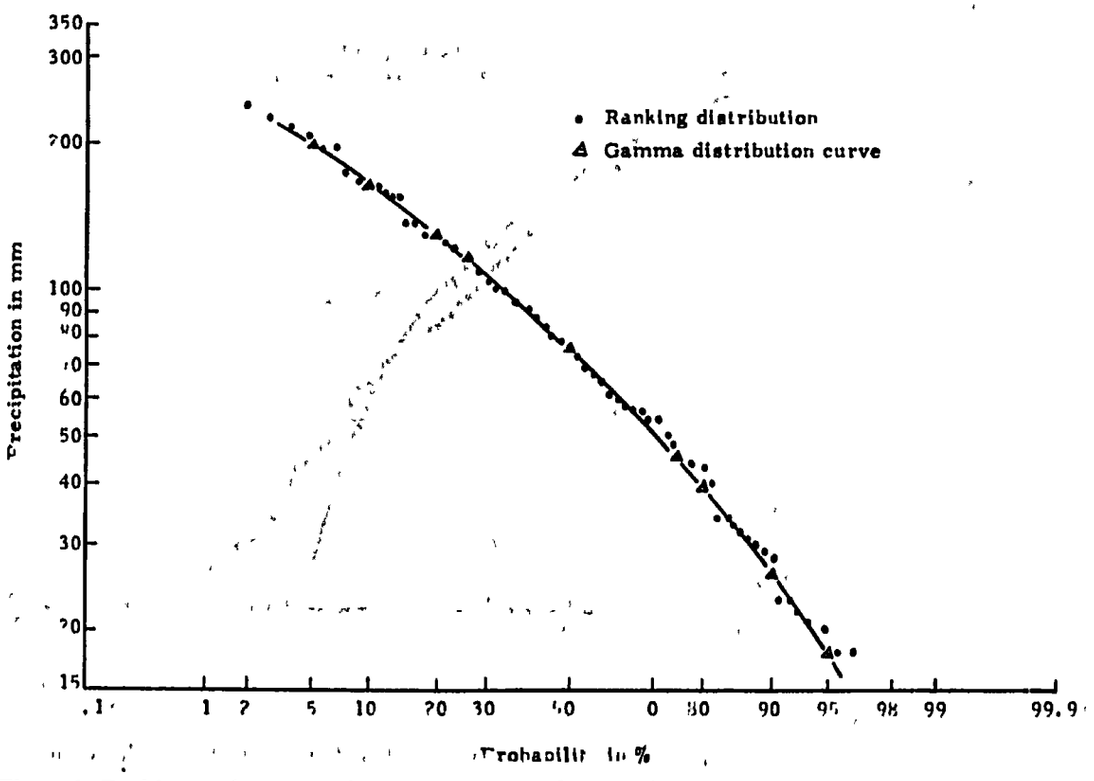

Figure 4 Ranking and gamma distribution curves for March at station Observatorio Meteorologico

The results obtained from a chi-square goodness of fit test for the normal curve are shown in Table 2. The null hypothesis that the precipitation data were normally distributed at an alpha level of 5 percent, failed to be accepted for 9 of the 12 monthly distributions. The same test for the gamma distribution, summarized in Table 3, shows that only three monthly distributions failed to be accepted at the same alpha level. Even though the gamma distribution did not pass the test for all the months, it still gives the best fit.

Table 2. Summary of a chi-square goodness of fit test of a normal distribution for station Observatorio Meteorologico Nacional. [a]

Month	Test Value	X^2 [b]	Conclusion
January	26.6	25.0	Fail to accept
February	35.0	25.0	Fail to accept
March	33.7	25.0	Fail to accept
April	27.1	25.0	Fail to accept
May	24.0	25.0	Accept
June	23.7	25.0	Accept
July	19 9	25.0	Accept
August	29.6	25.0	Fail to accept
September	45.5	25.0	Fail to accept
October	31.4	25.0	Fail to accept
November	25.9	25.0	Fail to accept
December	26.3	25.0	Fail to accept

[a]Null hypothesis that the precipitation is normally distributed.
[b]X^2 with 15 degrees of freedom and an alpha level of 5%.

Table 3. Summary of chi-square goodness of fit test of a gamma distribution for station Observatorio Meteorologico Nacional. [a]

Month	Test Value	X^2 [b]	Conclusion
January	14.7	14.1	Fail to accept
February	7.1	14.1	Accept
March	3.5	14.1	Accept
April	7.7	14.1	Accept
May	6.5	14.1	Accept
June	15.7	14.1	Fail to accept
July	11.7	14.1	Accept
August	7.5	14.1	Accept
September	14.9	14.1	Fail to accept
October	3.3	14.1	Accept
November	9.9	14.1	Accept
December	5.8	14.1	Accept

[a] Null hypothesis that the precipitation is gamma distributed.
[b]X^2 with 7 degrees of freedom and on alpha level of 5%.

Gamma Distribution of Precipitation

Results of the computer analysis of 97 stations, whose precipitation records were fit to a gamma distribution, appear in Appendices C and D. Monthly and annual probabilities of receiving equal to or greater than a certain amount of are given for 13 probability levels. The arithmetic mean, the gamma distribution parameters (Lambda and R), and the natural logarithm of the evaluation of the complete gamma distribution (LNGAM) for each month and the annual are also given.

The annual values represent the distribution of the annual totals for each year of record. They do not correspond to a sum of the monthly values at a given probability level. The arithmetic mean does not correspond to a 50 percent probability level. A probability level of 50 percent refers to the distribution of the precipitation and the mean refers to the magnitude of precipitation.

In the development of computer program 701 two limitations were imposed on the gamma distribution due to the computer's capacity The first is that a value of the gamma parameter R greater than 87 cannot be handled. This is the upper limit of the exponential library function built into the computer which operates on R. It is therefore assumed that the distribution is normal when this value is reached. In theory, R equal to 100 is the point where the gamma distribution approaches normalacy The second limitation occurs when a month has zero precipitation recorded for most of the years of data. This causes an overflow in the amount of allocated space for printing the gamma parameter R and LNGAM. These two values, therefore, are not printed out but the distribution is still valid.

Potential Irrigation Requirements

The results for 43 stations where climatological data were available to calculate potential evapotranspiration and potential irrigation requirements for 5 precipitation probability levels appear in Appendix D. The calculated value of potential evapotranspiration (ETCH) for each month and the annual value, being the sum of the monthly values, are printed out. From the ETCH values the precipitation at the five probability levels is subtracted to give the potential irrigation requirement. Positive values indicate requirements and negative values indicate no requirements.

A graphical representation of the results is given on Figure 5 for March for station Observatorio Meteorologico Nacional. The gamma distribution of precipitation is plotted on the log-probability graph. ETCH is calculated from mean values and represents a constant potential for all probability levels as used in this study Potential irrigation requirement at the 70 percent probability level of precipitation is the difference between the mean value of ETCH and the 70 percent level of precipitation. Annual values calculated in the same manner represent the difference between the sum of the mean monthly ETCH values and the annual distributions of precipitation at a given probability.

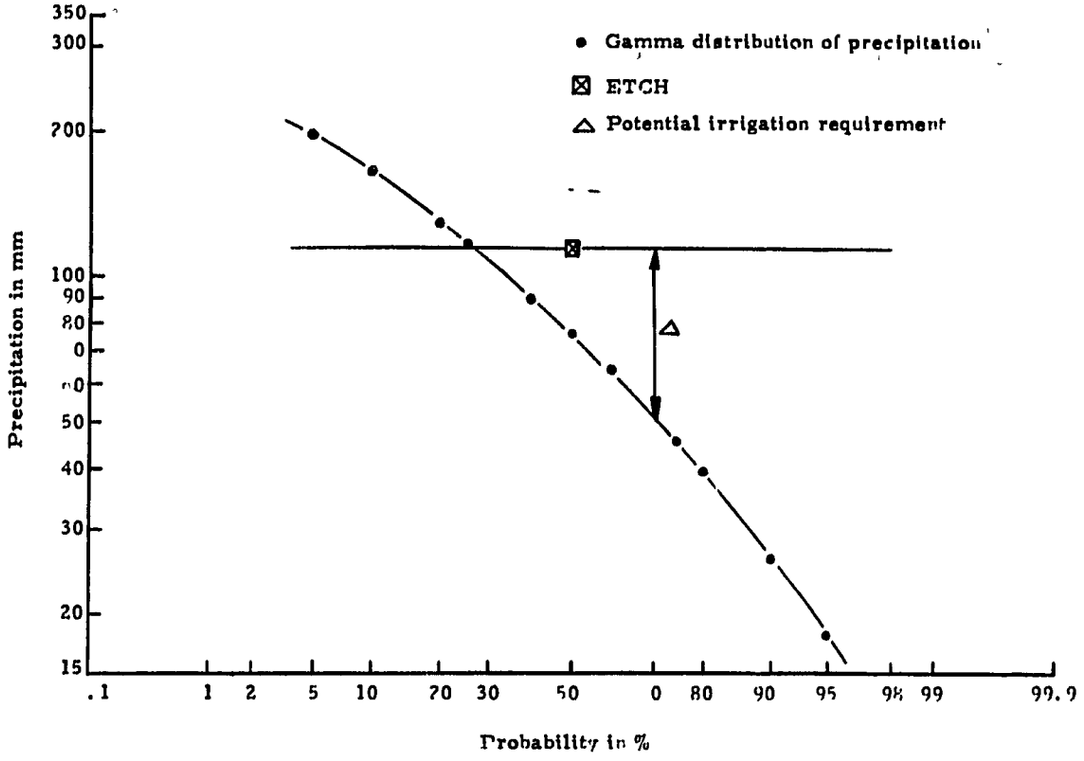

Figure 5. ETCH, gamma distribution and potential irrigation requirement for March at Observatorio Meteorologico Nacional.

SUMMARY AND CONCLUSIONS

From the analysis of 103 years of precipitation records from station Observatorio Meteorologico Nacional, a gamma distribution provided the best fit. This was concluded following a visual inspection of data and distribution curves plotted on log-probability paper, and a more rigorous chi-square goodness of fit test.

A computer program was developed to calculate monthly and annual gamma distributions from the recorded data for 97 stations throughout Colombia For each station 13 probability levels of precipitation were determined. Each precipitation amount is that which is expected to be equaled or exceeded at the given probability level.

Climatological data previously recorded for 43 of these stations were used to calculate potential evapotranspiration using the Christiansen and Hargreaves formula. For these stations the precipitation from the gamma distribution at five probability levels was subtracted from the potential evapotranspiration to arrive at potential irrigation requirements.

Estimates of precipitation probability, as presented in this study, are essential in solving many problems in engineering and agriculture For irrigation, drainage and hydraulic structure designs probabilities and their associated risks are essential for economic analysis. In experimental work the normalacy of the experimental period can be determined The wide range of probabilities presented herein offers a basic design tool from which rational conclusions can be made. The irrigation requirements presented provide a useful index of actual irrigation requirements. The unique environments at each locale must be evaluated and used to modify this index.

BIBLIOGRAPHY

Allred, E. R., and R. Chen. 1953. Evaluating irrigation needs in humid areas. Agricultural Engineering 34:611-615.

Barger, G. L., and H. C. S. Thom. 1949. Evaluation of drought hazard. Agronomy Journal 41:519-526.

Blaney, H. F. 1951. Irrigation requirements of crops. Agricultural Engineering 33(12):665-668. December.

Blaney, H. F., and Wayne D. Criddle. 1962. Determining consumptive use and irrigation water requirements. Agriculture Research Service, United States Department of Agriculture Technical Bulletin No. 1275. 59 p.

Burchinal, J. C., and W. H. Dickerson. 1961. Rainfall probability and its applications. West Virginia University Agricultural Experiment Station Bulletin 454T. 26 p.

Christiansen, J. E. 1971. Personal communication February 15.

Christiansen, J. E., and Ashwin D. Mehta. 1965. Estimation of pan evaporation from climatological data. Progress Report. Project WR-13, Utah Water Research Laboratory, College of Engineering, Utah State University, Logan, Utah. 77 p.

Christiansen, J. E., and G. H. Hargreaves 1970. Irrigation requirements in Latin American Countries. Second World Congress of Engineers and Architects, December 14-18, 1970. Tel Aviv, Israel. 20 p. (Xeroxed)

Christiansen, J. E., and G. H. Hargreaves. 1971. Irrigation requirements and climatic evaluations for Venezuela. Department of Agricultural and Irrigation Engineering, Utah State University, Logan, Utah. 137 p. January.

Cry, George W. 1965. Estimation of precipitation probabilities. Fourth Army Conference on Trophical Meteorology Proceedings, May 6-7, 1965, Miami Beach, Florida. 223 p.

Essenwagner, Oskar. 1960. Frequency distribution of precipitation, physics of precipitation. Geophysical Monograph No. 5, American Geophysical Union No. 746:14-25.

Frank, Ernest C., and Richard Lee 1966. Potential solar beam irradiation on slopes, Tables for 30° to 50° latitude. United States Forest Service Research Paper RM-18. Rocky Mountain Forest Range Experiment Station, Fort Collins, Colorado. 116 p.

Hargreaves, G. H. 1956. Irrigation requirements based on climatic data. American Society of Civil Engineers Proceedings, Journal of the Irrigation and Drainage Division 88(IR4):1-15. November.

Hershfield, D. 1964. Effective rainfall and irrigation water requirements. American Society of Civil Engineers Proceedings, Journal of the Irrigation and Drainage Division 90(IR2):33-47.

Jen-Hu, C. Hang. 1968. Climate and agriculture. Aladine Publishing Co., Chicago, Illinois 350 p.

Jensen, Marvin E., and Howard R. Haise. 1963. Estimating evapotranspiration from solar radiation. American Society of Civil Engineers Proceedings, Journal of the Irrigation and Drainage Division 39(IR4):15-41.

Linsley, Ray K., Jr., Max A. Kohler, and Joseph L. Paulhus. 1958. Hydrology for engineers. McGraw Hill Book Company, Inc., New York. 340 p.

Manning. 1950. Confidence limits of expected monthly rainfall. Journal of Agricultural Science 40:169-173.

Mather, J. R. 1954. The determination of soil moisture from climatic data. Bulletin of the American Meteorological Society 35:63-68.

Miller, Marvin E., C. R. Weaver. 1968. Monthly and annual precipitation probabilities for climatic divisions of Ohio. Ohio Research and Development Center Research Bulletin 1005:1-11.

Pair, Claude H., Walter W. Hinz, Crawford Reid, and Kenneth R. Frost (Editors). 1969. Sprinkler irrigation. Third edition. Sprinkler Irrigation Association, Washington, D.C. 444 p.

Pardo, Guillermo. 1968. Study of sheltered evaporation in Colombia. M.S. Thesis. Utah State University Library, Logan, Utah. 91 p.

Pearson, Karl. 1957. Tables of the incomplete gamma function. University Press, Cambridge, Great Britain. 267 p.

Stutler, R. Kern. 1970. Estimation of evaporation and evapotranspiration in Colombia. M.S. Thesis. Utah State University Library, Logan, Utah. 94 p.

Tanner, C. B. 1967. Measurement of evapotranspiration. p. 534-574. In R. M. Hagan, H. R. Haise, T. W. Edminster (Editors). Irrigation of agricultural lands. American Society of Agronomy, Madison, Wisconsin.

Thom, H. C. S. 1958. A note on the gamma distribution Monthly Weather Review 86(4):117-122.

Thom, H. C. S. 1967. Direct and inverse tables of gamma distribution. Environmental Science Services Administration Technical Report. 30 p. April.

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

Tucker, Joseph E. 1965. Investigation of precipitation distribution and probability of receiving selected amounts over Texas. M.S. Thesis. Texas A&M University, College Station, Texas. 113 p.

United States Department of Agriculture, Soil Conservation Service, Engineer Division 1967. Irrigation water requirements. Technical Release No. 21. 83 p. April.

Univac Division of Sperry Rand Corporation. 1967. Univac 1108 multiprocessor system math-pack program abstracts.

von Bavel, C. H. M. 1953. A drought criterion and its application in evaluating drought incidence and hazard. Agronomy Journal 45:167-172.

Walker, J. T. 1967. A computer program for calculating confidence limits of expected rainfall. Experimental Agriculture 3(4):337-353.

Weaver, C. R., and Marvin E. Miller. 1967. A precipitation probability computer program Ohio Research and Development Center Research Circular 155.1-10. November.

Wiser, E. H. 1965. Irrigation planning using climatological data. American Society of Civil Engineers Proceedings, Journal of the Irrigation and Drainage Division 91(IR4):1-11.

APPENDICES

Appendix A

Climatological Stations

Table 4. Climatological stations with precipitation data.

Serial Number	Name	State	Latitude Deg	Latitude Min	Longitude Deg	Longitude Min	Elevation	Years of Data Precipitation
10130	Arpto Turbo	Antioquia	8	07	76	43	2	9
10310	Bcs de Ceniza	Atlantico	11	04	74	50	10	10
10329	Repelon	Atlantico-3	10	27	75	08	12	13
10812	Arpto S Marcos	Boliva	8	39	75	10	41	8
10930	Arpto Corozal	Bolivar	9	20	75	17	166	9
10403	Jirocasaca	Magdalena	11	03	74	02	710	9
11545	San Isidro	N Santander	7	51	72	33	215	8
20625	Arpto Quibdo	Choco	5	42	76	38	73	9
31320	Rosas	Cauca	2	16	76	44	1760	11
31437	La Union	Narino	1	34	77	09	1400	5
40341	B-Bermeja	Santander	7	04	73	52	81	9
40703	Aguadas	Caldas	5	36	75	27	1460	7
40805	El Pedregal	Antioquia	6	17	75	37	1908	10
40808	Tulio Ospina	Antioquia	6	19	75	32	1435	9
40811	Rep Fabricato	Antioquia	6	21	75	35	2440	10
40845	Guadalupe	Antioquia	6	43	75	17	2134	10
40905	Finca Catay	Antioquia	6	03	75	37	1940	9
40915	Villa Hermosa	Antioquia	6	15	75	31	1722	10
40924	Mazo	Antioquia	6	16	75	30	2555	10
409-0	La Mosca	Antioquia	6	18	75	26	2195	10
40932	La Severa	Antioquia	6	15	75	26	2218	10
41010	Los Troncos	Antioquia	6	03	75	29	2220	10
41011	El Chuscal	Antioquia	6	03	75	26	2310	10
41013	Las Palmas	Antioquia	6	04	75	29	2220	10
41015	Vasconia	Antioquia	6	12	75	27	2555	10
41017	Col la Salle	Antioquia	6	10	75	38	2065	10
41021	La Macarena	Antioquia	6	09	75	20	2155	10
41130	Yolombo	Antioquia	6	36	75	03	1540	13
41150	Arpto Otu	Antioquia	7	03	74	44	610	9
41401	Arpto Barranca	Santander	7	00	73	48	126	10
41958	Las Vegas	Santander	7	16	73	09	1100	13
41925	Arpto B-Manga	Santander	7	06	73	12	931	10
50126	Belen de U	Caldas	5	11	75	49	1360	9
50213	Arpto Manizales	Caldas	5	05	75	40	1030	8
50350	Salamina	Caldas	5	25	75	30	1500	8
50425	Arpto Armenia	Caldas	4	31	75	40	1204	9
50435	Quimbaya	Caldas	4	37	75	45	1400	10
50453	Pereira	Caldas	4	48	75	45	1342	10
50525	El Paso	Tolima	4	31	75	31	3264	10
50610	La Leonera	Valle	3	27	76	36	1800	17
50611	Planta R Cali	Valle	3	27	76	33	1080	16
50612	El Selencio	Valle	3	35	76	37	1750	17
50613	Yanacones	Valle	3	25	76	35	1600	17
50615	Calipuerto	Valle	3	27	76	24	956	10
51365	La Plata	Huila	2	22	75	58	1350	8
51920	La Palma	Cundinamarca	5	21	74	24	1400	17
51955	Guaduas	Cundinamarca	5	04	74	36	1000	17
52015	La Mesa	Cundinamarca	4	38	74	28	1300	15
52180	Macheta	Cundinamarca	5	05	73	37	2100	15
52520	Puesto Monta F	Cundinamarca	4	21	74	21	1420	15
52530	Caracol	Cundinamarca	4	11	74	28	1350	16
52345	Las dos Aguas	Tolima	4	16	74	47	285	10
60210	Arpto Arauca	Arauca	7	04	70	44	122	9
60317	Quetame	Cundinamarca	4	20	73	52	1300	16

Table 5. Climatological stations with precipitation and climatic data collected by Pardo (1968).

Serial Number	Name	State	Latitude Deg	Latitude Min	Longitude Deg	Longitude Min	Elevation	Years of Data Prec.	Years of Data Clim.
10231	Arpto Monteria	Cordoba	8	45	75	51	15	10	3
10327	Arpto Cartegena	Bolivar	10	28	75	30	2	10	4
10420	Aracataca	Magdalena	10	33	74	13	40	10	4
11159	Robles	Magdalena	10	24	73	10	720	12	2
11171	Tolu Iaa	Bolivar	9	31	75	36	4	8	4
20520	Bajo Clima	Valle	3	59	76	52	40	11	3
20652	Andagoya	Choco	5	05	76	43	60	12	7
20680	Quibdo	Choco	5	41	76	40	43	6	4
40718	Est Jaramilla	Cordoba	5	55	75	43	1450	15	13
40818	S Jeronimo	Antioquia	6	26	75	44	703	9	5
40925	Fac Agron Med	Antioquia	6	16	75	35	1450	9	4
41000	Sonson	Antioquia	5	42	75	18	2530	14	5
41400	El Centra	Santander	6	57	73	45	135	12	7
41612	Ubate	Cundinamarca	5	19	73	49	2600	9	7
50320	Fac Agronomia	Caldas	5	04	75	31	2153	10	8
50420	La Bella	Caldas	4	31	75	38	1450	13	6
50917	Santander	Cauca	3	01	76	28	1112	16	6
52145	Obs Met Nal	Cundinamarca	4	38	74	06	2560	103	7
52162	Paraguaycito	Caldas	4	24	75	42	1250	4	3
52163	Palmira Ea	Valle	3	31	76	19	1006	6	7
52164	Ambalema	Tolima	4	46	74	50	250	6	5
52166	Popayan Univ	Cauca	2	26	76	37	1760	6	7
52172	Funza	Cundinamarca	4	42	74	11	2550	6	7

Table 6. Climatological stations with precipitation and climatic data collected by Stutler (1970).

Serial Number	Name	State	Latitude Deg	Latitude Min	Longitude Deg	Longitude Min	Elevation	Years of Data Prec.	Years of Data Clim.
11230	Pueblo Bello	Magdalena	10	26	73	35	980	13	7
11510	Bloway	N D Santander	7	35	72	36	1235	16	8
11535	Salazar	N D Santander	7	44	72	49	1000	11	5
20850	Restrepo	Valle	3	49	76	30	1670	11	5
30725	Ospina Perez	Narino	1	17	77	29	1700	13	7
31305	Manuel Mejia	Cauca	2	23	76	42	1750	12	5
40540	Jardin	Antioquia	5	34	75	56	1630	12	5
41655	Granja Bertha	Boyaca	5	56	73	36	1764	12	5
41644	San Vicente	Santander	6	57	73	26	1200	5	3
50308	Naranjal	Caldas	4	57	75	41	1400	14	4
50310	Chinchina	Caldas	4	58	75	37	1360	18	11
50700	Herasilio Uribe	Valle	4	17	75	55	1550	13	5
50963	La Florida	Cauca	2	26	76	36	1789	15	8
51460	El Carmen	Huila	2	21	75	31	1500	10	5
51709	Chapeton	Tolima	4	33	75	08	1295	11	8
51726	Libano	Tolima	4	56	75	03	1495	15	8
51745	Llandes	Caldas	5	13	75	09	1870	13	5
52005	Anolaima	Cundinamarca	4	45	74	29	1726	7	5
52035	Tibacuy	Cundinamarca	4	21	74	27	1550	16	8
52049	Dolores	Tolima	3	32	74	53	1590	6	3

Appendix B

Computer Programs

```
C*****  THIS IS THE MAIN PROGRAM TOO   TO READ IN THE BASIC PARAMETERS
C*****  STATIO = STATION NAME
C*****  Z - NORMAL DISTRIBUTION PARAMETER
C*****  PERFO = PROBABILITY LEVELS
C*****  NFPFO = NUMBER OF PROBABILITY LEVELS
C*****  LD,LM = LATITUDE  IN DEGREES AND MINUTES
C*****  LOD,LOM= LONGITUDE IN DEGREES AND MINUTES
C*****  LE = ELEVATION IN METERS
C*****  RUNP = DISTRIBUTION OF PRECIPITATION
C*****  KTAB = COUNTER FOR TABLE HEADINGS
C*****  DELIR   IRRIGATION REQUIREMENT AT GIVEN PROBABILITIES
C*****  ETC - ETCH POTENTIAL EVAPOTRANSPIRATION CALCULATED WITH THE
C*****  CHRISTIANSEN HARGREAVES FORMULA
C*****  PREC = MONTHLY PRECIPITATION FOR EACH YEAR IN MILLIMETERS
C*****  NSER - SERIAL NUMBER OF THE STATION
C*****  NYEARS = NUMBER OF YEARS OF DATA
C***** *  IPRINT, LRANK  = CONTROL FOR A LIST OF THE BASIC DATA AND
C*****  FOR THE RANKING TO BE CARRIED OUT
C*****  PMEAN - MEAN MONTHLY AND ANNUAL PRECIPITATION
C*****  IYEARS  - CALENDAR YEAR
C*****  NZONE = NUMBER OF ZONES USED
C*****  NSTA = NUMBER OF STATIONS WITHIN A ZONE
      COMMON STATIO(12) Z(6) PERFO(13) NFPFO,LD,LM,LOD,LOM,LE,RUNP(13,13
     $1 KTAB DELIR(13 12) ETC(13)
      COMMON /PR/PREC(14 103) NSER NYEARS NPRINT LRANK,PMEAN(13),IYEARS(
     $103)
      WRITE(6 2000)
 2000 FORMAT(1H1,/)
      READ(5 126)NFPFO (PERFO(I) I=1 NFPFO)
  126 FORMAT(I5 13F5.1)
      KTAB=0
      NPM=NFPFO/2
      READ(5,127)(Z(I),I=1 NPM)
  127 FORMAT(6F10.5)
      READ(5 1170) NPRINT,LRANK
 1170 FORMAT(2I5)
      READ(5,1100) NZONE
 1100 FORMAT(I5)
      DO 59 I=1,NZONE
      READ(5 1001)NSTA
  100 FORMAT(I5)
      DO 59 M=1 NSTA
      KTAB=KTAB+1
      READ(5,1011)NSER,NYEARS,(STATIO(M),M=1,6),LD,LM,LOD,LOM,LE
  101 FORMAT(I5 I8,2X,6A5,5X,I3,I2,I3,I2,I5)
      YEARS = NYEARS
      DO 8 J=1 13
    8 PMEAN(J)=0.0
      DO 11 M=1,NYEARS
      READ(5 102) IYEARS(M),(PREC(J,M),J=1,12)
  102 FORMAT(I5 12F5.1)
C*****  THE FOLLOWING PROCEDURE CALCULATES THE ANNUAL AND MEAN VALUES
      PREC(13,M)=0.
      DO 10 J=1 12
      PMEAN(J)=PMEAN(J) + PREC(J,M)
   10 PREC(13,M)=PREC(13,M)+PREC(J,M)
      PMEAN(13)=PMEAN (13)+PREC(13,M)
   11 CONTINUE
      DO 12 J=1 13
   12 PMEAN(J)=PMEAN(J)/YEARS
      CALL CRACK
   59 CONTINUE
      STOP
      END
C*****  SAMPLE DATA
C*****  NUMBER OF PROBABILITY LEVELS AND THEIR VALUES
   13   5   10   20   25   30   40   50   60   70   75   80   90   95
C*****  NORMAL CURVE PARAMETERS Z
   1 -4.4445   1.28155    .84162    .67449    .51440    .25300
C*****  CONTROL PARAMETERS NPRINT AND LRANK
    1    1
C*****  NUMBER OF ZONES
    1
C*****  NUMBER OF STATIONS
   59
C*****  STATION IDENTIFICATION
10170       9  1PRTC TUPRC      1971 CUTA              417 7667    2
C*****  PRECIPITATION  DATA
  195  100  [illegible]
```

```
      SUBROUTINE GAMMAX(X,GAMMAX 5,9)
C-----------------------------------------------------------------
C     SUBROUTINE GAMMA  704  FROM UNIVAC 1108 MULTI-PROCESSOR SYSTEM
C     MATH-PACK PROGRAM ABSTRACTS.
C     CALCULATION OF THE GAMMA FUNCTION OF X.
C-----------------------------------------------------------------
      DIMENSION A(8)
      DATA  (A(I) I=1 8)  /-.577191652,.988205891,-.897056937,
     1.918206857 -.756704078 ,.482199394,-.193527818,.035868343/
      DATA CV/.83929689/
      IF(ABS(X) LT.33 ) GO TO 1
C-----------------------------------------------------------------
C     THE MAGNITUDE OF X IS GREATER THAN 33.
C     THE BRIGGSIAN LOGARITHM OF THE GAMMA FUNCTION OF X IS CALCULATED.
C-----------------------------------------------------------------
      GAMMAX=(X-.5)*CV*ALOG(ABS(X))+CV*X+.399089935*CV*ALOG(1.+1./(12.*X)
     1+1./(288.*X*X)-139./(5184.0*X*X*X))
      RETURN 9
C-----------------------------------------------------------------
C     INITIALIZATION OF FACTOR (FACTORIAL X) AND XFACT (X-1).
C-----------------------------------------------------------------
    1 FACTOR=1
      XFACT=X-1.
      IF (XFACT.LT.0 ) GO TO 3
C-----------------------------------------------------------------
C     POSITIVE X
C-----------------------------------------------------------------
    2 IF(XFACT.LT.1.) GO TO 5
      FACTOR=FACTOR*XFACT
      XFACT=XFACT-1.
      GO TO 2
C-----------------------------------------------------------------
C     NEGATIVE X
C-----------------------------------------------------------------
    3 XFACT=XFACT+1.
      FACTOR=FACTOR*XFACT
      IF(XFACT) 3 7,4
    4 FACTOR=1./FACTOR
C-----------------------------------------------------------------
C     CALCULATION OF THE GAMMA FUNCTION OF X
C     THIS IS EQUAL TO THE GAMMA FUNCTION OF XFACT+1.
C-----------------------------------------------------------------
    5 GAMMAX=0
      DO 6 I=9 1 -1
    6 GAMMAX (GAMMAX+A(I))*XFACT
      GAMMAX=(1.+GAMMAX)*FACTOR
       RETURN
C-----------------------------------------------------------------
C     ERROR RETURN FOR X NEGATIVE INTEGER.
C-----------------------------------------------------------------
    7 RETURN 8
      END
```

```
      SUBROUTINE GPACK
C*****  SUBROUTINE 701  TO CALCULATE THE GAMMA DISTRIBUTION OF PRECIPITATION
C*****  ON A MONTHLY BASIS.  THE GAMMA PARAMETERS ARE CALCULATED WITH THE
C*****  USE OF MAX[illegible] LIKELIHOOD ESTIMATORS.  THE GAMMA FUNCTION IS
C*****  EVALUATED WITH THE USE OF A UNIVAC 1108 MATH PAK GAMMA.
C*****  THE PRECIPITATION BASED ON A GAMMA DISTRIBUTION AT A GIVEN
C*****  PROBABILITY IS CALCULATED USING A NEWTON APPROXIMATION.
C*****  VALUES IN COMMON CORRESPOND TO THOSE IN PROGRAM MAIN 700
C*****  AMBA = LAMBA THE SCALE PARAMETER OF THE GAMMA
C*****  GAMMAX = EVALUATION OF THE GAMMA BASED ON RPAR FROM 0 TO INFINITY
C*****  RPAR = SHAPE PARAMETER OF THE GAMMA
C*****  R = PRECIPITATION IN MM.
C*****  RUN1 = STORAGE FOR PRECIPITATION AT A GIVEN PROBABILITY
C*****  DIFN = DENOTATION IF DISTRIBUTION FOR MONTH IS NORMAL
      DOUBLE PRECISION RPIE,GAMMA1
      COMMON NAME(12),Z(6) P(13) NPPR,LD,LM,LOD LOM,LE,RUNP(13,13),KTAB,
     $DOL R(13,13) E(C(13)
      COMMON /PP/PREC(13,103),NSTA,NN,NPRINT,LRANK,PMEAN(13),IYEARS(103)
      REAL AV(13),NAME,P(103 13),AMBA(13),GAMMAX(13),RPAR(13),MONTH(13),
     $RUN1(13),DIFN(13)
      DATA MONTH/' JAN',' FEB',' MAR',' APR',' MAY',' JUN',' JUL'
     ',' AUG',' SEP',' OCT',' NOV',' DEC',' ANN'/
      DATA AST,BLANK/'*',' '/
      NPH=NPRB/2
      NPRBP=NPRB+1
C*****  EXCHANGE OF STORAGE LOCATION FOR PRECIPITATION DATA
      DO 63 I=1 NN
      DO 63 J=1 13
   63 R(I,J)=PREC(J,I)
      FN=NN
C*****  TABLE HEADINGS
      WRITE(6,421) KTAB
  421 FORMAT(1H1,4X,//////////////,5X,'TABLE  7.',I2,' PRECIPITATION FOR G
     $IVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.')
      WRITE(6,485)(NAME(I),I=1,6),NSTA
  485 FORMAT(1H0,16X 'STATION NAME',2X,6A5,1X,'SER. NO.',1X,I5)
      WRITE(6,486)LD LM,LOD,LOM,LE,NN
  486 FORMAT(1H ,16X,'LAT.',I4,I3,' LONG.',I4,I3,' ELEV.',I5,' YEARS
     $OF DATA',1X,I3)
      WRITE(6,420) (P(NPRBP-I),I=1,NPRB)
  420 FORMAT(1H0,4X,'PROBABILITY',1X,13F6.0)
      WRITE(6,422)
  422 FORMAT(1H0,4X,'MONTH ',2X,'MEAN',34X,'PRECIPITATION',/)
C*****  BEGINING OF LOOP TO CALCULATE THE MONTHLY AND ANNUAL DISTRIBUTIONS
      DO 401 J=1,13
      DIFN(J)= BLANK
      AV(J)=PMEAN(J)
      SX2=(R(1,J)-AV(J))*(R(1,J)-AV(J))
      ALSX=ALOG(R(1,J)+.001)
      DO 1405 I=2,NN
      SX2=SX2+(R(I,J)-AV(J))*(R(I,J)-AV(J))
 1405 ALSX=ALSX+ALOG(R(I,J)+.001)
      ALXRAR=ALOG(PMEAN(J)+.001)
      ALXRAR=ALXRAR-ALSX/FN
C*****  MAXIMUM LIKELIHOOD ESTIMATORS. R AND LAMBA. FOR THE GAMMA ARE CALCULATED
      RPAR(J)=1./(4.*ALXRAR)*(1.+SQRT(1.+4.*ALXRAR/3.))
      AMBA(J)=RPAR(J)/AV(J)
      RPAR1=RPAR(J)-1.0
C*****  SAMPLE STANDARD DEVIATION (STD1) CALCULATED
      STD1=SQRT(SX2/(FN-1.0))
C*****  FOR VALUES OF R GREATER THAN 85 THE DISTRIBUTION IS ASSUMED NORMAL
      IF(RPAR(J)  GT.  85.0) GO TO 4930
C*****  UNIVAC 1108 MATH PAK GAMMA EVALUATES THE GAMMA FUNCTION WITH R (RPAR)
      CALL GAMMA(RPAR(J),GAMMAX(J),$1252,$1253)
      GAMMAX(J)=ALOG(GAMMAX(J))
      GO TO 1521
 1253 WRITE(6,1254)
 1254 FORMAT(1H ,'GAMMA FUNCTION IS NOT DEFINED')
      GO TO 400
 1252 GAMMAX(J)=2.3025 85+GAMMAX(J)
 1521 GAMMA1=GAMMAX(J)
C*****  LOOP TO CALCULATE A PRECIPITATION FOR A GIVEN PROBABILITY BASED ON
C*****  A NEWTON APPROXIMATION
      DO 4070 II=1,NPRB
      NEST=0
      TEST=.0001
      DEST=.0004
      XO=RPAR1
      IF(RPAR(J)-1.0)  4051,4100,4100
 4100 IF(XO) 4050,4050,4015
 4051 XO=.0001
      GO TO 4015
 4050 XO=.01
 4015 Z1=2.0
      NEST=NEST+1
      T1=XO/(RPAR1+Z1)
      S=T1+1.0
C*****  LOOP TO CALCULATE S IN THE NEWTON APPROXIMATION
      DO 4016 L=1,100
      Z1=Z1+1.0
      T1=(T1*XO)/(RPAR1+Z1)
      CALL OVERFL(IFL)
      IF(IFL.NE.1) GO TO 4075
      WRITE(6,4444)
 4444 FORMAT(1H ,'OVERFLOW STOP AT 4444')
      STOP
 4075 S=S+T1
      IF(T1-TEST) 4017,4017,4016
 4016 CONTINUE
 4017 DL=P(II)/100.
      IF(DL)4041,4.01,4101
 4101 RPIE=XO
C*****  FOR VALUES OF XO GREATER THAN 86 THE DISTRIBUTION IS ASSUMED NORMAL
      IF(XO .GT. 86.0) GO TO 4930
      RPIE=EXP(GAMMA1-(RPAR)*DLOG(RPIE))
      X1=XO-(XO/RPAR(J))*S*(DL*RPIE*EXP(XO))
      DX=X1-XO
      CALL OVERFL(IFL)
      IF(IFL .NE. 1) GO TO 4078
      WRITE(6,4445)
 4445 FORMAT(1H ,'OVERFLOW STOP AT 4444')
      STOP
 4078 XO=X1
      IF(XO) 4041,4018,4019
 4019 IF(ABS(DX) .LE. DEST) GO TO 4018
      IF(NEST .LE. 100) GO TO 4015
 4041 X1=0.0
C*****  THE VALUE OF PRECIPITATION IS CALCULATED FOR THE PROBABILITY
 4018 RUN1(II)=X1/AMBA(J)
 4020 CONTINUE
      GO TO 400
C*****  LOOP TO CALCULATE A NORMAL DISTRIBUTION
 4930 DO 4008 I=1,NPH
      FACD=STD1*Z(I)
      RUN1(I)=AV(J)-FACD
      RUN1(NPRBP-I)=AV(J)+FACD
      IF(RUN1(I) .LT. 0.) RUN1(I)=0.
 4008 IF(RUN1(NPRBP+1).LT. 0.) RUN1(NPRBP+1)=0.
      RUN1(NPH+1)=PMEAN(J)
      DIFN(J)= AST
  400 CONTINUE
      DO  401 I=1,NPRB
  401 RUNP(I,J)=RUN1(I)
C*****  OUT PUT CONTROLS
      DO 1401 J=1,12
 1401 WRITE(6,430) MONTH(J),DIFN(J),PMEAN(J),(RUNP(I,J),I=1,NPRB)
      J=13
      WRITE(6,431) MONTH(J),DIFN(J),PMEAN(J),(RUNP(I,J),I=1,NPRB)
  430 FORMAT(1H ,4X A5 A1,14F6.0)
  431 FORMAT(1H0,4X,A5,A1,14F6.0)
      WRITE(6,433)
  433 FORMAT(1H0,4X,33HPARAMETERS FOR GAMMA DISTRIBUTION)
      WRITE(6,435) (MONTH(I),I=1,13)
  435 FORMAT(1H0 4X,'MONTH',1X,A5,1X,A5,1X,A5,1X,A5,1X,A5,1X,A5,1X
     $,A5,1X,A5,1X,A5,1X,A5,1X,A5,1X,A5)
      WRITE(6,436) (AMBA(J),J=1,13)
  436 FORMAT(1H0,4X,5HLAMBA,13F6.3)
      WRITE(6,437) (RPAR(I),I=1,13)
  437 FORMAT(1H ,4X 5H  R  ,13F6.2)
      WRITE(6,437) (GAMMAX(I),I=1,13)
  437 FORMAT(1H ,4X,5HLNGAM,13F6.1)
      WRITE(6,439)
  439 FORMAT(1H0,4X,'*     PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DI
     $STRIBUTED')
      WRITE (6,438)
  438 FORMAT(1H ,4X,'**** GAMMA PARAMETERS UNDEFINED',/)
      RETURN
      END
```

```
      SUBROUTINE CHET
C****** SUBROUTINE 702  TO CALCULATE POTENTIAL EVAPOTRANSPIRATION FROM
C*****  MEAN VALUES USING THE CHRISTIANSEN HARGREAVES FORMULA
C*****  ETCH = XKT* RMD * CTT * CWT * CHT * CS * CE * DM
C*****  VALUES IN COMMON CORRESPOND TO THOSE IN PROGRAM MAIN 700
C*****  DM = DAYS IN THE MONTHS
C*****  NST = STATION NUMBER
C*****  XLA = LATITUDE IN RADIANS
C*****  LL - ELEVATION IN METERS
C*****  MO = MONTHS
C*****  TM  TX  TI - MEAN  MAXIMUM AND MINIMUM TEMPERATURES RESPECTIVELY
C*****  IN DEGREES CENTIGRADE
C*****  HMP = PERCENT MEAN HUMIDITY
C*****  VPD = VAPOR PRESSURE DEFICITE
C*****  SP = SUNSHINE PERCENTAGE
C*****  VP - VAPOR  PRESSURE
C*****  DP = DAYS OF PRECIP TATION
C*****  EVFO = FUESS EVAPORATION
C*****  WKH - WIND IN KILOMETERS PER  HOUR
C*****  RMD = DAILY RADIATION IN EQUIVALENT MM OF EVAPORATION
C*****  CWT = WIND COFF. (EQUAL TO 1 FOR LACK OF MEASURED VALUES)
C*****  CHT = WIND COFF
C*****  CTT = TEMPERATURE COEF
C*****  CE - ELEVATION COEF.
C*****  CS - SUNSHINE COEF.
C*****  XKT = CONSTANT
C*****  ETC - ETCH THE CHRISTIANSE; HARGREAVES POTENTIAL EVAPOTRANSPIRATION
C****** DELIR = IRRIGATION REQUIREMENT
      COMMON STATIO(12) Z(6) PERFO(13),NFRED,LD,LM,LOD,LOM,LE,RUNP(13,13
     $),XTAR,DELIR(13 13) ETC(13)
      REAL DM(12)
      DATA (DM(M)  M=1 12)/31  28. 31.  30.  31 . 30.. 31..31.. 30 . 31.. 30..
     131./
      ETC(13)=0.
C*****  LOOP TO CALCULATE ETCH FROM THE BASIC DATA READ IN
      DO 40 J=1,12
C*****  READS AVERAGE VALUES
      READ(5,100) NST XLA,LL,MO,TM,TX TI,HMP,VPD,VP,SP,DP,EVFO,WKH,RMD,
     1DAM)
  100 FORMAT(I3 F6.2,I5 I2 8F5.1,2F5.2,2F6.2)
      M = MO
      S=SP/100
      HM=HMP/100.
      EL=LE
      CWT=1.
      CHT=(1 00-HM)/.301**.25
      CTT=.500+.40*(TM/25.)+.100*(TM/25.)**2
      CE=1.00+.06*(EL/1000.)
      CS= 44+.66*(S/ 5)-.14*(S/.5)**2
      XKT=0.28
      ETC(J)=XKT*RMD*CTT*CWT*CHT*CS*CE*DM(M)
   40 ETC(13)=ETC(13)+ETC(J)
C*****  LOOP TO CALCULATE IRRIGATION REQUIREMENT AT GIVEN PROBABILITIES
      DO 50 J=1,13
      DO 50 I=1,7
   50 DELIR(I,J)=ETC(J)-RUNP(I,J)
      RETURN
      END
```

```
      SUBROUTINE CHET2
C*****  SUBROUTINE 703  TO CALCULATE POTENTIAL EVAPOTRANSPIRATION FROM
C*****  MEAN VALUES USING THE CHRISTIANSEN HARGREAVES FORMULA
C*****  VALUES IN COMMON CORRESPOND TO THOSE IN PROGRAM MAIN 700
C*****  ETCH = XKT* RMD * CTT * CWT * CHT * CS * CE * DM
C*****  DM - DAYS IN THE MONTHS
C*****  DEC = MEAN MONTHLY DECLINATION OF SUN IN RADIANS
C*****  ES = SQUARE OF THE MONTHLY RELATIVE VALUES OF THE DISTANCE
C*****  FROM THE EARTH TO THE SUN
C*****  NST = STATION NUMBER
C*****  XLA = LATITUDE IN RADIANS
C*****  LL = ELEVATION IN METERS
C*****  MO = MONTHS
C*****  TM  TX  TI - MEAN  MAXIMUM AND MINIMUM TEMPERATURES RESPECTIVELY
C*****  IN DEGREES CENTIGRADE
C*****  HM = MEAN MONTHLY HUMIDITY IN PERCENT
C*****  SH = MEASURED SUNSHINE IN HOURS
C*****  DP = DAYS OF PRECIPITATION
C*****  W = WIND VELOCITY IN  KM PER HR.
C*****  DL - DAY LENGTH (THEORETICAL  SUNSHINE) IN HOURS
C*****  RMD = EXTRATERRESTRIAL RADIATION IN LANGLEYS PER DAY
C*****  S = PERCENT SUNSHINE
C*****  CWT - WIND COEF. (EQUAL TO 1 FOR LACK OF MEASURED VALUES)
C*****  CHT = WIND COEF
C*****  CTT = TEMPERATURE COEF.
C*****  CE - ELEVATION COEF
C*****  CS - SUNSHINE COEF.
C*****  XKT - CONSTANT
C*****  ETC = ETCH THE CHRISTIANSEN HARGREAVES POTENTIAL EVAPOTRANSPIRATION
C****** DELIR = IRRIGATION REQUIREMENT
      COMMON STATIO(12) Z(6) PERFO(13),NFRED,LD,LM,LOD,LOM,LE,RUNP(13,13
     $),XTAR,DELIR(13 13) ETC(13)
      REAL DM(12),DEC(12) DER(12),ES(12)
      DATA (DM(M), M=1,12)/31.,28.,31.,30.,31.,30.,31.,31.,30.,31.,30.,
     131 /
      DATA (DEC(M),M=1 12)/-20.989,-13.553,-2.683 9.207,18.606,23.015,21
     $.196 13.573,2 289 -9 565 -18 354,-23.040/
      DATA (ES(M),M=1 12)/.97104  .99135,.99653,1.01313,1.02625,1.03281,1
     $.02987 1 01916,1.00387 .99697,.97369,.96812/
      ETC(13)=0
C*****  LOOP TO CALCULATE ETCH FROM THE BASIC DATA READ IN
      DO 40 J=1,12
C*****  READS AVERAGE VALUES
      READ(5 100) NST,XLA,LL MO TM TX TI,HM,VP,SH,DP,W
  100 FORMAT(I3,F6 2 I5,I2,8F5 1 F5.2,2F5.1,F4.0,F5.2)
      M = MO
      EL=LE
C*****  CALCULATES EXTRATERRESTRIAL RADIATION RMD
      DER(M)=(DEC(M))/57.2958
      ZZ=-TAN(XLA/57.2958)*TAN(DER(M))
      DM    =ATAN(SQRT(1.0-ZZ*ZZ)/ABS(ZZ))
      DL    = DM/0 1309
      IF (ZZ)12 13 12
   12 DL    = 24.-DL
   13 SINO = SIN(DM)
      RLO=120 *(DL*SIN(XLA/57.2958)*SIN(DER(M))+5.8197*COS(XLA/57.2958)*
     1COS(DER(M))*2 *SINO)/ES(M)
      RMD=10.*RLO/(595.9-0.5*TM)
      S=SH/DL
      CWT=1
      CHT=(1 00-HM)/.301**.25
      CTT=.500+ 40*(TM/25.)+.100*(TM/25.)**2
      CE=1.00+.06*(EL/1000.)
      CS=.44+ 66*(S/.5)-.14*(S/.5)**2
      XKT=0.28
      ETC(J)=XKT*RMD*CTT*CWT*CHT*CS*CE*DM(M)
   40 ETC(13)=ETC(13)+ETC(J)
C*****  LOOP TO CALCULATE IRRIGATION REQUIREMENT AT GIVEN PROBABILITIES
      DO 50 J=1 13
      DO 50 I=1 7
   50 DELIR(I,J)=ETC(J)-RUNP(I,J)
      RETURN
      END
```

Appendix C

Gamma Distribution of Precipitation

TABLE 7. 1 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME ARPTO TURBO ANTIOQUIA SER. NO. 10130
LAT. 8 7. LONG. 76 43. ELEV. 2. YEARS OF DATA 9

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	101.	13.	21.	36.	43.	50.	64.	81.	100.	123.	137.	154.	206.	255.
FEB	69.	1.	3.	8.	12.	16.	25.	38.	55.	78.	93.	111.	172.	235.
MAR	62.	1.	2.	7.	10.	14	23.	34.	49.	70.	84.	102.	158.	217.
APR	233.	142.	159.	187.	197.	201.	217.	233.	250.	269.	280.	293.	327.	358.
MAY	276.	103.	129.	166.	182.	197.	225.	256.	289.	327.	349.	375.	450.	518.
JUN	205.	86.	104.	131.	147	152.	177.	193.	215.	240.	255.	273.	322.	366.
JUL	244.	129.	149.	176.	187	197.	217.	236.	256.	279.	293.	308.	351.	389.
AUG	230.	66.	98.	121.	136.	150.	177.	206.	238.	276.	298.	325.	401.	473.
SEP	258.	117.	140.	172.	185.	197.	221.	245.	270.	300.	317.	336.	392.	442.
OCT	249.	199.	209.	221.	226	231.	239.	247.	255.	263.	268.	274.	289.	302.
NOV	275.	101.	127.	164.	180.	195.	225.	255.	288.	326.	349	375.	450.	519.
DEC	222.	82.	109.	133.	146.	158.	182.	206.	233.	263.	281.	302.	363.	418.
ANN	2624.	1943.	2041.	2165.	2213.	2257.	2338.	2415.	2494.	2580.	2629	2684.	2832.	2958.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.015	.010	.010	.054	.016	.027	.039	.014	.025	.253	.016	.020	.025
R	1.62	.66	.68	12.99	4.55	5.55	9.37	3.21	6.57	67.72	4.44	4.52	61.70
LNGAM	-.1	.3	.3	20.0	2.5	4.0	11.4	.9	5.8	195.7	2.4	2.5	191.5

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7. 2 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME RCS DE CENIZA ATLANTICO SER. NO. 10310
LAT. 11 4. LONG. 74 50. ELEV. 16. YEARS OF DATA 10

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	2.
FEB	0.	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.
MAR	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
APR	1.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	2.	3.	5.
MAY	69.	5.	10.	19.	23.	28.	39.	50.	64.	82.	94.	107.	149.	190.
JUN	73.	13.	20.	30.	35.	40.	50.	61.	74.	89.	99	109.	141.	172.
JUL	31.	0.	1.	2.	3.	5.	9.	14.	22.	33.	41.	50.	83.	117.
AUG	58.	9.	14.	22.	26.	30.	39.	48.	58.	71.	79.	88.	116.	143.
SEP	109.	28.	34.	54.	61.	67.	81.	95.	111.	130.	141.	154.	193.	230.
OCT	171.	45.	63.	87.	99.	109.	130.	152.	177.	206.	223.	244.	303.	359.
NOV	57.	10.	15.	23.	27.	31.	39.	47.	57.	69.	77.	85.	111.	136.
DEC	7.	0.	0.	0.	0.	0.	0	0.	1.	1.	5.	8.	21.	37
ANN	573.	253.	304	376.	405.	434.	494.	542.	601.	668.	707.	752.	891.	997.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.406	.000	.000	.221	.019	.028	.017	.031	.026	.017	.036	.029	.011
R	.19************			.24	1.28	2.04	.51	1.74	2.83	2.97	1.93	.16	6.18
LNGAM	1.6************			1.3	-.1	.0	.6	-.1	.5	.7	-.0	1.7	5.1

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7. 3 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME REPELON ATLANTICO 3 SER. NO. 10329
LAT. 10 27. LONG. 75 8. ELEV. 12. YEARS OF DATA 13

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	1.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	1.	3.	6.
FEB	3.	0.	0.	0.	0.	0.	0.	0.	1.	2.	2.	4.	10.	17.
MAR	8.	0.	0.	0.	0.	0.	0.	1.	3.	5.	8.	11.	24.	40.
APR	43.	0.	1.	4.	6.	9.	15.	23.	34.	48.	58.	70.	111.	153.
MAY	120.	51.	62.	77.	84.	90.	101.	113.	126.	141.	149.	159.	187.	213.
JUN	100.	28.	37.	52.	58.	64.	77.	89.	104.	120.	130.	142.	176.	208.
JUL	99.	25.	35.	49.	56.	62.	75.	88.	103.	120.	131.	143.	179.	213.
AUG	110.	15.	24.	40.	47.	55.	71	89.	110.	135.	150.	169.	225.	279.
SEP	131.	41.	53.	72.	80.	88.	103.	119.	137.	157.	169.	184.	225.	263.
OCT	164.	61.	76.	98.	108.	117.	134.	152.	171.	194.	207.	223.	267.	307.
NOV	96.	21.	30.	44.	51.	57.	70.	83.	99.	117.	128.	141.	179.	216.
DEC	29.	0.	0.	0.	1.	1.	3.	7.	13.	25.	33.	44.	85.	133.
ANN	905.	623.	677.	747.	774.	800.	847.	893.	940.	993.	1023.	1057.	1150.	1231.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.162	.052	.028	.014	.008	.031	.028	.015	.027	.028	.025	.010	.026
R	.17	.17	.22	.61	5.75	3.08	2.79	1.64	3.54	4.56	2.41	.30	23.79
LNGAM	1.7	1.7	1.4	.4	4.4	.8	.5	-.1	1.2	2.5	.2	1.1	50.9

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7. 4 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME APPTO S MARCOS BOLIVAR SER. NO. 10812
LAT. 8 39 LONG. 75 10. ELEV. 41. YEARS OF DATA 8

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	10.	0.	0.	0.	0.	0.	0.	1.	2.	5.	8.	13.	31.	54.
FEB	12.	0.	0.	0.	0.	0.	0.	1.	2.	6.	9.	14.	36.	66.
MAR	16.	0.	0	0.	0.	0.	1.	2.	5.	11.	16.	23.	50.	82.
APR	77.	6.	11.	21.	26.	31.	42.	54.	69.	88.	99.	113.	156.	198.
MAY	216	79.	99.	129.	141.	153.	176.	200.	226.	256.	274.	295.	354.	408.
JUN	230	104.	135.	163.	164.	175.	197.	218.	241.	267.	282.	300.	350.	395.
JUL	287.	95.	122	162.	179.	196.	229.	262.	299.	342.	364.	397.	483.	562.
AUG	290.	141.	166.	200	219.	227.	252.	278.	304.	335.	352.	373.	430.	482.
SEP	226	180.	189	201.	206.	210.	218.	225.	233.	241.	246.	251.	266.	278.
OCT	201	177.	180.	159.	165.	172.	184.	197.	209.	223.	231.	241.	266.	288.
NOV	84	0	1.	5	9.	12.	23.	38.	59.	90.	111.	137.	226.	321.
DEC	35.	0.	0.	0.	1.	1.	4.	9.	16.	30.	40.	54.	104.	162.
ANN	1680.	1227.	1315.	1428.	1473.	1514.	1589.	1662.	1738.	1820.	1867	1921.	2066.	2191.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.019	.013	.013	.018	.020	.028	.013	.026	.059	.082	.006	.008	.019
R	.13	.15	.22	1.28	4.43	6.52	3.83	7.63	57.33	16.42	.50	.30	32.63
LNGAM	1.6	1.7	1.4	-.1	2.4	5.7	1.6	7.8	173.7	29.1	.6	1.1	80.3

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7. 5 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME ARPTO COROZAL BOLIVAR SER. NO. 10930
LAT. 9 20. LONG. 75 17. ELEV. 166. YEARS OF DATA 9

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH MEAN	PRECIPITATION												
JAN 25.	0.	0.	0.	1.	1.	3.	6.	12.	22.	29.	39.	75.	116.
FEB 32.	0.	0.	0.	1.	1.	4.	8.	15.	28.	37.	49.	94.	146.
MAR 38.	0.	0.	0.	1.	1.	3.	8.	16.	31.	41.	57.	112.	177.
APR 82.	14.	22.	34.	39.	45.	56.	69.	83.	101.	111.	128	161.	196.
MAY 119.	13.	22	34.	47.	55.	73.	93.	117.	146.	164.	186.	252.	317.
JUN 147.	17.	29.	49.	59.	69.	91.	116.	144.	179.	201.	227.	306.	383.
JUL 119.	9.	16.	32.	40.	48.	66.	87.	113.	145.	165.	189.	264.	339.
AUG 94.	7.	13.	25.	32.	38.	53.	70.	89.	115.	130.	150.	208.	266.
SEP 99.	9.	16.	29.	36.	43.	58.	75.	95.	120.	136.	155.	213.	269.
OCT 95.	14.	22.	36.	42.	49.	69.	77.	95.	116.	129.	144.	191.	235.
NOV 53.	2.	4.	9.	12.	16.	24.	34.	46.	63.	73.	86.	120.	170.
DEC 38.	0.	1.	4.	5.	7.	13.	20.	29.	43.	52.	63.	99.	138.
ANN 942.	156.	240.	377.	447.	507.	640.	784.	949.	1149.	1272.	1417.	1851.	2265.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.012	.009	.007	.024	.012	.010	.010	.013	.013	.018	.016	.016	.002
R	.30	.70	.79	1.97	1.83	1.49	1.15	1.18	1.31	1.74	.83	.59	1.91
LNGAM	1.1	1.1	1	-.0	-.1	-.1	-.1	-.1	-.1	-.1	.1	.4	-.0

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
*** GAMMA PARAMETERS UNDEFINED

TABLE 7. 7 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME SAN ISIDRO N SANTANDER SER. NO. 11545
AT. 7 51. LONG. 72 33. ELEV. 215. YEARS OF DATA 8

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH MEAN	PRECIPITATION												
JAN 60.	0.	0.	2.	4.	6.	12.	22.	37.	60.	76.	97.	169.	248.
FEB 55.	17.	22.	30.	34.	37.	43.	50.	57.	65.	70.	76.	93.	109.
MAR 59.	13.	14.	27.	31.	35.	42.	50.	59.	70.	77.	85.	108.	129.
APR 61.	31.	36.	43.	45.	48.	53.	58.	64.	70.	73.	77.	89.	99.
MAY 78.	15.	22.	33.	39.	44.	55.	66.	80.	95.	105.	116.	150.	182.
JUN 34.	7.	10.	15.	18.	20.	25.	30.	35.	42.	46.	51.	65.	78.
JUL 17.	2.	4.	6.	7.	9.	11.	14.	17.	21.	23.	26.	35.	43.
AUG 18.	6.	7.	10.	11.	12.	14.	16.	18.	21.	23.	25.	30.	35.
SEP 72.	9.	14.	24.	29.	35.	45.	57.	71.	88.	99.	111.	150.	187.
OCT 148.	20.	33.	54.	64.	74.	96.	120.	147.	181.	201.	226.	300.	372.
NOV 124.	27.	39.	58.	66.	75.	92.	110.	130.	155.	170.	187.	239.	287.
DEC 91.	20.	29.	42.	48.	54.	66.	79.	93.	111.	121.	134.	170.	204.
ANN 819.	513.	569.	643.	673.	700.	752.	802.	855.	914.	947.	986.	1092.	1184.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.007	.066	.092	.137	.027	.066	.098	.212	.021	.011	.018	.026	.019
R	.40	3.60	2.45	8.32	2.12	2.28	1.67	3.74	1.52	1.67	2.36	2.41	15.88
LNGAM	.8	1.3	.3	9.2	.1	.1	-.1	1.5	-.1	-.1	.2	.2	27.6

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
*** GAMMA PARAMETERS UNDEFINED

TABLE 7. 6 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME JIRICASACA MAGDALENA SER. NO. 10403
LAT. 11 3. LONG. 74 2. ELEV. 710. YEARS OF DATA 8

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH MEAN	PRECIPITATION												
JAN 60.	0.	0.	0.	0.	0.	2.	6.	15.	35.	53.	78.	183.	313.
FEB 1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	2.	3.
MAR 9.	0.	0.	0.	0.	0.	0.	0.	1.	3.	6.	9.	22.	51.
APR 54.	0.	2.	5.	8.	11.	19.	30.	44.	64.	78.	95.	142.	211.
MAY 345.	157.	188.	230.	244.	264.	296.	328.	362.	401.	424.	451.	525.	592.
JUN 290.	123.	149	186.	201.	216.	244.	273.	304.	339.	360.	384.	452.	514.
JUL 247.	76.	100.	135.	150.	169.	198.	224.	257.	296.	314.	346.	425.	497.
AUG 312.	101.	130.	174.	193.	211.	247.	284.	325.	372.	400.	433.	579.	616.
SEP 343.	199.	235.	259.	273.	286.	310.	334.	359.	387.	403.	422.	473.	519.
OCT 517.	355.	386.	426.	442.	456.	483.	510.	537.	567.	584.	604.	657.	704.
NOV 235.	47.	68.	103.	114.	134.	166.	200.	239.	285.	314.	348.	447.	541.
DEC 67.	7.	12.	21.	26.	31.	41.	52.	65.	87	97.	104.	147.	178.
ANN 2484.	1479.	1670.	1900.	1997.	2086.	2256.	2422.	2596.	2791.	2904.	3032.	3388.	3701.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.003	.364	.015	.010	.019	.020	.014	.012	.036	.046	.009	.021	.005
R	.19	.73	.14	.58	6.54	5.68	3.48	3.71	12.27	23.45	2.70	1.42	13.27
LNGAM	1.6	1.4	1.9	.4	5.9	4.2	1.7	1.4	18.7	50.7	.1	-.1	20.7

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
*** GAMMA PARAMETERS UNDEFINED

TABLE 7. 9 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME ARPTO QUIBDO CHOCO SER. NO. 20625
LAT. 5 42. LONG. 76 38. ELEV. 73. YEARS OF DATA 9

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH MEAN	PRECIPITATION												
JAN 464.	247.	319.	362.	379.	395.	425.	454.	484.	518.	538.	560.	622.	676.
FEB 331.	169.	197.	235.	250.	265.	292.	320.	349.	383.	402.	424.	487.	542.
MAR 386.	182.	216.	262.	281.	299.	333.	368.	405.	447.	471.	499.	579.	650.
APR 517.	270.	312.	370.	393.	415.	456.	498.	542.	591.	620.	653.	745.	828.
MAY 513.	147.	245.	313.	342.	370.	424.	478.	538.	606.	646.	693.	828.	950.
JUN 635.	423.	469.	515.	535.	554.	590.	624.	660.	700.	723.	748.	819.	881.
JUL 665.	376.	427.	495.	523.	549.	597.	645.	696.	752.	785.	823.	927.	1019.
AUG 643.	295.	351.	430.	462.	493.	552.	611.	675.	747.	789.	838.	976.	1101.
SEP 571.	303.	349.	411.	437.	461.	506.	551.	594.	652.	683.	718.	818.	907.
OCT 539.	374.	405.	446.	462.	477.	505.	532.	559.	590.	608.	627.	692.	729.
NOV 533.	282.	325.	383.	407.	430.	472.	514.	559.	610.	639.	672.	766.	850.
DEC 581.	318.	364.	426.	451.	474.	519.	563.	609.	661.	691.	726.	823.	908.
ANN 6380.	5103.	5395	5727.	5856.	5965.	6184.	6380.	6577.	6795.	6904.	7034.	7375.	7657.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.033	.025	.018	.018	.009	.032	.017	.010	.017	.046	.017	.018	.012
R	15.15	8.37	7.17	9.06	4.79	20.52	11.33	6.65	9.83	29.70	9.29	10.27	77.38
LNGAM	25.5	9.3	5.4	10.7	2.9	40.9	15.9	5.9	11.5	53.8	11.2	13.4	257.7

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
*** GAMMA PARAMETERS UNDEFINED

TABLE 7.9 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME ROSAS CAUCA SER. NO. 31320
LAT. 2 16. LONG. 76 44. ELEV. 1760. YEARS OF DATA 11

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	183.	22.	37.	63.	75.	88.	115.	145.	180.	225.	260.	282.	379.	472.
FEB	114.	6.	12.	26.	33.	41.	54.	79.	104.	137.	158.	183.	262.	340.
MAR	165.	34.	47.	66.	74.	89.	112.	137.	166.	201.	223.	248.	324.	396.
APR	247.	107.	129.	160.	173.	186.	209.	233.	259.	286.	306.	326.	387.	434.
MAY	175.	74.	90.	112.	121.	130.	147.	165.	184.	205.	218.	232.	274.	312.
JUN	84.	4.	4.	18.	23.	29.	42.	57.	76.	101.	117.	136.	195.	255.
JUL	43.	0.	0.	1.	1.	2.	5.	11.	21.	37.	50.	67.	127.	197.
AUG	27.	0.	0.	0.	1.	1.	3.	6.	12.	22.	30.	41.	80.	125.
SEP	107.	11.	18.	33.	40.	48.	64.	82.	104.	131.	147.	167.	229.	288.
OCT	312.	184.	204.	239.	251.	267.	283.	304.	326.	350.	364.	380.	425.	464.
NOV	381.	220.	244.	286.	302.	316.	343.	370.	398.	430.	449.	469.	527.	578.
DEC	375.	170.	203.	249.	264.	286.	321.	356.	393.	435.	461.	490.	571.	645.
ANN	2212.	1735.	1831.	1952.	1999.	2042.	2122.	2198.	2276.	2367.	2410.	2465.	2612.	2738.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.008	.009	.012	.024	.022	.011	.007	.011	.013	.043	.031	.017	.024
P	1.54	1.01	1.37	5.44	5.62	.46	.31	.29	1.36	13.41	11.47	6.50	52.38
LNGAM	-.1	-.0	-.0	4.7	4.1	.0	1.1	1.1	-.1	21.0	17.4	5.7	153.7

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.10 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME LA UNION NARINO SER. NO. 31437
LAT. 1 34. LONG. 77 4. ELEV. 1400. YEARS OF DATA 5

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	119.	60.	70.	84.	89.	98.	104.	114.	124.	136.	142.	150.	172.	192.
FEB	90.	27.	36.	48.	54.	60.	70.	81.	94.	108.	117.	127.	156.	183.
MAR	159.	36.	49.	116.	123.	129.	142.	154.	167.	181.	190.	199.	226.	250.
APR	190.	143.	151.	160.	164.	167.	174.	179.	186.	192.	196.	200.	212.	221.
MAY	163.	119.	120.	135.	141.	146.	156.	166.	177.	188.	195.	202.	223.	241.
JUN	130.	62.	64.	81.	89.	95.	109.	122.	137.	153.	163.	175.	207.	237.
JUL	25.	0.	0.	1.	1.	2.	4.	8.	14.	24.	31.	41.	75.	113.
AUG	30.	0.	0.	1.	1.	2.	5.	9.	17.	28.	37.	48.	86.	129.
SEP	49.	2.	5.	13.	17.	22.	32.	45.	61.	81.	95.	111.	163.	215.
OCT	271.	84.	114.	152.	169.	184.	215.	248.	283.	324.	349.	377.	460.	536.
NOV	311.	93.	123.	167.	187.	205.	242.	281.	323.	371.	402.	437.	538.	631.
DEC	196.	124.	141.	157.	164.	170.	181.	192.	204.	217.	224.	232.	255.	275.
ANN	1750.	1225.	1276.	1456.	1527.	1559.	1649.	1727.	1815.	1913.	1968.	2031.	2203.	2351.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.072	.037	.052	.319	.103	.040	.013	.012	.013	.014	.011	.096	.015
P	3.55	3.32	9.93	57.60	17.41	5.16	.35	.16	.87	3.74	3.37	18.77	25.88
LNGAM	9.7	1.1	12.6	174.8	31.4	3.4	.9	.9	.1	1.5	1.1	35.7	57.6

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.11 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME R-BERMEJA SANTANDER SER. NO. 40341
LAT. 7 4. LONG. 73 52. ELEV. 41. YEARS OF DATA 9

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	99.	0.	0	1.	2.	3.	9.	20.	40.	73.	99.	153.	260.	407.
FEB	114.	48.	58.	73.	79.	85.	96.	107.	119.	133.	141.	151.	178.	202.
MAR	164.	54.	69.	92.	107.	112.	131.	150.	171.	196.	211.	228.	277.	323.
APR	245.	96.	119.	151.	165.	178.	203.	229.	257.	289.	308.	330.	392.	449.
MAY	286.	176.	196	223.	233.	243.	267.	280.	299.	320.	332.	346.	384.	417.
JUN	258.	118.	140.	172.	185.	197.	221.	245.	270.	299.	316.	336.	391.	441.
JUL	154.	66.	80.	101.	109.	117.	133.	149.	166.	185.	197.	210.	248.	282.
AUG	277.	140.	163.	195.	208.	220.	243.	266.	290.	318.	334.	353.	405.	451.
SEP	249	179.	200	226.	237.	246.	265.	283.	302.	323.	335.	349.	387.	421.
OCT	405.	247.	276.	314.	329.	343.	370.	396.	423.	453.	470.	490.	545.	594.
NOV	267	131.	153.	195	197.	210.	237.	256.	280.	308.	325.	344.	396.	444.
DEC	110.	20.	29.	46.	53.	61.	76.	93.	112.	135.	149.	165.	215.	262.
ANN	2661.	2279.	2364.	2466.	2505.	2537.	2603.	2661.	2720.	2786.	2818.	2857.	2959.	3044.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.003	.049	.023	.020	.052	.026	.035	.030	.053	.035	.029	.018	.055
P	.29	5.61	3.79	4.98	15.01	6.66	5.54	8.37	15.33	14.57	7.65	2.00	145.92
LNGAM	1.1	4.1	1.5	3.2	25.2	5.8	4.0	9.3	26.1	24.0	7.9	.0	57.6

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.12 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME AGUADAS CALDAS SER. NO. 40703
LAT. 5 35. LONG. 75 27. ELEV. 1460. YEARS OF DATA 7

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	29.	0.	0.	1.	2.	3.	6.	10.	17.	28.	36.	46.	80.	117.
FEB	64.	7.	12	21.	25.	30.	39.	50.	62.	74.	87.	99.	133.	167.
MAR	105.	61.	69.	79.	83.	87.	95.	102.	109.	118.	123.	129.	144.	158.
APR	177.	140.	149.	157	161.	164.	170.	176.	182.	189.	193.	197.	208.	218.
MAY	211.	95.	114	140.	151.	161.	181.	200.	222.	246.	260.	277.	323.	365.
JUN	157.	73.	87.	106.	114.	121.	135.	149.	165.	182.	192.	204.	237.	266.
JUL	109.	37.	37.	53.	60.	67.	81.	96.	117.	137.	144.	157.	198.	236.
AUG	163.	40.	56	80.	90.	101.	122.	144.	168.	198.	215.	236.	297.	353.
SEP	175.	125.	135.	147.	153.	157.	165.	173.	181.	191.	196.	202.	218.	232.
OCT	239.	142.	159	182.	192.	200.	217.	233.	250.	269.	279.	292.	326.	357.
NOV	223	94.	115	143	155.	166.	188.	210.	234.	261.	277.	295.	348.	396.
DEC	91.	29.	39.	51.	56.	62.	72.	83.	95.	109.	118.	127.	156.	182.
ANN	1743.	1257.	1352.	1473.	1520.	1564.	1685.	1724.	1804.	1894.	1944.	2002.	2158.	2293.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.014	.023	.117	.314	.030	.044	.025	.017	.164	.055	.025	.040	.017
P	.40	1.47	12.71	55.59	6.39	6.91	2.71	2.71	28.75	13.16	5.68	3.66	30.40
LNGAM	.8	-.1	18.0	166.7	5.5	6.5	.4	.4	67.1	20.4	4.2	1.4	72.6

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.13 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME EL FONDEGAL ANTIOQUIA SER. NO. 40805
LAT. 6 17. LONG. 75 37. ELEV. 1908. YEARS OF DATA 10

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	96.	8.	12.	19.	22.	25.	32.	38.	46.	56.	62.	69.	89.	108.
FEB	70.	17.	24.	34.	39.	43.	52.	61.	72.	85.	92.	101.	128.	152.
MAR	85.	30.	38.	50.	55.	60.	69.	78.	89.	101.	108.	116.	140.	162.
APR	170.	80.	95.	115.	124.	132.	147.	162.	179.	197.	204.	221.	257.	289.
MAY	227.	133.	149.	172.	181.	189.	205.	221.	237.	255.	266.	278.	311.	341.
JUN	114.	45.	56.	72.	79.	85.	97.	110.	123.	139.	148.	159.	190.	218.
JUL	120.	58.	69.	83.	89.	94.	104.	115.	126.	138.	146.	154.	178.	199.
AUG	123.	57.	69.	83.	89.	95.	106.	117.	129.	143.	151.	160.	186.	210.
SEP	165.	98.	110.	126.	132.	138.	149.	160.	172.	185.	193.	201.	225.	246.
OCT	199.	113.	129.	149.	157.	165.	179.	193.	208.	225.	235.	246.	278.	305.
NOV	160.	95.	107.	122.	128.	134.	145.	156.	168.	180.	188.	196.	219.	240.
DEC	90.	30.	39.	51.	57.	62.	72.	83.	94.	107.	115.	125.	151.	176.
ANN	1573.	1185.	1262.	1359.	1397.	1432.	1497.	1560.	1629.	1694.	1734.	1779.	1901.	2006.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.049	.038	.050	.041	.035	.041	.063	.055	.040	.057	.081	.043	.025
R	2.01	2.64	4.25	6.97	12.55	8.82	7.59	6.77	13.15	11.39	13.03	3.89	39.47
LNGAM	.0	.4	2.1	5.5	18.9	7.9	7.7	6.1	20.4	16.0	20.1	1.7	104.5

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.14 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME TULIO OSPINA ANTIOQUIA SER. NO. 40808
LAT. 6 19. LONG. 75 32. ELEV. 1435. YEARS OF DATA 9

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	49.	12.	16.	20.	22.	30.	36.	43.	51.	60.	65.	72.	91.	108.
FEB	65.	5.	10.	18.	23.	27.	37.	49.	62.	80.	90.	103.	143.	182.
MAR	44.	7.	11.	17.	20.	23.	29.	36.	44.	53.	59.	66.	87.	107.
APR	134.	54.	66.	84.	91.	98.	112.	126.	141.	158.	168.	180.	213.	244.
MAY	190.	93.	104.	128.	136.	144.	158.	173.	188.	206.	216.	228.	260.	289.
JUN	121.	33.	45.	62.	70.	78.	93.	109.	127.	148.	160.	175.	218.	258.
JUL	117.	33.	43.	59.	66.	73.	87.	101.	116.	135.	146.	159.	196.	230.
AUG	91.	49.	56.	66.	70.	74.	81.	88.	95.	104.	109.	114.	130.	144.
SEP	142.	88.	98.	111.	116.	121.	130.	139.	148.	159.	164.	171.	190.	206.
OCT	185.	105.	119.	138.	145.	153.	166.	180.	194.	210.	219.	229.	258.	284.
NOV	123.	51.	67.	78.	85.	91.	103.	116.	129.	145.	154.	164.	194.	221.
DEC	64.	14.	21.	31.	35.	40.	49.	59.	70.	84.	92.	102.	130.	157.
ANN	1317.	908.	986.	1087.	1127.	1164.	1232.	1299.	1367.	1444.	1487.	1536.	1671.	1788.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.052	.019	.042	.038	.049	.024	.029	.105	.109	.061	.044	.033	.018
R	2.59	1.24	1.82	5.15	8.77	2.96	3.24	9.57	15.54	11.25	5.43	2.27	24.01
LNGAM	.4	-.1	-.1	3.4	10.1	.7	.4	11.9	26.7	15.7	3.4	.1	51.6

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.15 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME REP FABRICATO ANTIOQUIA SER. NO. 40811
LAT. 6 21. LONG. 75 35. ELEV. 2440. YEARS OF DATA 10

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	42.	6.	10.	16.	19.	22.	28.	35.	42.	52.	57.	64.	85.	104.
FEB	70.	9.	15.	25.	30.	34.	45.	56.	69.	85.	95.	107.	143.	177.
MAR	78.	25.	32.	43.	48.	53.	62.	71.	81.	93.	100.	108.	132.	155.
APR	166.	85.	99.	118.	125.	132.	146.	159.	174.	190.	199.	210.	241.	268.
MAY	227.	147.	162.	182.	190.	197.	210.	223.	237.	252.	261.	271.	298.	321.
JUN	132.	49.	61.	79.	87.	94.	108.	122.	138.	156.	167.	179.	215.	247.
JUL	150.	68.	82.	100.	108.	115.	129.	142.	157.	174.	184.	196.	228.	258.
AUG	143.	62.	75.	93.	101.	108.	121.	135.	150.	167.	177.	189.	221.	251.
SEP	180.	132.	142.	154.	158.	163.	171.	179.	187.	195.	200.	206.	222.	235.
OCT	179.	107.	120.	137.	144.	151.	163.	175.	187.	201.	209.	218.	244.	266.
NOV	138.	77.	88.	102.	108.	113.	124.	134.	144.	156.	163.	171.	193.	212.
DEC	93.	29.	38.	51.	57.	62.	73.	84.	97.	111.	120.	130.	160.	187.
ANN	1598.	1702.	1780.	1880.	1919.	1955.	1521.	1585.	1650.	1722.	1763.	1809.	1934.	2041.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.042	.023	.047	.052	.080	.035	.044	.042	.184	.075	.080	.038	.024
R	1.77	1.61	3.65	8.69	18.22	4.55	6.46	5.97	33.11	13.48	11.04	3.51	38.98
LNGAM	-.1	-.1	1.4	9.9	34.1	2.5	5.8	4.7	81.9	21.2	15.2	1.2	102.9

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.16 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME GUADALUPE ANTIOQUIA SER. NO. 40845
LAT. 6 43. LONG. 75 17. ELEV. 2134. YEARS OF DATA 10

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	91.	8.	14.	27.	33.	40.	53.	69.	87.	111.	125.	142.	195.	247.
FEB	87.	10.	17.	30.	36.	42.	55.	69.	86.	107.	119.	135.	181.	226.
MAR	122.	36.	48.	65.	73.	80.	95.	110.	127.	147.	159.	173.	213.	251.
APR	340.	187.	214.	250.	265.	278.	304.	330.	356.	387.	404.	425.	481.	531.
MAY	471.	350.	374.	405.	417.	428.	449.	469.	489.	511.	524.	538.	577.	611.
JUN	376.	211.	240.	279.	295.	309.	337.	365.	394.	426.	445.	467.	527.	580.
JUL	377.	265.	296.	314.	325.	335.	354.	373.	397.	412.	424.	438.	475.	507.
AUG	307.	136.	163.	201.	217.	232.	261.	290.	321.	357.	378.	402.	471.	533.
SEP	337.	188.	215.	249.	264.	277.	302.	327.	353.	382.	399.	418.	477.	520.
OCT	417.	266.	294.	330.	345.	359.	384.	409.	435.	464.	480.	499.	551.	596.
NOV	266.	145.	166.	194.	206.	217.	237.	258.	279.	303.	317.	333.	378.	418.
DEC	122.	47.	58.	74.	81.	88.	100.	113.	127.	144.	153.	164.	196.	225.
ANN	3316.	2565.	2715.	2925.	2979.	3047.	3172.	3292.	3415.	3550.	3627.	3713.	3946.	4146.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.014	.017	.027	.031	.075	.029	.069	.020	.032	.041	.038	.040	.014
R	1.31	1.52	3.29	10.40	35.38	10.99	26.08	6.20	10.92	17.00	10.04	4.81	47.32
LNGAM	-.1	-.1	1.0	13.7	89.8	15.1	58.3	5.1	14.9	30.7	12.9	2.9	134.2

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.17 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME FINCA CATAY ANTIOQUIA SER. NO. 40905
LAT. 6 7. LONG. 75 37. ELEV. 1900. YEARS OF DATA 9

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	84.	27.	35.	47.	52.	57.	67.	77.	88.	101.	108.	117.	143.	166.
FEB	90.	25.	34.	47.	52.	58.	69.	81.	93.	109.	118.	128.	159.	188.
MAR	143.	82.	93.	107.	113.	118.	129.	139.	150.	162.	169.	177.	199.	218.
APR	266.	190.	205.	223.	231.	238.	250.	262.	275.	289.	297.	306.	330.	352.
MAY	275.	212.	225.	241.	247.	253.	264.	274.	285	296.	303.	310.	331.	348.
JUN	179.	111.	123.	140.	146.	152.	164.	175.	186.	193.	207.	215.	239.	259.
JUL	172.	80	95.	116.	125.	133.	144.	163.	180.	199.	210.	222.	258.	290.
AUG	164.	76.	91.	111.	119.	127.	141.	156.	172.	190.	201.	213.	248.	279.
SEP	227.	140.	156.	177.	185.	193.	208.	222.	237.	254.	263.	274.	304.	331.
OCT	247.	224.	242.	254.	258.	259.	280.	290.	300.	311.	317.	325.	344.	360.
NOV	229.	151.	155.	185.	192.	199.	213.	225.	239.	254.	262.	272.	299.	322.
DEC	151.	81.	93.	110.	117	123.	135.	147.	160.	174.	182.	192.	219.	242.
ANN*	2274.	1430.	1328.	2047.	2092.	2130.	2216	2274.	2343.	2419.	2457.	2502.	2621.	2719.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.044	.034	.041	.109	.161	.047	.041	.042	.066	.181	.084	.062	.035
R	3.73	7.05	11.51	29.96	49.59	15.46	6.99	6.88	15.04	53.43	19.20	9.47	79.02
LNGAM	1.5	.7	16.6	67.8	123.8	26.8	6.6	6.3	27.5	159.1	37.0	11.6	265.0

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.18 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME MAZO ANTIOQUIA SER. NO. 40920
LAT. 6 16. LONG. 75 30. ELEV. 2555. YEARS OF DATA 16

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	48.	5.	9.	16.	19.	22.	30.	38.	47.	59.	66.	75.	102.	128.
FEB	69.	16.	23.	33.	37.	42.	51.	60.	70.	83.	91.	100.	126.	150.
MAR	91.	46.	53.	64.	68.	72.	79.	87.	95.	104.	109.	116.	133.	148.
APR	140.	79.	99.	117.	126.	135.	153.	170.	189.	211.	223.	238.	280.	318.
MAY	209.	121.	137.	158.	166.	174.	189.	203.	218.	236.	245.	257.	288.	316.
JUN	120.	49.	59.	75.	82.	88.	100.	112.	126.	141.	150.	161.	191.	218.
JUL	121.	47.	54.	74.	81.	87.	100.	113.	126.	142.	152.	163.	194.	222.
AUG	116.	36.	48.	64.	71.	78.	91.	105.	121.	139.	150.	162.	199.	232.
SEP	166.	80.	95.	114.	122.	130.	144.	159.	174.	191.	202.	213.	246.	276.
OCT	221.	119.	137	160.	170.	179.	196.	213.	231.	252.	263.	277.	315.	348.
NOV	173.	99.	112	130	137.	143.	156.	168.	181.	196.	204.	214.	241.	265.
DEC	116.	38.	49.	66.	73	79.	92.	106.	121.	138.	148.	160.	195.	227.
ANN*	1629.	1334.	1399.	1478.	1508.	1533.	1584.	1629.	1675.	1725.	1750.	1780.	1859.	1925.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.030	.038	.091	.033	.059	.043	.041	.031	.045	.044	.067	.033	.057
R	1.44	2.59	8.29	5.87	12.23	5.15	4.93	3.57	7.54	9.40	11.57	3.85	92.66
LNGAM	-.1	.3	9.1	4.6	14.1	3.4	3.1	1.3	7.6	12.4	16.5	1.6	111.6

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.19 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME VILLA HERMOSA ANTIOQUIA SER. NO. 40915
LAT. 6 15. LONG. 75 31. ELEV. 1722. YEARS OF DATA 10

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	36.	6.	9.	14.	17.	19.	25.	30.	36.	44.	49.	54.	71.	87.
FEB	59.	4	9.	16.	20.	24.	33.	43	56.	72.	82.	94.	130.	167.
MAR	78.	31.	39.	49.	53.	57.	65.	73.	82.	92.	98.	105.	124.	142.
APR	175.	94.	105.	123.	130.	136.	148.	160.	173.	187.	195.	204.	230.	253.
MAY	141.	90.	105.	126.	135.	143.	158.	174.	190.	209.	219	232.	267.	298.
JUN	99.	24.	34.	44.	54.	61.	73.	87.	102.	119.	130.	142.	179.	213.
JUL	104.	51.	61.	73.	79.	84.	93.	103.	113.	125.	132.	140.	162.	182.
AUG	109.	43.	54.	68	76.	80.	91.	102.	114.	128.	137	146.	174	199.
SEP	136.	79.	93.	112.	118.	113.	127.	131.	140.	151.	157.	164.	184.	201.
OCT	167.	84.	103.	120.	127.	134.	148.	161.	175	190.	200.	210.	239.	265
NOV	145.	67.	80.	97	105.	112.	125.	138.	152.	169.	174.	184.	220.	247.
DEC	91.	27.	36.	43	54.	60.	71.	82.	95.	110	119	129.	159.	187.
ANN	1373.	1141.	1107.	1131.	1227	1273.	1309.	1362.	1416.	1476.	1510.	1548.	1652.	1742.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.053	.026	.066	.069	.084	.027	.066	.047	.047	.056	.047	.036	.030
R	1.91	1.19	5.19	11.47	7.92	2.70	7.07	5.10	11.02	9.32	6.76	3.28	41.34
LNGAM	-.0	-.1	7.5	16.2	8.4	.4	6.7	3.3	20.0	13.3	6.1	1.0	111.6

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.20 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME LA MOSCA ANTIOQUIA SER. NO. 40930
LAT. 6 14. LONG. 75 26. ELEV. 2195. YEARS OF DATA 10

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	51.	8.	12.	20.	23.	27.	34.	42.	51.	62.	69.	77.	101.	125.
FEB	56.	9.	14.	22	26.	30.	38.	46.	56.	68.	76.	84.	110.	135.
MAR	84.	41.	49.	53.	64.	68.	76.	84.	92.	102.	108.	114.	133.	149.
APR	217.	121.	134.	160.	169.	178.	194.	210.	227.	246.	257.	269.	304.	335.
MAY	224.	151.	165.	184.	192.	199.	212.	224.	238.	252.	261.	270.	296.	319.
JUN	131.	46	59	77.	84.	92.	106.	121.	137.	156.	167.	180.	217.	251.
JUL	146.	56.	73	89.	97	105.	120.	136.	152.	172.	183.	197.	234.	269.
AUG	127.	55.	63.	84.	91.	97.	109.	121.	134.	148.	157.	166.	194.	219.
SEP	195.	97.	113.	136.	146.	154.	171.	188.	206	226.	234.	252.	290.	325.
OCT	231	117.	136.	162.	173.	183	203.	222.	243.	267.	279.	295.	339.	378.
NOV	165.	83	97	116.	124.	131.	146.	160	175.	192.	202.	213.	245.	274.
DEC	95	27.	35.	50.	56.	62.	73.	85.	99.	115.	124.	135.	168.	198.
ANN	1733.	1241.	1396	1459.	1507.	1551.	1634.	1713.	1796.	1886.	1938.	1996.	2156.	2293.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.015	.034	.074	.050	.046	.032	.033	.051	.040	.036	.048	.033	.017
R	1.90	1.93	5.87	10.83	19.67	4.21	4.81	6.48	7.78	8.28	8.01	7.12	29.10
LNGAM	-.1	-.0	5.1	14.7	38.4	7.1	2.9	5.6	8.1	9.1	8.5	.8	68.2

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.21 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION, IN MM.

STATION NAME LA SEVERA ANTIOQUIA SER. NO. 40932
LAT. 6 15. LONG. 75 26. ELEV. 2218. YEARS OF DATA 10

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	55.	10.	15.	23.	27.	30.	38.	46.	56.	67.	74.	83.	107.	131.
FEB	64.	12.	17.	27.	31.	35.	44.	54.	65.	76.	86.	96.	124.	151.
MAR	109.	36.	47.	62.	68.	74.	87.	99.	113.	129.	139.	150.	182.	212.
APR	172.	84.	99.	118.	127.	135.	150.	165.	181.	199.	209.	222.	256.	287.
MAY	201.	145.	156.	170.	175.	180.	190.	199.	208.	219.	224.	231.	249.	265.
JUN	120.	49.	60.	75.	82.	88.	100.	113.	126.	141.	150.	161.	191.	218.
JUL	125.	51.	67.	79.	85.	92.	105.	117.	131.	147.	156.	167.	198.	226.
AUG	119.	53.	64.	78.	84.	90.	101.	112.	124.	138.	146.	155.	181.	204.
SEP	162.	92.	105.	121.	128.	134.	146.	157.	170.	183.	191.	200.	225.	248.
OCT	203.	115.	131.	151.	160.	168.	182.	197.	217.	229.	239.	251.	282.	310.
NOV	182.	117.	129.	145.	151.	157.	168.	179.	190	202.	209.	218.	240.	260.
DEC	103.	35.	45.	58.	64.	70.	82.	94.	107.	123.	133.	143.	175.	204.
ANN	1614.	1230.	1306.	1403.	1441.	1476.	1540.	1602.	1665.	1734.	1774.	1818.	1939.	2042.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.035	.032	.026	.040	.149	.084	.042	.059	.071	.056	.095	.036	.026
R	2.00	2.02	3.49	7.55	29.98	5.23	5.31	6.42	11.55	11.43	17.28	3.70	42.55
LNGAM	.0	.0	1.7	7.6	71.2	5.5	3.7	5.5	16.8	16.1	31.5	1.4	116.1

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.22 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION, IN MM.

STATION NAME LOS TRONCOS ANTIOQUIA SER. NO. 41010
LAT. 6 3. LONG. 75 29. ELEV. 2220. YEARS OF DATA 10

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	99.	16.	24.	37.	43.	49.	62.	75.	90.	108.	119.	132.	171.	208.
FEB	102.	18.	27.	42.	49.	56.	70.	86.	103.	124.	137.	153.	199.	243.
MAR	139.	82.	93.	106.	111.	116.	126.	135.	145.	156.	162.	169.	189.	207.
APR	209.	157.	167.	180.	185	190.	198.	207.	215.	225.	230.	236.	252.	266.
MAY	249.	144.	163.	188.	198.	207.	225.	243.	261.	282.	294.	307.	345.	379.
JUN	156.	74.	84.	106.	114	121.	135.	148.	163.	180.	190.	201.	233.	261.
JUL	161.	55.	70.	92.	102.	111.	129.	147.	168.	191.	205.	222.	268.	312.
AUG	147.	78.	90.	106.	112.	118.	130.	142.	154.	168.	176.	185.	211.	234.
SEP	201.	131.	145.	162.	168.	175.	186.	198.	210.	223.	231.	239.	263.	284.
OCT	250.	156.	173.	196	205.	213.	229.	245.	261.	279.	289.	301.	333.	361.
NOV	209.	120.	136.	157.	166.	174.	188	203.	219.	236.	246.	258.	290.	318.
DEC	131.	47.	59	77.	84.	92.	106.	121.	137.	155.	166.	179.	216.	249.
ANN	2042.	1522.	1707	1814.	1856	1893.	1963.	2030.	2099.	2173.	2216.	2263.	2392.	2501.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.023	.019	.096	.187	.089	.047	.025	.063	.093	.063	.057	.033	.028
R	2.07	1.98	13.95	38.93	11.96	7.24	3.99	9.31	18.66	15.91	11.99	4.27	58.18
LNGAM	.0	-.0	20.6	102.7	17.0	7.0	1.8	11.3	35.8	27.9	17.2	7.1	177.1

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.23 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION, IN MM.

STATION NAME EL CHUSCAL ANTIOQUIA SER. NO. 41011
LAT. 6 3. LONG. 75 26. ELEV. 2310. YEARS OF DATA 10

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	71.	22.	29.	38.	43.	47.	55.	64.	73.	85.	91.	99.	121.	142.
FEB	81.	10.	16.	25.	34.	39.	51.	65.	80.	99.	111.	126.	168.	210.
MAR	117.	75.	82.	91.	95.	98.	104.	110.	116.	123.	127.	132.	144.	155.
APR	189.	137.	147.	160.	165.	170.	178.	187.	195.	205.	210.	216.	233.	247.
MAY	242.	146.	167.	186.	195.	204.	220.	236.	253.	271.	282.	294.	328.	357.
JUN	163.	84.	94.	116.	123.	130.	144.	157.	171.	187.	196.	207.	237.	263.
JUL	155.	64.	74.	98.	107.	115.	130.	146.	162.	182.	193.	206.	243.	277.
AUG	165.	111.	121.	134.	140.	145.	154.	163.	172.	182.	188.	194.	212.	228.
SEP	183.	143.	151.	161.	165.	169.	176.	182.	189.	196.	200.	204.	217.	227.
OCT	229.	170.	182.	196.	202.	208.	217.	227.	236.	247.	253.	260.	279.	295.
NOV	192.	94.	114.	136.	145.	153.	169.	184.	201.	220.	231.	243.	279.	310.
DEC	124.	43.	55.	72.	79.	86.	100.	114.	129.	147.	158.	170.	206.	239.
ANN	1905.	1539.	1614.	170 .	1744.	1777.	1838.	1896.	1955.	2020.	2057.	2098.	2209.	2303.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.049	.019	.187	.167	.058	.054	.036	.129	.278	.159	.045	.033	.035
R	3.46	1.54	20.87	31.49	13.92	8.78	5.51	21.29	50.94	36.35	8.69	4.10	67.03
LNGAM	1.2	-.1	81.9	76.4	22.3	10.1	4.0	43.2	148.3	93.4	9.8	1.9	213.7

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.24 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION, IN MM.

STATION NAME LAS PALMAS ANTIOQUIA SER. NO. 41013
LAT. 6 4. LONG. 75 29. ELEV. 2220. YEARS OF DATA 10

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	53.	12.	17.	24.	28.	31.	38.	46.	54.	64.	70.	77.	98.	117.
FEB	119.	8.	15.	30.	38.	46.	64.	85.	111.	144.	164.	189.	267.	344.
MAR	111.	50.	59.	73.	79.	84.	95.	106.	117.	130.	137.	146.	171.	194.
APR	185.	103.	118.	137.	145.	152.	166.	180.	194.	210.	219.	230.	260.	286.
MAY	240.	141.	159	182.	192.	201.	217.	234.	251.	270.	281.	294.	329.	360.
JUN	131.	45.	58.	76.	84.	91.	105.	120.	137.	156.	167.	180.	218.	252.
JUL	127.	44.	56.	73.	81.	88.	102.	117.	132.	151.	162.	175.	211.	245.
AUG	124.	62.	73.	87.	92.	98.	109.	119.	130.	142.	149.	158.	181.	202.
SEP	184.	119.	131.	147.	153.	159.	170.	181.	191.	204.	211.	219.	241.	260.
OCT	222.	136.	157	172.	181.	188.	203.	217.	232.	249.	258.	269.	299.	326.
NOV	200.	106.	122.	144.	153.	161.	177.	193.	209.	228.	239.	251.	286.	317.
DEC	133.	40.	52.	71.	79.	88.	103.	120.	138.	160.	172.	187.	231.	271.
ANN	1829.	1440.	1518	1617.	1655.	1690.	1755.	1817.	1880.	1950.	1989.	2033.	2152.	2254.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.045	.009	.056	.058	.053	.031	.032	.067	.100	.065	.047	.025	.030
R	2.43	1.10	6.24	10.82	12.70	4.09	4.07	8.22	18.36	14.53	9.47	3.33	54.33
LNGAM	.7	-.1	5.7	14.7	19.7	1.9	1.9	9.0	34.5	23.9	11.6	1.0	161.6

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.25 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME VASCONIA ANTIOQUIA SER. NO. 41015
LAT. 6 12. LONG. 75 27. ELEV. 2555. YEARS OF DATA 10

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	70.	11.	17.	27.	32.	36.	46.	57.	70.	85.	94.	105.	139.	171.
FEB	99.	22.	31.	46.	53.	59.	77.	86.	107.	120.	131.	145.	184.	220.
MAR	148.	65.	79.	97.	104.	112.	126.	140.	155.	173.	183.	195.	229.	259.
APR	218.	137.	152.	172.	179.	187.	200.	214.	227.	243.	252.	262.	290.	314.
MAY	274.	179.	196.	220.	229.	237.	253.	269.	285.	303.	314.	325.	358.	386.
JUN	146.	88.	98.	112.	114.	123.	133.	143.	153.	164.	171.	178.	199.	217.
JUL	145.	68.	82.	82.	91.	99.	116.	133.	151.	173.	186.	201.	245.	285.
AUG	192.	51.	65.	84.	92.	100.	115.	131.	148.	168.	180.	193.	232.	268.
SEP	186.	105.	119.	138.	146.	153.	167.	180.	194.	210.	219.	230.	259.	285.
OCT	281.	128.	149.	184.	199.	213.	239.	266.	295.	328.	347.	369.	433.	490.
NOV	231.	130.	148.	172.	181.	190.	207.	224.	242.	262.	274.	287.	324.	356.
DEC	157.	48.	67.	85.	95.	104.	123.	142.	163.	188.	203.	221.	271.	318.
ANN	2097.	1709.	1777.	1830.	1874.	1922.	2003.	2082.	2167.	2250.	2299.	2356.	2508.	2638.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.026	.025	.141	.078	.068	.083	.026	.031	.060	.022	.048	.022	.021
P	1.80	2.46	6.05	16.16	18.64	17.63	3.80	4.38	11.16	6.17	11.03	3.40	49.69
LNGAM	-.1	.3	4.9	28.3	35.3	71.6	1.5	2.3	15.5	5.1	15.2	1.1	174.1

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.26 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME COL LA SALLE ANTIOQUIA SER. NO. 41017
LAT. 6 10. LONG. 75 38. ELEV. 2065. YEARS OF DATA 10

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	65.	24.	30.	39.	42.	46.	53.	60.	68.	77.	82.	88.	106.	122.
FEB	91.	35.	44.	56.	61.	66.	75.	85.	96.	108.	115.	123.	147.	169.
MAR	115.	53.	64.	81.	86.	91.	101.	111.	121.	132.	139.	146.	168.	187.
APR	227.	132.	149.	172.	181.	189.	205.	221.	238.	256.	267.	279.	313.	343.
MAY	239.	110.	131.	160.	172.	183.	205.	226.	250.	276.	292.	310.	360.	406.
JUN	166.	75.	91.	111.	119.	127.	142.	158.	174.	192.	203.	216.	251.	283.
JUL	182.	59.	77.	90.	99.	105.	119.	133.	149.	167.	177.	189.	228.	255.
AUG	144.	72.	88.	101.	108.	114.	126.	138.	151.	166.	176.	188.	211.	236.
SEP	183.	106.	120.	139.	146.	153.	166.	178.	192.	207.	216.	226.	253.	278.
OCT	233.	148.	161.	184.	193.	202.	219.	233.	253.	268.	279.	291.	324.	354.
NOV	223.	150.	168.	182.	189.	195.	207.	219.	232.	245.	253.	262.	286.	308.
DEC	137.	50.	62.	80.	87.	95.	108.	123.	138.	156.	166.	179.	213.	245.
ANN	1965.	1567.	1644.	1749.	1789.	1825.	1891.	1954.	2019.	2090.	2130.	2175.	2297.	2400.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.054	.053	.073	.054	.028	.040	.039	.057	.066	.058	.096	.036	.031
P	4.44	4.84	8.42	17.37	6.77	6.70	5.42	8.17	12.10	13.84	21.37	4.69	59.99
LNGAM	2.4	2.3	4.4	13.4	6.1	6.0	3.4	4.4	17.7	22.1	43.5	2.7	184.5

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.27 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME LA MACAPENA ANTIOQUIA SER. NO. 41021
LAT. 6 9. LONG. 75 20. ELEV. 2155. YEARS OF DATA 10

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	54.	12.	17.	25.	29.	32.	39.	47.	55.	65.	71.	78.	99.	119.
FEB	70.	16.	22.	33.	37.	42.	51.	61.	72.	85.	93.	102.	129.	155.
MAR	98.	44.	52.	64.	69.	74.	83.	93.	107.	114.	120.	128.	150.	169.
APR	162.	95.	107.	123.	129.	135.	147.	158.	169.	183.	190.	199.	223.	244.
MAY	244.	161.	177.	197.	205.	213.	227.	240.	254.	270.	279.	289.	317.	342.
JUN	179.	92.	107.	127.	135.	143.	157.	172.	187.	205.	215.	227.	259.	288.
JUL	191.	97.	113.	135.	144.	153.	169.	185.	202.	222.	233.	246.	283.	315.
AUG	180.	92.	107.	127.	136.	144.	158.	173.	189.	207.	217.	229.	262.	292.
SEP	215.	156.	168.	182.	188.	193.	203.	212.	222.	233.	239.	246.	264.	281.
OCT	233.	133.	151.	174.	184.	193.	210.	226.	244.	264.	275.	288.	324.	356.
NOV	173.	85.	99.	119.	128.	136.	150.	165.	181.	199.	209.	222.	255.	286.
DEC	95.	51.	59.	69.	73.	77.	84.	92.	99.	108.	113.	119.	135.	149.
ANN	1895.	1493.	1574.	1676.	1716.	1757.	1819.	1883.	1949.	2020.	2061.	2106.	2230.	2335.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.085	.036	.064	.077	.080	.049	.043	.048	.149	.049	.045	.105	.029
P	2.47	2.49	6.29	12.47	19.64	8.75	8.23	8.56	31.95	11.51	7.74	9.98	59.55
LNGAM	.1	.1	5.1	18.7	34.3	10.1	9.0	9.7	77.9	16.3	8.0	12.8	162.5

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.28 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME YOLOMBO ANTIOQUIA SER. NO. 41130
LAT. 6 36. LONG. 75 3. ELEV. 1540. YEARS OF DATA 13

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	52.	1.	2.	5.	4.	11.	18.	28.	41.	59.	71.	86.	136.	188.
FEB	115.	10.	17.	33.	40.	48.	66.	86.	110.	140.	159.	182.	251.	320.
MAR	41.	18.	26.	38.	43.	49.	59.	71.	83.	99.	108.	119.	151.	181.
APR	274.	128.	152.	186.	200.	213.	239.	264.	291.	323.	341.	362.	421.	475.
MAY	374.	160.	194.	241.	261.	280.	316.	353.	393.	438.	464.	495.	583.	662.
JUN	233.	83.	105.	137.	151.	164.	189.	215.	244.	277.	297.	319.	385.	445.
JUL	193.	80.	98.	123.	133.	143.	162.	182.	202.	226.	241.	257.	303.	345.
AUG	242.	143.	167.	199.	212.	224.	244.	271.	296.	324.	341.	360.	412.	460.
SEP	369.	178.	210.	253.	271.	288.	320.	353.	387.	426.	449.	476.	550.	616.
OCT	406.	148.	187.	241.	265.	287.	331.	376.	424.	481.	514.	553.	664.	766.
NOV	294.	121.	149.	187.	203.	219.	249.	279.	312.	350.	372.	398.	472.	538.
DEC	146.	75.	97.	103.	110.	116.	128.	140.	153.	167.	176.	185.	212.	236.
ANN	2829.	1451.	2074.	2772.	2368.	2455.	2619.	2779.	2945.	3130.	3236.	3356.	3687.	3975.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.012	.011	.030	.029	.015	.018	.029	.030	.020	.011	.018	.059	.007
P	.61	1.24	2.44	6.69	5.79	4.26	5.49	8.38	7.43	4.43	5.28	8.66	18.95
LNGAM	.4	-.1	.3	6.0	4.4	2.1	3.9	9.3	7.4	2.4	3.6	9.9	36.2

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.29 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME ARPTO OTU ANTIOQUIA SER. NO. 41150
LAT. 7 1 LONG. 70 44. ELEV. 610. YEARS OF DATA 9

PROBABILITY	95.	90.	80.	75.	70.	60	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	53.	2.	5.	11.	14.	18.	26	36.	48.	64.	74.	87.	126.	166.
FEB	50.	2.	5.	16.	13.	17.	24.	34.	45.	60.	69.	81.	117.	154.
MAR	79.	9.	15	27.	37.	38.	50.	63.	78.	97.	109.	123.	165.	206.
APR	251.	115.	177.	168.	181.	193.	216.	239.	264.	292.	309.	327.	381.	430.
MAY	295.	147.	170.	202	215.	224.	251.	274.	299.	327.	343.	362.	414.	461.
JUN	293.	147.	171.	202.	215.	227.	250.	271	297.	325.	340.	359.	410.	455.
JUL	269.	152.	177.	200	212.	222.	242.	261.	281.	304.	318.	333.	375.	412.
AUG	294.	139.	165.	201	216.	230	257.	283.	312.	345.	364.	386.	448.	504.
SEP	270.	167.	186.	210	220.	230.	247.	264.	282.	302.	313.	326.	362.	394.
OCT	356.	252.	277.	298.	308.	317	335	351.	369.	388.	399.	411.	445.	474.
NOV	253.	109.	131.	163.	177.	190.	214.	239.	265.	296.	314.	335.	396.	447.
DEC	125.	44.	56.	73	81.	88.	101.	115	131.	148.	159.	171.	206.	238.
ANN	2573.	1975.	2194.	2245.	2304	2358.	2458.	2554.	2652.	2760.	2821.	2890.	3077.	3237.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.017	.019	.019	.027	.030	.032	.042	.023	.056	.077	.023	.034	.017
R	.91	.93	1.57	6.67	5.69	8.93	11.35	6.94	15.08	27.45	5.82	4.25	44.71
LNGAM	.1	.0	-.1	6.0	10.0	10.5	15.9	6.5	25.4	62.7	4.5	2.1	174.7

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.30 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME ARPTO BARRANCA SANTANDER SER. NO. 41401
LAT. 7 0. LONG. 73 48. ELEV. 126. YEARS OF DATA 10

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	92.	0.	0.	1.	3.	5.	12.	24.	46.	91.	108.	143.	271.	416.
FEB	116.	15.	24.	41.	49.	57.	74.	93.	115.	142.	154.	179.	239.	297.
MAR	148.	57.	75.	101.	117.	123.	145.	167.	192.	221.	239.	258.	316.	370.
APR	306.	150.	176.	212.	226.	240.	264.	293.	321.	352.	371	392.	452.	506.
MAY	329.	225	245.	270.	280.	289.	306.	323.	340.	359.	370.	382.	416.	445.
JUN	294.	122	149.	184.	204.	219.	249.	273.	312.	349	371.	397.	469.	535.
JUL	191.	94.	109.	129.	137.	145.	160.	174.	190.	207.	217.	229.	261.	290.
AUG	244.	131.	153.	184.	196.	208.	231.	253.	277.	304.	320.	338.	389.	435.
SEP	313.	106.	136.	179.	198.	216.	251	287.	327.	373.	400.	432.	524.	609.
OCT	412.	227.	255.	293.	317.	334.	366.	398.	432.	470.	492.	518.	588.	651.
NOV	304.	176	199.	229.	242.	253.	275.	296.	318.	344.	358.	375.	421.	461.
DEC	99.	30.	34.	51.	56.	61.	71.	81.	92.	106.	113.	122.	149.	173.
ANN	2897.	2185.	2324.	2501.	2570.	2634.	2751.	2863.	2979.	3106.	3178.	3259.	3480.	3669.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.003	.014	.019	.025	.073	.018	.050	.030	.013	.024	.040	.044	.018
R	.31	1.59	3.50	7.74	23.74	5.34	6.97	7.93	3.95	9.75	12.04	3.93	40.71
LNGAM	1.0	-.1	1.2	8.0	50.9	3.8	10.5	8.4	1.7	12.2	17.6	1.7	104.2

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.31 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME LAS VEGAS SANTANDER SER. NO. 41958
LAT. 7 16. LONG. 73 7. ELEV. 1100. YEARS OF DATA 13

PROBABILITY	95.	90.	80.	75.	70.	60	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	93.	30.	39.	52.	58.	63.	74.	85.	97.	111.	119.	129.	158.	184.
FEB	99.	17.	25.	40.	46.	53.	67.	82.	98.	119.	131.	146.	190.	233.
MAR	113.	16.	26	42.	50.	58.	74.	92.	113.	139.	154.	173.	228.	282.
APR	152.	27.	40	62.	73.	83.	104.	127.	154.	186.	205.	228.	297.	362.
MAY	147.	86.	102.	124.	133.	142.	159.	174.	191.	211.	223.	236.	274.	307.
JUN	111.	66.	74.	85.	89.	93.	101.	108.	116.	125.	130.	136.	152.	166.
JUL	76.	19.	25.	36.	41.	46.	55.	66.	78.	92.	101.	111.	140.	168.
AUG	84.	32.	40.	51.	56.	60.	69.	79.	88.	100.	107.	.14.	137.	157.
SEP	90.	29.	38.	51.	56.	61.	72	82.	94.	104.	114.	125.	153.	178.
OCT	196.	93.	110.	131.	143.	152.	170.	187.	206.	227.	239.	253.	294.	330.
NOV	212.	90	110.	137.	148.	159.	179.	200.	223.	248.	263.	281.	331.	376.
DEC	100.	19.	29.	43.	50.	56.	70.	85.	101.	122.	134.	148.	191.	232.
ANN	1508.	1029.	1120	1238.	1285.	1328.	1408.	1486.	1567.	1657.	1703.	1766.	1925.	2064.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.040	.026	.015	.013	.039	.118	.033	.055	.042	.037	.027	.021	.015
R	3.71	1.96	1.72	1.98	7.15	13.06	2.52	4.66	3.75	7.19	5.76	2.13	22.73
LNGAM	1.4	-.0	-.1	-.0	6.4	20.1	.3	2.7	1.5	6.9	4.4	.1	47.6

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.32 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME ARPTO B-MANGA SANTANDER SER. NO. 41925
LAT. 7 6. LONG. 73 12. ELEV. 931. YEARS OF DATA 10

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	70.	0.	1.	4.	5.	7.	12.	17.	25.	35.	42.	50.	77.	105.
FEB	71.	16.	23.	33.	38.	43.	53.	63.	75.	89.	97.	107.	136.	164.
MAR	59.	0.	1.	3.	4.	7.	13.	23.	38.	60.	76.	96.	164.	238.
APR	70.	6.	11.	21.	25.	30.	41.	53.	67.	85.	96.	110.	151.	191.
MAY	95.	41.	49.	61.	66.	71.	80.	90.	100.	111.	118.	126.	148.	169.
JUN	89.	33.	41.	53.	58.	63.	72.	82.	92.	104.	111.	119.	143.	164.
JUL	68.	20.	26.	36.	40.	45.	53.	61.	71.	82.	88.	96.	119.	139.
AUG	47.	30.	38.	50.	55.	60.	70.	80.	91.	103.	111.	120.	145.	168.
SEP	67.	26.	33.	41.	45.	49.	56.	63.	70.	79.	84.	90.	107.	122.
OCT	98.	10.	18	31.	34.	45.	59.	76.	95.	119.	134.	152.	206.	259.
NOV	94.	13.	21.	35.	41.	48.	61.	76.	93.	118.	127.	143.	189.	234.
DEC	49.	3.	6.	12.	15.	18.	26.	34.	45.	58.	66.	76.	108.	139.
ANN	876.	454.	576.	623.	663.	701.	772.	843.	918.	1003.	1053.	1110.	1268.	1410.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.022	.033	.007	.019	.060	.052	.048	.046	.075	.015	.018	.023	.010
R	.67	2.39	.44	1.30	5.75	4.58	3.26	4.00	5.05	1.47	1.70	1.09	8.83
LNGAM	.3	.2	.7	-.1	4.4	7.6	1.0	1.8	3.7	-.1	-.1	-.0	10.3

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.33 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION, IN MM.

STATION NAME RELEN DE U CALDAS SER. NO. SC125
LAT. 5 11. LONG. 75 49. ELEV. 1360. YEARS OF DATA 9

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	104.	36.	46.	60	67.	72.	84.	96.	109.	124.	133.	143.	173.	200.
FEB	91.	33.	41.	54.	59.	64.	74.	84.	95.	104.	116.	124.	150.	173.
MAR	159.	100.	111.	125.	131.	136.	146.	156.	166.	177.	183.	191.	211.	228.
APR	221.	128.	144.	166.	175.	183.	199.	215.	231.	249.	259.	272.	305.	334.
MAY	233.	139.	156.	174.	187.	196.	211.	227.	243.	262.	277.	284.	318.	347.
JUN	234.	75.	97.	130.	144.	158	185.	213.	243.	279.	300.	325.	397.	463.
JUL	174.	56.	73.	98.	109.	119	140.	162.	185.	213.	229.	248.	304.	355.
AUG	123.	20.	31.	49.	58.	67.	86.	106.	130.	158.	175.	196.	259.	318.
SEP	165.	89.	107.	120.	127.	134.	146.	159.	173.	188.	196.	207.	235.	260.
OCT	251.	106.	124.	161.	174.	187.	211.	236.	263.	294.	312.	332.	391.	445.
NOV	220.	135.	151.	171.	179.	187.	201.	215.	229	246.	255.	266.	295.	321.
DEC	145.	51.	64.	95.	107.	118.	141.	165	191.	222.	241.	263.	326.	386.
ANN	2150.	1411.	1552.	1736.	1810.	1878.	2005.	2129.	2258.	2401.	2483.	2577.	2834.	3058.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.039	.047	.103	.055	.057	.016	.020	.014	.060	.023	.068	.016	.009
R	4.11	4.31	16.33	12.07	13.24	3.67	3.59	1.79	9.83	5.68	14.93	3.05	18.51
LNGAM	1.9	2.2	28.*	17.7	20.7	1.4	1.3	-.1	17.4	4.2	25.0	.7	35.0

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.34 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION, IN MM.

STATION NAME ARPTO MANIZALES CALDAS SER. NO. SC213
LAT. 5 5. LONG. 75 40. ELEV. 1050. YEARS OF DATA 8

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	106.	7.	14.	27.	34.	42.	59.	77.	99.	128.	146.	168.	216.	303.
FEB	96.	5.	10.	21.	27.	34.	49.	66	84.	115.	132.	154.	220.	286.
MAR	119.	50.	60.	74.	80.	86.	97.	108.	119.	132.	140.	149.	175.	198.
APR	215.	101.	120.	146.	157.	167.	196.	205.	226.	249.	263.	279.	323.	363.
MAY	239.	148.	165.	187.	195.	204.	219.	234.	249.	267.	277.	288.	319.	347.
JUN	183.	60.	78.	103.	114.	125.	146.	168.	191.	219.	235.	254.	310.	361.
JUL	132.	22.	33.	52.	61.	70.	89.	109.	133	161.	178.	199.	260.	319.
AUG	139.	39.	77.	99.	97.	104.	117.	131.	146.	163.	173.	185.	218.	247.
SEP	183.	53.	70.	96.	104.	119	141.	165.	190.	220.	238	260.	321.	378.
OCT	241.	110.	132.	161.	173.	185.	207	229	253	280.	296	315.	366.	413.
NOV	143.	21.	39	60.	70.	79.	99	121.	145.	174.	192.	213.	276.	336.
DEC	151.	42.	57.	79	88.	97.	116.	135.	156.	182.	197	214.	266.	313.
ANN	1947.	1068.	1221.	1425.	1509.	1587.	1734.	1880	2034.	2207.	2307.	2422.	2747.	3027.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.011	.010	.059	.033	.029	.021	.014	.041	.017	.027	.014	.021	.005
R	1.13	1.00	6.15	7.08	15.40	3.79	1.99	5.69	3.20	6.67	2.06	3.11	10.39
LNGAM	-.1	.0	5.1	6.7	26.9	1.5	-.0	4.3	.9	5.9	.0	.8	13.7

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.35 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION, IN MM.

STATION NAME SALAMINA CALDAS SER. NO. SC350
LAT. 5 25. LONG. 75 30. ELEV. 1500. YEARS OF DATA 8

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	84.	27	35.	46.	52.	57.	66.	77.	88.	101.	109.	118.	144.	168.
FEB	111.	25.	35.	51.	59.	66.	81.	96.	114.	135.	148.	163.	207.	249.
MAR	122.	53.	64.	79.	86.	92.	103.	115.	128.	143.	151.	161.	189.	215.
APR	222.	165.	176.	191.	196.	202.	211.	220.	230.	240.	246.	253.	271.	287.
MAY	215.	121.	138	160.	169.	177.	193.	209.	225.	243.	254.	266.	300.	330.
JUN	176.	51.	63.	79.	86.	93.	105.	118.	132.	148.	154.	169.	200.	228.
JUL	96.	13.	20	34.	41.	48.	62.	77.	95.	118.	132.	148.	197.	245.
AUG	84.	21.	29.	42.	48.	53.	65	77.	91.	107.	116.	126.	162.	193.
SEP	133.	84	57.	75.	83.	91.	106.	122.	139.	158.	170.	184.	223.	259.
OCT	219.	146.	160.	178.	185.	192.	204.	216.	228.	242.	250.	259.	283.	305.
NOV	204.	130.	144.	162.	169.	175.	189.	200.	217.	226.	234.	244.	269.	291.
DEC	117.	25.	35	53.	60.	68.	84.	101.	120.	143.	156.	173.	221.	266.
ANN	1739.	1402.	1471	1557.	1590.	1621.	1677.	1730.	1785.	1845.	1878.	1916.	2019.	2106.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.042	.022	.048	.161	.052	.042	.017	.029	.029	.094	.094	.020	.038
R	3.59	2.42	5.89	35.82	11.25	5.27	1.61	2.57	3.89	23.49	17.10	2.30	51.88
LNGAM	1.3	.2	4.5	91.5	15.7	3.6	-.1	.3	1.7	41.1	31.0	.2	208.8

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.36 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION, IN MM.

STATION NAME ARPTO ARMENIA CALDAS SER. NO. SC425
LAT. 4 31. LONG. 75 46. ELEV. 1480. YEARS OF DATA 9

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	40.	8.	14.	26.	31.	37.	49.	62.	78.	98.	110.	125.	170.	214.
FEB	71.	14.	21.	31.	36.	41.	50.	60.	72.	86.	94.	104.	133.	161.
MAR	121.	27.	39.	56.	64.	72.	88.	105	124.	147.	160.	177.	224.	269.
APR	213.	111.	134.	152.	162.	171.	184.	205.	224.	244.	256.	270.	308.	343.
MAY	170.	30.	44.	69.	81.	93.	116.	142.	172.	207.	224.	255.	332.	405.
JUN	128.	29.	41.	60.	68.	77.	93.	111.	131.	155.	169.	186.	236.	283.
JUL	64.	14.	20.	30.	34.	38.	46.	55.	65.	77.	84.	93.	118.	142.
AUG	60.	15.	21.	29.	33.	37.	45.	53.	62.	73.	80.	87.	110.	131.
SEP	118	18.	28	45.	53.	62.	74.	97.	118.	144.	160.	178.	235.	289.
OCT	250	101.	124.	156.	170.	183.	209.	234.	262.	294.	313.	335.	397.	454.
NOV	181.	87.	103	124.	133.	141.	157.	173.	190.	209.	220.	233.	269.	301.
DEC	152.	70.	84.	102.	110.	117.	131.	145.	160.	177.	187.	198.	231.	260.
ANN	1609.	1073.	1131.	1273.	1330.	1382.	1480.	1576.	1676.	1787.	1851.	1924.	2125.	2300.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.014	.032	.070	.042	.012	.020	.039	.045	.015	.021	.041	.044	.011
R	1.41	2.26	2.45	8.93	1.97	2.50	2.46	2.69	1.80	5.18	7.49	6.74	16.91
LNGAM	-.1	.1	.2	10.4	-.0	.3	.3	.4	-.1	3.4	7.5	6.1	30.4

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.37 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME QUIMBAYA CALDAS SER. NO. 50495
LAT. 4 37. LONG. 75 45. ELEV. 1400. YEARS OF DATA 10

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	92.	33.	41.	54.	59.	65.	75.	85.	97.	110.	118.	127.	153.	177.
FEB	109.	32.	42.	58.	65.	71.	84.	98.	113.	131.	142.	154.	190.	223.
MAR	167.	81.	95.	114.	122.	130.	145.	159.	175.	192.	203.	214.	248.	278.
APR	249.	126.	147.	175.	187.	198.	219.	239.	261.	287.	301.	318.	365.	407.
MAY	235.	101.	172.	152.	164.	176.	199.	222.	246.	275.	291.	311.	365.	415.
JUN	155.	73.	97.	105.	113.	120.	134.	148.	163.	180.	190.	201.	233.	262.
JUL	116.	22.	33.	50.	58.	66.	82.	94.	118.	142.	156.	173.	223.	271.
AUG	126.	56.	67.	83.	89.	95.	107.	119.	132.	146.	155.	165.	193.	218.
SEP	147.	57.	71.	90.	98.	106.	122.	137.	154.	173.	185.	198.	236.	270.
OCT	259.	136.	157.	186.	198.	208.	229.	250.	272.	296.	311.	327.	373.	414.
NOV	286.	85.	117.	153.	170.	188	222.	253.	297.	343.	371.	403.	497.	584.
DEC	153.	52.	66	87.	96.	105.	123.	140.	160.	183.	196.	212.	257.	299.
ANN	2095.	1366.	1502.	1680.	1751.	1816.	1939	2058.	2187.	2320.	2399.	2489.	2736.	2952.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.045	.030	.045	.033	.025	.046	.014	.050	.033	.035	.012	.025	.009
R	4.19	3.26	7.48	8.29	5.41	7.10	2.12	6.28	4.91	9.19	3.31	3.91	18.65
LNGAM	2.0	1.0	7.5	9.1	4.5	6.9	.1	5.3	3.0	11.0	1.0	1.7	35.4

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.38 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME PEREIRA CALDAS SER. NO. 50493
LAT. 4 48. LONG. 75 45. ELEV. 1342 YEARS OF DATA 10

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	122.	59.	69.	84.	90.	95.	106.	117.	124.	141.	149.	158.	182.	204.
FEB	132.	53.	66.	83.	90.	97.	110.	124.	138.	155.	165.	176.	209.	238.
MAR	151.	73.	86.	104.	111.	118.	131.	144.	158.	174.	183.	194.	224.	251.
APR	244.	128.	148.	176.	187.	198.	213.	234.	260.	284.	298.	314.	360.	400.
MAY	260.	146.	166.	193.	204.	214.	233.	252.	272.	295.	308.	323.	365.	401.
JUN	159.	62.	77.	98.	106.	115.	131	148.	166.	187.	199.	214.	255.	292.
JUL	117.	28.	38.	56.	63.	71.	86.	102	120.	142.	155.	170.	215.	257.
AUG	117.	40.	51.	66.	73.	79.	91	103.	117.	132.	141.	152.	183.	211.
SEP	109.	27.	37.	53.	60.	67.	81.	96.	113.	137.	144.	158.	198.	236.
OCT	262.	95.	120.	155.	171.	185.	213.	242.	274.	310.	332.	357.	429.	495.
NOV	248.	162.	178.	199.	207.	215.	229.	243.	258	274.	283.	294.	323.	348.
DEC	191.	93.	104.	131.	141.	149.	166.	183.	200.	220.	237.	246.	284.	318.
ANN	2110.	1659.	1760.	1964.	1904.	1950.	2075.	2097.	2171.	2251.	2297.	2348.	2487.	2606.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.060	.040	.050	.035	.042	.031	.022	.039	.025	.017	.077	.040	.025
R	7.39	5.26	7.57	8.70	10.95	4.91	2.45	4.37	2.71	4.40	18.47	7.55	53.58
LNGAM	7.3	3.6	7.7	10.0	15.0	3.0	.3	2.3	.4	2.3	36.3	7.6	154.6

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.39 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME EL PASO TOLIMA SER. NO. 50525
LAT. 4 31. LONG. 75 31. ELEV. 1264. YEARS OF DATA 10

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	103.	27.	37.	52.	58.	65.	78.	92.	107.	125.	136.	148.	185.	220.
FEB	80.	25.	32.	43.	48.	53.	63.	72.	83.	96.	103.	112.	137.	161.
MAR	133.	50.	62.	80.	88.	95.	109.	124.	139.	158.	168.	181.	217.	250.
APR	159.	77.	91.	109.	117.	124.	138.	152.	166.	183.	193.	204.	235.	263.
MAY	197.	118.	132.	151.	159.	166.	179.	192.	205.	221.	229.	239.	267.	292.
JUN	149.	46.	61.	82.	91.	100.	117.	135.	155.	178.	192.	208.	255.	299.
JUL	129.	50.	62.	79.	87.	94.	107.	121.	136.	153.	163.	174.	208.	238.
AUG	82.	32.	40.	50.	55.	59.	68.	77.	86.	97.	104.	111.	133.	152.
SEP	75.	29.	36.	46.	50.	54.	62.	70	78.	88.	94.	100.	119.	137.
OCT	224.	50.	71.	103.	118.	133.	163.	194.	230.	272.	297.	328.	416.	500.
NOV	247.	70.	94.	129.	145.	160.	190.	222.	257.	298.	322.	351.	435.	512.
DEC	217.	63.	85.	120.	135.	150.	180.	211.	245.	287.	311.	340.	424.	503.
ANN	1816.	1102.	1232.	1403.	1472.	1535.	1655.	1773.	1896.	2028.	2113.	2204.	2454.	2674.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.024	.044	.034	.048	.059	.024	.038	.059	.067	.011	.013	.012	.008
R	2.85	3.48	4.55	7.66	13.63	3.52	4.89	4.84	5.00	2.49	3.15	2.91	14.19
LNGAM	.6	1.2	2.5	7.8	21.6	1.2	3.0	2.9	3.2	.2	.8	.6	23.0

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.40 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME LA LEONERA VALLE SER. NO. 50610
LAT. 3 27. LONG. 76 36. ELEV. 1800. YEARS OF DATA 17

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	72.	24.	30.	40.	45.	49.	57.	65.	75.	85.	92.	99.	121.	141.
FEB	65.	12.	18.	27.	32.	36.	45.	55.	66.	79.	87.	97.	125.	152.
MAR	105.	54.	63.	75.	80.	84.	93.	101.	111.	121.	127.	134.	153.	170.
APR	162.	95.	107.	123.	130.	136.	147.	158.	170.	183.	190.	199.	222.	243.
MAY	200.	110.	126.	147.	155.	163.	178.	193.	209.	227.	237.	249.	281.	310.
JUN	111.	23.	33.	50.	57.	64.	79.	95.	113.	134.	147.	163.	208.	250.
JUL	63.	18.	24.	33.	37.	41.	48.	56.	65.	75.	82.	89.	110.	129.
AUG	67.	12.	18.	27	31.	35.	44.	53.	63.	75.	83.	92.	118.	143.
SEP	72.	21.	28.	38.	43.	47.	56.	65.	75.	86.	93.	102.	125.	147.
OCT	147.	105.	113.	124.	128.	132.	139.	145.	152.	160.	164.	169.	183.	194.
NOV	116.	30.	41.	58.	65.	72.	87.	102.	120.	140.	152.	166.	208.	248.
DEC	90.	54.	61.	69.	73.	76.	82.	88.	94.	100.	104.	109.	121.	132.
ANN	1764.	991.	1046.	1115.	1147.	1167.	1212.	1256.	1300.	1349.	1377.	1408.	1492.	1564.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.053	.032	.043	.078	.053	.021	.051	.035	.046	.198	.024	.159	.041
R	3.81	7.08	8.72	12.72	10.54	2.32	3.19	2.20	3.31	29.10	2.81	14.24	52.41
LNGAM	1.6	.0	10.0	19.3	14.0	.2	.9	.1	1.0	68.2	.5	23.2	154.0

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.41 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME PLANTA R CALI VALLE SER. NO. 50611
LAT. 3 27. LONG. 76 33. ELEV. 1080. YEARS OF DATA 16

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH MEAN						PRECIPITATION							
JAN	59.	19.	20.	28.	32.	36.	44.	52.	61.	71.	78.	85.	107.	128.
FEB	56.	7.	11.	19.	23.	27.	35.	44.	55.	64.	76.	86.	115.	144.
MAR	78.	26.	33.	44.	49.	53.	62.	71.	81.	92.	99.	107.	130.	152.
APR	123.	63.	73.	87.	93.	98.	108.	118.	128.	140.	147.	155.	178.	198.
MAY	124.	73.	82.	94.	99.	104.	112.	121.	130.	140.	146.	152.	170.	186.
JUN	77.	17.	24.	36.	41.	46.	56.	67.	79.	94.	103.	113.	144.	173.
JUL	37.	5.	9.	13.	16.	19.	24.	30.	37.	46.	51.	57.	77.	95.
AUG	40.	2.	5.	10.	17.	15.	21.	29.	38.	49.	56.	65.	92.	118.
SEP	65.	13.	18.	28.	32.	37.	46.	55.	66.	79.	87.	97.	125.	151.
OCT	116.	60.	70.	82.	88.	93.	102.	112.	121.	133.	139.	147.	168.	187.
NOV	103.	46.	55.	68.	73.	74.	88.	98.	108.	120.	127.	135.	158.	179.
DEC	82.	22.	30.	42.	47.	52.	62.	73.	85.	99.	107.	117.	146.	173.
ANN	960.	738.	782.	838.	860.	880.	917.	953.	989.	1029.	1052.	1078.	1147.	1206.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.045	.027	.050	.071	.107	.031	.083	.026	.033	.076	.061	.036	.087
P	2.66	1.52	3.89	8.74	12.71	2.41	1.62	1.07	2.14	8.85	6.93	2.95	87.24
LNGAM	.4	-.1	1.6	10.1	13.3	.2	-.1	-.0	.1	10.5	5.4	.6	176.2

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.42 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME EL SELENCIO VALLE SER. NO. 50612
LAT. 3 35 LONG. 76 37. ELEV. 1750. YEARS OF DATA 17

PROBABILITY	95.	90.	80	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH MEAN						PRECIPITATION							
JAN	111.	25.	36.	52.	59	67.	81.	97.	114.	135.	147.	162.	206.	247.
FEB	115.	23.	38.	51.	59.	66.	82.	99.	117.	140.	154.	170.	214.	264.
MAR	165.	60.	75	98.	107.	116.	138	153.	172.	195.	209.	225.	270.	312.
APR	217.	127.	139.	162	171.	179.	195	211.	227.	246.	257.	269.	303.	336.
MAY	228.	130.	149.	171.	180.	189.	205.	222.	239.	258.	269.	282.	317.	348.
JUN	130.	24.	36.	55.	64.	73.	91.	110.	132.	158.	175.	196.	251.	305.
JUL	63.	9.	18	23.	27.	32	41.	51.	63.	77.	86.	96.	127.	154.
AUG	71.	17.	24.	35.	39.	44.	54	64.	75	88	96	105	133.	159.
SEP	88.	25	37.	46.	52.	57.	68	79.	92.	106.	115.	125.	155.	183.
OCT	230.	140.	155.	179.	187	195	210.	225	240.	258.	264.	279.	310.	338.
NOV	234.	136.	153.	177	186.	195.	211.	228.	245.	264.	275.	288.	323.	354.
DEC	197.	55.	73	101	113.	125.	144	172.	199.	231.	250.	272.	337.	397.
ANN	1887.	1034	1313	1523.	1663.	1700.	1769	1834	1901	1975.	2017	2064.	2191.	2300.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.022	.019	.027	.052	.051	.016	.027	.036	.035	.027	.052	.016	.027
P	2.49	2.24	4.39	11.24	11.67	2.08	1.69	2.59	3.11	24.36	12.21	3.16	49.30
LNGAM	.1	1	2.3	15.7	16.5	.0	-.1	.4	.8	23.5	18.0	.8	141.8

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.43 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME YANACONES VALLE SER. NO. 50613
LAT. 3 25. LONG. 76 35. ELEV. 1600. YEARS OF DATA 17

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH MEAN						PRECIPITATION							
JAN	84.	19.	27.	39.	45.	50.	62.	73.	86.	102.	111.	123.	155.	186.
FEB	76.	14.	21.	32.	37.	42.	53.	64.	77.	93.	103.	114.	148.	181.
MAR	103.	37.	47.	61.	67.	73.	84.	95.	108.	122.	131.	141.	170.	196.
APR	168.	87.	100.	114.	125.	132.	145.	158.	172.	187.	196.	207.	235.	261.
MAY	175.	74.	95.	116.	125.	134.	150.	167.	184.	204.	216.	230.	268.	302.
JUN	128.	20.	31.	50.	59.	67.	85.	106.	129.	157.	176.	194.	255.	313.
JUL	49.	11.	16.	23.	26.	30.	36.	43.	51.	60.	66.	72.	92.	110.
AUG	50.	9.	13.	20.	24.	27.	34.	42.	50.	61.	67.	75.	98.	119.
SEP	70.	23.	30.	39.	44.	48.	55.	64.	73.	83.	89.	97.	117.	137.
OCT	154.	51.	65.	87.	96.	105.	127.	140.	160.	183.	197.	213.	259.	302.
NOV	132.	55.	67.	84.	91.	98.	111.	124.	138.	155.	164.	176.	207.	236.
DEC	96.	12.	20.	33.	40.	47.	61.	76.	95.	117.	131.	148.	198.	246.
ANN	1287.	769.	944.	1049.	1089.	1126.	1195.	1263.	1332.	1409.	1453.	1509.	1641.	1760.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.030	.026	.047	.057	.037	.044	.050	.039	.055	.025	.042	.016	.017
P	2.51	2.02	4.31	9.30	6.86	1.82	2.46	1.95	3.82	3.80	5.50	1.56	22.16
LNGAM	.3	.0	2.2	11.3	5.6	-.1	.3	-.0	1.6	1.6	4.0	-.1	45.9

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.44 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME CALIPUERTO VALLE SER. NO. 50615
LAT. 3 27. LONG. 76 24. ELEV. 956. YEARS OF DATA 10

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH MEAN						PRECIPITATION							
JAN	85.	37.	44.	55.	60.	64.	72.	81.	90.	100.	106.	113.	133.	151.
FEB	62.	20.	26.	34.	38.	42.	49.	56.	64.	74.	80.	86.	105.	123.
MAR	90.	20.	29.	41.	47.	53.	65.	78.	92.	109.	119.	131.	167.	201.
APR	157.	44.	53.	85.	95.	104.	123.	142.	163.	188.	203.	220.	270.	316.
MAY	132.	40.	53	71	80.	87.	101.	119.	137.	158.	170.	185.	227.	266.
JUN	63.	1.	3.	9.	13.	16.	26.	38.	53.	73.	87.	103.	156.	210.
JUL	38.	4.	7.	12.	15.	17.	23.	29.	37.	46.	52.	59.	81.	101.
AUG	24.	2.	4	7.	9	11.	14.	18.	23.	29.	33.	37.	51.	64.
SEP	46.	5.	8	14.	17.	21.	28.	35.	44.	56.	63.	72.	98.	123.
OCT	121.	36.	44.	65.	77.	80.	94.	109.	126.	146.	157.	171.	211.	247.
NOV	123	30	41	59.	67.	75.	91.	108.	127.	149.	167.	178.	224.	268.
DEC	106.	33	44.	58.	65.	71.	83.	96.	110.	127.	136.	148.	181.	211.
ANN	1046.	650	723.	818	856.	892.	958	1024.	1092.	1168.	1211.	1261.	1398.	1519.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.064	.059	.077	.022	.026	.012	.037	.057	.030	.027	.022	.034	.015
P	5.81	3.64	2.40	3.45	3.44	.74	1.39	1.36	1.37	3.31	2.65	3.60	14.45
LNGAM	4.5	1.4	.7	1.2	1.1	.2	-.1	-.1	-.1	1.0	.4	1.3	26.4

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.45 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME LA PLATA HUILA SER. NO. 51365
LAT. 2 27. LONG. 75 58. ELEV. 1350. YEARS OF DATA 8

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	175.	31.	47.	72.	84.	96.	121.	147.	177.	214.	236.	262.	341.	416.
FEB	135.	27.	39.	59.	68.	77.	95.	115.	137.	164.	180.	199.	256.	310.
MAR	202.	87.	105.	131.	142.	152.	171.	191.	212.	236.	250.	267.	313.	355.
APR	154.	82.	95.	113.	120.	127.	140.	153.	166.	182.	191.	201.	230.	255.
MAY	168.	51.	67.	91.	102.	112.	132.	152.	175.	202.	218.	236.	290.	340.
JUN	126.	62.	73.	88.	94.	99.	110.	121.	132.	145.	152	161.	185.	207.
JUL	76.	17.	24	36.	41.	46.	55.	66.	78.	92.	101.	111.	140.	168.
AUG	53.	14.	19.	26.	30.	33.	40.	47.	54.	64.	69.	76.	95.	112.
SEP	51.	22.	27.	31.	36.	38.	43.	48.	53.	59.	63.	67.	78.	89.
OCT	171.	71.	87.	109.	118.	127.	144.	161.	179.	201.	213.	228.	269.	306.
NOV	221.	101.	120	147.	159.	169.	190.	210.	232.	257.	272.	289.	337.	380.
DEC	198.	108.	124.	145.	157.	161.	177.	192.	208.	226.	236.	248.	282.	311.
ANN	1735.	1350.	1477.	1525.	1563	1598.	1667.	1723.	1780.	1856.	1895.	1939.	2058.	2160.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.011	.016	.029	.056	.020	.063	.033	.059	.119	.032	.050	.051	.029
R	2.01	2.19	5.91	8.86	3.44	7.97	2.50	2.82	6.07	5.48	6.58	10.07	49.46
LNGAM	.0	.1	4.6	10.3	1.1	8.5	.7	.5	4.9	3.9	5.8	13.0	147.5

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.46 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME LA PALMA CUNDINAMARCA SER. NO. 51920
LAT. 5 21. LONG. 74 24. ELEV. 1400. YEARS OF DATA 17

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	117.	29.	40.	57.	65.	72.	87.	103.	121.	147.	155.	170.	213.	255.
FEB	125.	3.	8.	19.	27.	35.	53.	77.	107.	147.	172.	204.	306.	410.
MAR	204.	93.	111.	136.	146.	156.	175.	194.	214.	237.	251.	266.	311.	350.
APR	287.	156.	179.	210.	222.	234.	256.	278.	301.	327.	342.	359.	407.	450.
MAY	245.	109.	130.	161.	174.	186.	209.	232.	257.	285.	302.	321.	376.	425.
JUN	174.	45.	61.	87.	99.	110.	137.	156.	183.	215.	234.	256.	321.	383.
JUL	133.	55.	67.	84.	91.	98.	111.	125.	139.	156.	166.	177.	209.	239.
AUG	115.	34.	45.	61.	68.	75.	89.	104.	120.	138.	150.	163.	201.	236.
SEP	186.	73.	90.	115.	125.	135.	158.	174.	195.	219.	233.	250.	297.	340.
OCT	278.	122.	147.	182.	196.	210.	236.	263.	291.	324.	343.	365.	428.	485.
NOV	229.	78.	99.	131.	145.	158.	184.	210.	239.	273.	293.	316.	383.	445.
DEC	140.	58.	71.	89	96.	104.	117.	131.	146.	164.	174.	186.	219.	250.
ANN	2236.	1525.	1661.	1835.	1905.	1969.	2089.	2203.	2324.	2456.	2542.	2618.	2854.	3058.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.023	.006	.017	.035	.025	.015	.041	.028	.027	.022	.017	.039	.010
R	2.67	.77	6.57	10.12	6.23	2.74	5.39	3.27	5.01	6.10	3.97	5.50	22.79
LNGAM	.4	.2	5.8	13.1	5.2	.5	3.8	1.0	3.2	5.0	1.8	4.0	47.8

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.47 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME GUADUAS CUNDINAMARCA SER. NO. 51955
LAT. 5 4. LONG. 74 36. ELEV. 1000. YEARS OF DATA 17

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	53.	18.	23	30.	34.	37.	43.	49.	56.	64.	68.	74.	90.	104.
FEB	77.	20.	28.	39.	44.	49.	58.	68.	79.	93.	101.	110.	137.	162.
MAR	147.	65.	74.	95.	102.	109.	122.	135.	149.	165.	174.	185.	215.	242.
APR	203.	100.	117.	141.	150.	160.	177.	194.	213.	234.	246.	260.	299.	335.
MAY	166.	79.	94.	113.	122.	129.	144.	159.	174.	192.	203.	215.	248.	279.
JUN	49.	3.	8.	18.	24.	30.	45.	64.	86.	116.	135.	159.	233.	308.
JUL	30.	1.	1.	4.	6.	7.	12.	18.	25.	35.	41.	49.	75.	102.
AUG	18.	1.	2.	6.	8.	11.	16.	23.	32.	44.	52.	62.	93.	124.
SEP	106.	41.	50.	64.	70.	76.	87.	98.	111.	125.	133.	143.	171.	196.
OCT	230.	107.	127.	155.	167.	177.	198.	219.	241.	266.	281.	298.	346.	389.
NOV	174.	71.	88.	111.	121.	130.	148.	166.	186.	209.	222.	238.	282.	323.
DEC	99.	24.	33.	47.	54.	60.	73.	86.	101.	119.	130.	142.	179.	214.
ANN	1418.	1002.	1087.	1185.	1226.	1264.	1333.	1401.	1470.	1547.	1591.	1641.	1777.	1894.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.073	.038	.047	.039	.044	.009	.023	.021	.045	.030	.029	.027	.019
R	3.89	2.92	6.77	7.85	7.30	.87	.70	.78	4.78	6.94	5.17	2.64	27.07
LNGAM	1.7	.6	6.1	9.2	7.1	.1	.3	.2	2.9	6.5	3.4	.4	61.5

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.48 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME LA MESA CUNDINAMARCA SER. NO. 52015
LAT. 4 34. LONG. 74 28. ELEV. 1300. YEARS OF DATA 15

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION											
JAN	66.	6.	11.	20.	25.	29.	39.	51.	64.	81.	91.	104.	142.	179.
FEB	81.	8.	14.	25.	31.	36.	49.	62.	78.	99.	111.	126.	173.	218.
MAR	104.	12.	20.	35.	42.	49.	65.	82.	102.	127.	143.	162.	218.	273.
APR	174.	63.	80.	103.	113.	123.	147.	161.	182.	206.	221.	238.	286.	330.
MAY	147.	47.	61.	81.	90.	99.	116.	134.	153.	176.	189.	205.	251.	293.
JUN	97.	20.	28.	42.	49.	54.	66.	79.	94.	117.	123.	135.	173.	208.
JUL	42.	4.	7.	12.	15.	18.	25.	32.	41.	51.	58.	66.	91.	116.
AUG	36.	11.	15.	20.	22.	24.	28.	33.	38.	43.	47.	51.	62.	72.
SEP	86.	12.	19.	32.	38.	44.	56.	70.	86.	105.	117.	131.	174.	215.
OCT	227.	70.	92.	124.	134.	151.	178.	206.	236.	272.	293.	318.	389.	456.
NOV	238.	92.	114.	146.	159.	172.	196.	222.	249.	281.	299.	321.	382.	438.
DEC	145.	30.	43.	64.	74.	83.	103.	124.	148.	176.	193.	213.	273.	330.
ANN	1438.	797.	909.	1060.	1121.	1178.	1287.	1393.	1506.	1633.	1707.	1791.	2025.	2233.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.020	.017	.014	.025	.025	.025	.031	.098	.020	.015	.020	.016	.007
R	1.35	1.37	1.49	4.38	3.67	2.34	1.29	3.54	1.69	3.50	4.86	2.26	10.62
LNGAM	-.1	-.1	-.1	2.3	1.3	.2	-.1	1.2	-.1	1.2	3.0	.1	14.2

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.49 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME MACHETA CUNDINAMARCA SER. NO. 52180
LAT. 5 5. LONG. 73 37. ELEV. 2100. YEARS OF DATA 15

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	11.	0.	0.	0.	1.	1.	2.	4.	8.	13.	16.	21.	38.	57.
FEB	20.	0.	0.	1.	2.	2.	5.	8.	13.	21.	26.	33.	55.	80.
MAR	60.	2.	4.	10.	13.	17.	26.	37.	52.	71.	83.	98.	147.	196.
APR	99.	32.	41.	55.	61.	67.	78.	90.	102.	117.	126.	136.	166.	193.
MAY	133.	49.	61.	79.	87.	94.	108.	123.	139.	157.	168.	180.	217.	250.
JUN	147.	50.	69.	95.	107.	119.	142.	166.	193.	225.	244.	267.	332.	393.
JUL	175.	107.	120.	136.	143.	149.	160.	171.	183.	196.	203.	212.	235.	256.
AUG	129.	64.	78.	92.	98.	103.	113.	123.	134.	146.	153.	161.	183.	203.
SEP	80.	47.	52.	60.	64.	66.	77.	78.	83.	90.	93.	98.	110.	120.
OCT	96.	45.	54.	65.	70.	74.	83.	92.	101.	111.	117.	124.	144.	162.
NOV	74.	41.	47.	55.	58.	61.	66.	72.	78.	84.	89.	92.	104.	114.
DEC	27.	1.	2.	4.	6.	8.	17.	17.	24.	32.	34.	45.	67.	90.
ANN	1091.	824.	877.	944.	970.	994.	1039.	1082.	1126.	1174.	1202.	1233.	1317.	1389.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.027	.023	.013	.038	.074	.016	.084	.074	.157	.074	.187	.029	.077
R	.37	.45	.79	3.77	4.47	2.46	14.78	9.43	12.41	7.08	10.90	.79	80.07
LNGAM	.9	.7	.7	1.5	2.4	.7	24.6	11.5	18.7	6.7	14.4	.2	106.9

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.50 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME PUERTO MONTA F CUNDINAMARCA SER. NO. 52520
LAT. 4 21. LONG. 74 21. ELEV. 1420. YEARS OF DATA 15

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	64.	1.	2.	7.	10.	14.	23.	35.	51.	73.	87.	106.	164.	225.
FEB	61.	4.	8.	16.	20.	24.	34.	44.	57.	74.	84.	96.	134.	172.
MAR	93.	1.	3.	9.	13.	18.	31.	48.	72.	104.	125.	153.	242.	335.
APR	133.	55.	67.	84.	91.	98.	111.	125.	139.	156.	166.	177.	210.	239.
MAY	126.	37.	49.	67.	75.	83.	98.	113.	131.	151.	163.	177.	218.	256.
JUN	72.	9.	15.	25.	30.	35.	45.	57.	71.	88.	99.	111.	149.	186.
JUL	39.	3.	6.	11.	13.	16.	22.	29.	37.	47.	53	61.	85.	108.
AUG	28.	3.	5.	9.	11.	13.	17.	22.	28.	35.	39.	44.	60.	75.
SEP	49.	6.	10.	17.	20.	23.	31.	39.	48.	59	67.	75.	101.	126.
OCT	154.	60.	75.	95.	103.	112.	128.	144.	161.	181.	193	207.	247.	283.
NOV	144.	65.	82.	107.	118.	128.	149.	170.	192.	219.	235.	253.	305.	353.
DEC	43.	15.	22.	36.	43.	49.	62.	77.	93.	114.	126.	141.	185.	227.
ANN	1095.	695.	769.	966.	905.	941.	1004.	1073.	1147.	1218.	1261.	1311.	1448.	1568.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.010	.019	.006	.041	.026	.021	.032	.050	.032	.032	.023	.020	.015
R	.64	1.17	.59	5.40	3.33	1.59	1.23	1.40	1.59	4.95	4.16	1.82	10.79
LNGAM	.3	-.1	.4	3.8	1.0	-.1	-.1	-.1	-.1	3.1	2.0	-.1	30.1

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.51 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME CARACOL CUNDINAMARCA SER. NO. 52530
LAT. 4 11. LONG. 74 28. ELEV. 1350. YEARS OF DATA 16

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	67.	1.	4.	10.	14.	18.	28.	41.	57.	78.	92.	110.	166.	222.
FEB	78.	22.	29.	40.	45.	50.	60.	70.	81.	94.	102.	111.	138.	163.
MAR	115.	26.	37.	54.	61.	69.	84.	100.	118.	139.	152.	168.	212.	255.
APR	153.	77.	90.	107.	114.	121.	134.	147.	160.	175.	184.	194.	223.	248.
MAY	165.	54.	69.	92.	102.	112.	131.	150.	172.	197.	211.	229.	279.	325.
JUN	94.	43.	51.	63.	64.	72.	81.	90.	99.	110.	116.	123.	143.	162.
JUL	67.	22.	29.	38.	42.	45.	53.	61.	69.	79.	85.	92.	112.	131.
AUG	52.	26.	30.	36.	39.	41.	46.	50.	54.	60.	63.	67.	77.	86.
SEP	77.	25.	37.	43.	47.	52.	61.	70.	80.	92.	99.	108.	132.	154.
OCT	147.	97.	109.	126.	133.	139.	151.	163.	175.	189.	197.	206.	231.	253.
NOV	147.	86.	104.	128.	139.	149.	167.	186.	207.	230.	244.	260.	305.	346.
DEC	110.	44.	54.	68.	74.	80.	91.	103.	115.	129.	138.	148.	175.	200.
ANN	1342.	1005.	1072.	1156.	1190.	1220.	1276.	1330.	1386.	1447.	1482.	1521.	1627.	1718.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.011	.039	.022	.055	.023	.070	.057	.154	.047	.072	.030	.046	.028
R	.75	3.05	2.49	8.35	3.74	6.56	3.80	8.07	3.63	12.03	6.01	5.09	38.10
LNGAM	.2	.7	.3	4.2	1.5	5.8	1.5	8.7	1.3	17.6	1.8	3.3	99.7

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.52 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME LAS DOS AGUAS TOLIMA SER. NO. 52345
LAT. 4 16. LONG. 74 47. ELEV. 285. YEARS OF DATA 10

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	60.	5.	9.	17	21.	26.	35.	45.	58.	73.	83.	95.	131.	166.
FEB	118.	0.	1.	6.	10.	15.	29.	50.	80.	124.	155.	194.	325.	467.
MAR	105.	15.	24.	39.	46.	54.	69.	86.	105.	128.	143.	160.	211.	261.
APR	237.	110.	131.	159.	171.	183.	204.	226.	249.	275.	291.	309.	359.	404.
MAY	224.	85.	106.	136.	148.	161.	184.	208.	234.	264.	282.	302.	361.	415.
JUN	104.	1.	2.	8.	13	18.	32.	51.	77.	114.	139.	171.	276.	386.
JUL	54.	13.	19.	27.	31.	35.	42.	50.	59.	70.	77.	84.	107.	128.
AUG	60.	7.	11.	20	24.	28.	37.	47.	59.	74.	83.	94.	127.	159.
SEP	102.	20.	29.	44.	51.	58.	72.	87.	104.	124.	137.	151.	195.	236.
OCT	224.	87.	104.	139.	157.	164.	188.	213.	240.	270.	289.	310.	370.	426.
NOV	144.	96.	113.	136.	146.	155.	173.	190.	209.	230.	243.	257.	297.	333.
DEC	120.	16.	26	43.	52.	60.	78.	97.	119.	147.	164.	184.	244.	303.
ANN	1617.	1077.	1179.	1311.	1364.	1412.	1502.	1590.	1682.	1783.	1841.	1907.	2088.	2246.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.021	.004	.015	.029	.021	.005	.043	.029	.021	.021	.037	.014	.013
R	1.76	.46	1.73	6.79	4.73	.55	2.51	1.45	2.17	4.69	7.34	1.65	20.47
LNGAM	-.1	.6	-.1	6.2	2.8	.5	.3	-.1	.1	2.7	7.2	-.1	40.7

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.53 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME ARPTO ARAUCA ARAUCA SER. NO. 60210
LAT. 7 4. LONG. 70 44. ELEV. 127. YEARS OF DATA 9

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	4.	0.	0.	0.	0.	0.	0	0.	1.	2.	3.	5.	13.	22.
FEB	8.	0.	0.	0.	0.	0.	0.	1.	2.	5.	7.	11.	24.	42.
MAR	15.	0.	0.	0.	0.	0.	1.	2.	4.	10.	14.	20.	45.	75.
APR	175.	4.	17.	36.	47.	59.	96.	119.	158.	210.	243.	283.	409.	535.
MAY	217.	35.	53.	85.	100.	115.	145.	179.	218.	264.	293.	327.	479.	526.
JUN	239.	45.	66.	101.	117.	134.	167.	202.	247.	291.	321.	356.	460.	559.
JUL	236.	63.	96.	120.	135.	150.	179.	210.	244.	285.	309.	338.	421.	498.
AUG	185.	38.	55.	83.	95.	107.	137.	159	189.	225.	247.	273.	349.	421.
SEP	174.	80.	95.	117.	125.	134.	150.	166.	183.	202.	214.	227.	265.	298.
OCT	193.	102.	119.	139.	147.	155.	171.	186.	202	221.	231.	243.	277.	308.
NOV	65.	10.	15.	25.	29.	34.	43.	53.	65.	80.	88.	99.	131.	161.
DEC	25.	0.	0.	0.	0.	1.	2.	5.	10.	19.	26.	37.	75.	120.
ANN	1536.	729.	862.	1045.	1121.	1192.	1329.	1466.	1617.	1778.	1875.	1987.	2302.	2585.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.042	.026	.014	.005	.009	.009	.012	.012	.038	.048	.027	.010	.005
R	.17	.20	.21	.94	1.85	2.09	2.95	2.28	6.67	9.28	1.75	.25	7.18
LNGAM	1.7	1.5	1.5	.0	-.1	.0	.6	.1	6.0	11.7	-.1	1.3	6.9

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

TABLE 7.54 PRECIPITATION FOR GIVEN PROBABILITY LEVELS USING A GAMMA DISTRIBUTION. IN MM.

STATION NAME GUETAME CUNDINAMARCA SER. NO. 60317
LAT. 4 20. LONG. 73 52. ELEV. 1300. YEARS OF DATA 16

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.
MONTH	MEAN	PRECIPITATION												
JAN	40.	0.	0.	2.	3.	4.	9.	15.	25.	40.	51.	64.	110.	161.
FEB	43.	16.	20.	26.	28.	31.	35.	40.	45.	51.	54.	58.	69.	80.
MAR	107.	34.	44.	59.	66.	72.	85.	97.	111.	128.	138.	149.	182.	213.
APR	185.	102.	117.	136.	144.	152.	166.	180.	194.	211.	221.	232.	262.	289.
MAY	299.	179.	165.	201.	216.	231.	258.	285.	314.	347.	367.	389.	452.	509.
JUN	325.	219.	239.	265.	275.	285.	307.	320.	337.	357.	369.	381.	417.	447.
JUL	351.	195.	227.	259.	274.	288.	314.	340.	368.	399.	417.	437.	495.	545.
AUG	286.	164.	186.	215.	226.	237.	258.	278.	300.	324.	338.	353.	397.	436.
SEP	211.	6.	15.	36.	48.	62.	94.	133.	183.	249.	291.	344.	510.	674.
OCT	139.	81.	91.	105.	111.	116.	126.	136.	146.	157.	164.	171.	192.	210.
NOV	107.	42.	57.	66.	72.	78.	89.	100.	112.	126.	134.	143.	170.	195.
DEC	61.	17.	23.	32.	35.	39.	47.	55.	63.	74.	80.	87.	108.	128.
ANN*	2155.	1720.	1816.	1932.	1977.	2014.	2088.	2155.	2222.	2296.	2333.	2377.	2494.	2590.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.011	.109	.034	.056	.023	.067	.030	.041	.004	.068	.047	.050	.035
R	.45	4.65	3.63	10.41	6.83	21.67	10.61	11.72	.81	12.31	5.07	3.86	74.73
LNGAM	.7	2.7	1.3	13.7	6.3	44.4	14.2	16.8	.1	18.3	3.3	.7	246.4

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED
**** GAMMA PARAMETERS UNDEFINED

Appendix D

Gamma Distribution of Precipitation and Potential Irrigation Requirements

TABLE 8. 1 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME PUEBLO BELLO MAGDALENA SER. NO. 11230. LAT. 10 26. LONG. 73 35. ELEV. 980. YEARS OF DATA 13

PROBABILITY		95.	90.	80.	75.	70	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION								ETCH	IRRIGATION REQUIREMENT **				
JAN	36.	0.	0.	1.	1.	7.	5.	10.	19.	33.	43.	57.	105.	160.	118.	118.	117.	117.	116.	113.
FEB	30.	3.	5.	9.	11.	13.	18.	23.	29.	36.	41.	47.	64.	80.	120.	115	111.	109.	107.	103.
MAR	54.	7.	11.	15.	23.	27.	35.	43.	54.	66.	74.	84.	112.	139.	138.	127.	119.	115.	111.	103.
APR	108.	31.	41.	57.	64.	70.	84.	97	112.	130.	141.	154.	190.	224.	118.	77.	61.	54.	46.	35.
MAY	323.	175.	200.	235.	249.	262.	287.	312.	339.	368.	385.	405.	460.	509.	103.	-97.	-132.	-146.	-159.	-184.
JUN	256.	87.	111.	147.	167.	177.	205.	235	268	306.	328.	354.	430.	499.	100.	-12.	-47.	-62.	-77.	-106.
JUL	194.	110.	125.	145.	153.	160.	175	189.	203.	220.	229.	240.	271.	297.	117.	-4.	-28.	-36.	-43.	-58.
AUG	234.	148.	164.	185.	193.	201.	215.	229.	244	261.	270.	281.	310.	336.	114.	-50.	-71.	-79	-87	-101.
SEP	281.	169.	189.	216.	227.	237.	256.	274.	294.	315.	328.	342.	387.	416.	102.	-87	-114.	-125	-135.	-154
OCT	392.	235.	263.	301.	316.	330	356.	387.	409.	440.	457.	477.	533.	582.	96	-168.	-205.	-220.	-234.	-261.
NOV	259.	87.	112.	147.	163.	177.	206.	236.	269.	307.	329.	356.	431.	501.	92	-20.	-56.	-71.	-86.	-115.
DEC	56.	0.	1.	3.	5.	7.	14.	24.	38.	59.	73.	91.	152.	218.	105	104.	102.	100.	97.	91.
ANN	2223.	1693.	1798.	1932.	1984.	2032	2120	2205.	2292.	2388.	2442.	2504.	2670.	2812.	1372.	-476.	-609.	-662.	-710.	-798.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0092	.0457	.0290	.0293	.0306	.0159	.0588	.0704	.0487	.0347	.0153	.0085	.0191
R	.334	1.365	1.577	3.176	9.880	3.948	11.412	16 485	13.675	13.507	3.952	.472	42.494
LNGAM	.9845	-.1168	-.1153	.8615	12.5314	1.7270	16.0824	29 2350	21.7114	21.4838	1.7316	.6301	115.6896

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 8. 2 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM

STATION NAME BLOWAY N D SANTANDER SER. NO. 11510. LAT. 7 35. LONG 72 36. ELEV 1235. YEARS OF DATA 16

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION								ETCH	IRRIGATION REQUIREMENT **				
JAN	44.	0.	0.	2.	3.	5.	10.	18.	29	46.	57.	72.	123.	179.	96.	96	94	93.	91.	86.
FEB	66.	5.	9.	17.	22.	26.	37.	48.	62.	80.	91.	104	146.	187.	98.	89.	80.	76.	71.	61.
MAR	51.	5.	9.	16.	20.	24.	32.	41.	52.	65	73	83.	114.	144	111.	102.	95.	91	87.	79.
APR	143.	23.	36.	56.	66.	76.	96.	118	144.	174	193.	215.	282	346.	91.	55.	34	24	15.	-6.
MAY	213.	84.	104.	132.	144.	155.	177.	199.	223.	251.	267	296	340.	389	97	-7.	-35.	-47.	-58	-80.
JUN	104.	43.	57.	66.	72.	77.	87.	98	109.	123	130.	139.	165	188.	94.	41.	28	22	17	6.
JUL	87	36.	44.	54	59	63.	71.	79	87.	97	103.	110	128.	146.	104.	60.	50	46.	42	34.
AUG	100.	52.	60.	71.	76.	80.	88	96.	105	115	120.	127	145	161	111	51.	40	36	31.	23.
SEP	125.	40	52.	69.	77.	84	99.	114.	131	150.	161.	175.	214	250	111	59.	41.	34	26	12.
OCT	237.	51.	71.	107.	122.	138.	169	201.	234	283.	304.	341.	434	522.	105	32	-2	-18.	-33.	-64.
NOV	217.	91.	111.	139.	150	161	183.	205	228.	255	271.	289.	341	388.	89	-22.	-50.	-62	-73.	-94.
DEC	127.	22.	33.	52.	61.	69.	87	106.	128	155.	171	191	248	303.	84.	55	37	28.	19.	1.
ANN	1510.	1088.	1170.	1275.	1317	1355	1425	1493	1563.	1641.	1685.	1735.	1871	1988.	1194	24	-81	-123.	-161.	-231.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0099	.0177	.0252	.0131	.0237	.0515	.0226	.0840	.0289	.0103	.0256	.0154	.0200
R	.439	1.162	1.344	1.873	5 037	5.372	6 042	8.816	5.619	2.403	4.577	1.964	30.232
LNGAM	.7015	-.0736	-.1145	-.0482	3 2343	3.7529	4.8594	10.2124	1.3348	.2190	4.0821	- .0149	72.0439

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 8. 3 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME SALAZAR N D SANTANDER SER. NO. 11535. LAT. 7 44. LONG. 72 49. ELEV. 1000. YEARS OF DATA 11

PROBABILITY		95.	90.	80.	75.	70	60.	50.	40.	30.	25.	20	10	5.		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION								ETCH	IRRIGATION REQUIREMENT **				
JAN	97.	3.	6.	16.	22.	28	43	61.	84.	114.	134.	158.	235.	314.	97.	90.	81.	75.	69.	54.
FEB	115.	23.	33.	50.	58	65.	81.	98.	117.	140.	154.	170.	219	266.	100.	67	50.	42.	35.	19.
MAR	113.	12.	20.	35.	43.	51.	64.	87.	110.	138	155.	176	240.	307.	119.	99	84.	76.	68.	51.
APR	214.	27.	44	74.	89.	104.	135	170	211	261.	292.	329.	441.	550.	93.	49.	19.	4.	-11.	-42.
MAY	329.	159.	187.	226.	242.	257.	286.	315	345.	381.	401.	425.	491	550.	102.	-85.	-124	-140.	-155.	-184.
JUN	154.	28	42.	65.	75.	86.	107.	130.	156.	188.	207	230.	298.	362.	109	67.	44.	34.	23.	2.
JUL	113.	17.	27.	43.	51.	59.	75.	93	113.	138.	153.	171.	225.	277	127.	100.	84.	76.	68.	52.
AUG	171.	25.	37.	56.	65.	74.	92.	111.	133	159.	176	195.	251.	305.	135.	98.	79.	70.	61.	43.
SEP	185.	28	43.	70.	81.	96	122.	151	185	226.	251.	280	370.	455	129.	86.	59.	47.	34.	7.
OCT	459.	96.	127.	194.	226.	257	320.	388.	465.	559.	616.	683	883	1073	115.	-12.	-79.	-111	-141.	-205.
NOV	454.	185.	227.	286.	311.	334	380.	426.	476	534.	568.	607.	718.	820.	92.	-136.	-194.	-219.	-243.	-288.
DEC	270	54.	78.	118.	136	154	191.	231.	275.	329.	362	401.	515.	624.	91.	13.	-27.	-45.	-64	-100.
ANN	2634.	1466.	1672.	1946.	2058.	2167	2358.	2553.	2758	2989.	3127.	3275	3701.	4078.	1308.	-363	-638	-750.	-854.	-1050.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0043	.0189	.0122	.0073	.0225	.0134	.0159	.0162	.0096	.0046	.0117	.0081	.0041
R	.803	2.172	1.382	1.558	7 422	2.065	1.798	2.123	1.771	2.091	5.314	2.189	10.765
LNGAM	.1487	.0817	-.1184	-.1171	7.3826	.0786	-.0717	.0566	-.0790	.0410	3.6615	.0911	14 5554

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 8. 4 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME RESTREPO VALLE SER. NO. 20850. LAT. 3 49. LONG. 76 30. ELEV. 1670. YEARS OF DATA 11

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION								ETCH	IRRIGATION REQUIREMENT **				
JAN	43.	12.	16.	22.	25.	28.	33.	39.	45.	52.	57.	62.	77.	91.	108.	92.	86.	83.	80.	75.
FEB	41.	14.	23.	28.	30.	32.	35.	39.	43.	48.	50.	54.	62.	70.	105	82.	77	75.	73.	69.
MAR	74.	41.	47.	55.	59	61.	66.	71.	77.	83.	87.	91.	103.	113.	120.	73.	65.	62.	59.	54.
APR	134.	75.	85.	99.	105.	110.	120.	130.	141.	152.	159.	167.	189.	208.	98.	13.	-1.	-7.	-12.	-22.
MAY	103.	57.	65.	76.	80	85	92.	100.	108	117.	122.	129.	145.	160.	98.	33.	22.	17.	13.	6.
JUN	90.	17.	25.	38.	44	51.	63.	76.	92.	110.	121.	134.	173.	211.	94	69.	55.	49.	43.	31.
JUL	54.	15.	20.	28.	32.	36.	43.	51.	59.	70.	76.	83.	104.	124.	104.	84.	75.	71.	68.	60.
AUG	57.	14.	25.	33.	37.	39.	46.	53.	60.	68.	74.	79.	96.	112.	110.	86.	78.	74.	71.	64.
SEP	74.	20.	28.	39.	44.	49.	59.	70.	82.	96.	104.	114.	143.	170.	108.	80.	69.	64.	59.	48.
OCT	150.	84.	96.	111.	117.	123.	134.	145.	157.	170.	177.	186.	210.	231.	104.	9.	-7.	-13.	-19.	-30.
NOV	108.	54.	63.	75.	81.	85	95	104.	114	125.	131.	139.	160.	179.	90.	27.	14.	9.	4.	-5.
DEC	79.	28.	35.	46.	51	55	64.	73.	83.	94.	101.	109.	131.	152.	97.	61.	51.	46.	41.	33.
ANN	1017.	729	785.	857.	885.	911.	959.	1006.	1054.	1107.	113 . 1	2.	1265.	1346.	1235.	450.	378.	350.	324.	275.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0685	.1640	.1514	.0802	.1026	.0233	.0478	.0679	.0351	.0730	.0730	.0524	.0287
R	2.969	6.745	11.142	10.770	10.545	2.103	2.758	3.901	2.778	10.941	7.910	4.147	29.216
LNGAM	.6651	4.1063	15.4401	14.5671	14.1597	.0471	.4817	1.6684	.4987	14.9654	8.3446	1.9796	68.6144

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 8. 5 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION, IN MM.

STATION NAME OSPINA PEREZ NARINO SER. NO. 30725, LAT. 1 17, LONG. 77 29, ELEV. 1700, YEARS OF DATA 13

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN							PRECIPITATION						ETCH	IRRIGATION REQUIREMENT **				
JAN	113.	30.	41.	57.	64.	71.	85.	100.	117.	136.	148.	161.	201.	239.	107.	67.	50.	43.	36.	22.
FEB	91.	21.	29.	43.	49.	55.	67.	79.	93.	110.	121.	133.	168.	202.	101.	71.	58.	52.	46.	34.
MAR	107.	61.	69.	80.	84.	89.	96.	104.	117.	122.	127.	133.	150.	165.	104.	36.	25.	20.	16.	8.
APR	163.	84.	98.	116.	123.	130.	144.	157.	171.	187.	196.	207.	237.	264.	92.	-6.	-24.	-31.	-38.	-52.
MAY	169.	95.	108.	125.	133.	139.	152.	164.	177.	192.	200.	210.	237.	261.	103.	-4.	-22.	-29.	-36.	-48.
JUN	117.	8.	16.	32.	41.	51.	72.	97.	127.	166.	190.	220.	313.	405.	106.	90.	74.	65.	55.	34.
JUL	44.	5.	8.	14.	17.	20.	27.	34.	43.	54.	61.	69.	95.	119.	122.	114.	108.	105.	101.	95.
AUG	47.	1.	3.	7.	10.	13.	20.	29.	40.	55.	65.	77.	115.	154.	133.	130.	125.	123.	120.	113.
SEP	54.	6.	13.	21.	25.	30.	38.	48.	59.	72.	80.	90.	120.	149.	125.	113.	104.	100.	96.	87.
OCT	174.	59.	76.	100.	110.	120.	139.	159.	181.	207.	222.	239.	290.	336.	112.	37.	13.	2.	-7.	-27.
NOV	191.	104.	119.	139.	148.	155.	170.	184.	200.	217.	227.	238.	270.	298.	95.	-24.	-44.	-53.	-60.	-75.
DEC	156.	87.	99.	115.	122.	128.	139.	151.	163.	177.	184.	193.	218.	241.	97.	-2.	-19.	-25.	-31.	-43.
ANN	1452.	963.	1055.	1175.	1222.	1266.	1348.	1428.	15 7.	1602.	165 .	1715.	1879.	2022.	1298.	242.	123.	76.	32.	-50.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0258	.0274	.1042	.0534	.0645	.0076	.0312	.0165	.0279	.0230	.0535	.0695	.0139
R	2.907	2.494	11.188	8.714	10.922	1.044	1.387	.778	1.649	3.996	10.205	10.885	20.117
LNGAM	.6094	.2802	15.5489	9.9964	14.9217	-.0239	-.1187	.1740	-.1055	1.7868	13.2660	14.8346	39.6863

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 8. 6 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BAS. ON GAMMA DISTRIBUTION, IN MM.

STATION NAME MANUEL MEJIA CAUCA SER. NO. 31305, LAT. 2 23, LONG. 76 43, ELEV. 1750, YEARS OF DATA 12

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN							PRECIPITATION						ETCH	IRRIGATION REQUIREMENT **				
JAN	149.	58.	71.	90.	98.	106.	121.	136.	152.	170.	181.	194.	230.	263.	94.	27.	8.	-0.	-8.	-23.
FEB	115.	25.	36.	52.	60.	68.	83.	99.	118.	140.	154.	169.	215.	259.	97.	61.	44.	37.	29.	14.
MAR	152.	30.	44.	66.	76.	87.	107.	129.	155.	185.	203.	225.	289.	350.	103.	59.	37.	27.	17.	-4.
APR	196.	90.	108.	131.	141.	151.	169.	187.	206.	228.	241.	255.	297.	335.	87.	-20.	-44.	-54.	-64.	-81.
MAY	171.	83.	98.	118.	126.	134.	149.	164.	180	198.	208.	221.	255.	285.	94.	-4.	-24.	-32.	-40.	-55.
JUN	85.	7.	13.	24.	30.	36.	49.	63.	81.	103.	117.	134.	185.	235.	96.	63.	72.	66.	60.	47.
JUL	52.	8.	12.	19.	23.	27.	34.	42.	52	63.	70.	79.	104.	128.	114.	102.	94.	91.	87.	80.
AUG	52.	3	5.	12.	15.	19.	27.	36.	48.	63.	72.	84.	120.	157.	122.	116.	110.	107.	103.	95.
SEP	106.	34.	44.	59.	65.	71.	84.	96.	110.	126.	136.	147.	180.	210.	117.	68.	54.	47.	41.	29.
OCT	352.	190	218.	256.	271	285.	313.	340.	368.	401.	419.	441.	501.	554.	99.	-119.	-157.	-172.	-187.	-214.
NOV	110.	203.	223.	249.	260.	269.	287.	305.	323.	343.	354.	367.	403.	435.	83.	-140.	-166.	-176.	-186.	-204.
DEC	110.	148.	175.	211.	227	241.	268.	296.	325.	359.	378.	400.	464.	520.	84.	-91.	-128.	-143.	-157.	-185.
ANN	2045.	1538.	1634	1766	1816	1862	1946.	2028	2112	2204.	2256.	2315.	2475.	2612.	1148.	-450.	-578.	-628.	-673.	-758.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0355	.0207	.0144	.0343	.0439	0147	.0336	.0190	.0347	.0280	.0618	.0234	.0191
R	5.149	2.376	2.189	6.724	7.516	1.244	1.741	.993	3.660	9.842	19.145	7.249	39.009
LNGAM	3.4045	.2017	.0909	6 0678	7.5646	-.0968	-.0867	.0041	1.3816	12.4976	36.8181	7.0499	103.0008

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 8. 7 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION, IN MM.

STATION NAME JARDIN ANTIOQUIA SER. NO. 40540, LAT. 5 34, LONG. 75 56, ELEV. 1630, YEARS OF DATA 12

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN							PRECIPITATION						ETCH	IRRIGATION REQUIREMENT **				
JAN	87.	29.	37.	49.	55.	60.	70.	80.	91.	104.	112.	121.	147.	172.	102.	65.	52.	47.	42	32.
FEB	104.	50.	60	73.	78.	84.	94.	104.	114.	127.	134.	142.	165.	186.	94.	34.	21.	15.	10.	-0.
MAR	172.	94.	111.	129.	136.	142.	155.	167.	180.	194.	203.	212.	239.	262.	99.	-12.	-29.	-36.	-43.	-55.
APR	306.	196.	217.	243.	254.	264.	282.	300.	319	340.	352.	366.	403.	436.	85.	-132.	-159.	-169.	-179.	-198.
MAY	267.	174.	195.	215.	223.	231	245.	258.	272	288	297.	307.	335.	359.	87.	-108	-128.	-136.	-144.	-158.
JUN	149.	67.	85.	111.	122.	137.	153	175.	198.	225.	241.	259.	313.	362.	97.	8.	-18.	-29.	-39.	-60.
JUL	157.	51.	65.	87.	96.	104	122.	139.	159.	181.	194.	210.	255.	296.	108.	43.	21.	12.	4.	-14.
AUG	184.	96.	112.	133.	142.	150.	166	182	198	217.	228.	241	277.	308.	111.	-1.	-23.	-31.	-40.	-56.
SEP	196.	148.	157.	169.	174	178	186	194.	202.	210.	215.	221.	236.	249.	102.	-55.	-67	-72.	-76.	-84.
OCT	244.	160.	176	196.	205.	212.	226.	240.	255	271	280	290.	319.	343.	95.	-81.	-101.	-109.	-117.	-131.
NOV	185.	109.	123.	141.	148.	155	168	180.	193.	208	217.	226.	253.	277.	86.	-36.	-54.	-62.	-68.	-81.
DEC	177.	85.	99.	119.	128.	135.	150	165.	181	199.	209.	221.	255.	285.	90.	-10	-30.	-38.	-46.	-61.
ANN*	2265.	1842.	1936	2049.	2091.	2127	2200	2265.	2330.	2402.	2438.	2481.	2594.	2687.	1151.	-785.	-897.	-940.	-976.	-1045.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0437	.0611	.0674	.0569	.0869	0223	.0257	.0441	.2055	.0778	.0697	.0449	.0367
R	3.827	6.663	11.588	17 432	22.777	4.711	3.911	8.339	40.185	19.012	12.890	7.740	83.163
LNGAM	1.5786	5.9573	16.5044	31.8894	47.1783	2.0634	1.6811	9.2160	107.3106	36.4291	15.7103	8.0064	283.1924

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 8. 8 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION IN MM.

STATION NAME GRANJA MERINA BOYACA SER. NO. 41655, LAT. 5 56, LONG. 73 36, ELEV. 1764, YEARS OF DATA 12

PROBABILITY	95.	90.	80.	75.	70	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN							PRECIPITATION						ETCH	IRRIGATION REQUIREMENT **				
JAN	67.	17.	23.	32.	36.	40.	47.	55.	64.	74.	80.	87.	108.	128.	111.	88.	79.	75.	71.	64.
FEB	54.	11.	17.	26.	30.	34.	42.	50.	60.	72.	80.	88.	114.	138.	106.	89.	81.	77.	73.	64.
MAR	143.	54.	67.	86.	95.	102.	118.	133.	150.	170.	181.	194.	234.	268.	119.	52.	33.	24.	17.	1.
APR	215.	103.	127.	147.	158.	168.	184.	205.	225.	248.	262.	277.	320.	359.	99.	-23.	-48.	-59.	-69.	-88.
MAY	256.	144.	181	204.	213.	221.	236.	251.	267.	285.	295.	306.	337.	365.	98.	-84.	-106.	-115.	-123.	-139.
JUN	247.	115.	136.	166	179.	190	212.	235.	259.	286.	302.	321.	373.	419.	92.	-45.	-74.	-87.	-98.	-121.
JUL	172.	68.	84.	107.	116.	125.	143.	160.	180.	202.	215.	230.	273.	313.	104.	20.	-3.	-12.	-21.	-39.
AUG	157.	97.	108.	122.	128.	133.	143.	153.	164.	175.	182.	189.	210.	229.	106.	-1.	-16.	-22.	-27.	-37.
SEP	170.	105.	117.	133.	139.	145	156.	166.	177.	190.	197.	205.	228.	247.	100.	-17.	-32.	-39.	-44.	-55.
OCT	220.	131.	144	170.	180	188.	204.	220.	236.	255.	265.	278.	311.	341.	99.	-49.	-71.	-80.	-89.	-105.
NOV	211.	124.	140	160	169.	176.	191.	205.	220.	237.	247.	258.	288.	315.	94.	-46.	-66.	-74.	-82.	-97.
DEC	101.	33	43	57.	63	69.	80.	92.	106.	121.	130.	141.	171.	200.	103.	60.	46.	40.	34.	23.
ANN*	2018.	1749.	1808.	1880.	1908	1931.	1977.	2018.	2059.	2105.	2128.	2156.	2227.	2287.	1231.	-577.	-649.	-676.	-699.	-745.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0503	.0360	.0322	.0145	.0680	.0278	.0297	.0959	.0845	.0542	.0615	.0371	.0841
R	3.101	2.139	4.624	7.406	17.418	6.865	5.049	15.028	15.209	12.239	12.950	3.759	169.788
LNGAM	.7841	.0648	2.6275	7.3523	11.8498	6.3274	3.3137	25.2652	25.7529	18.0888	19.8621	1.4972	283.1924

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 8. 9 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME SAN VICENTE SANTANDER SER. NO. 99. LAT. 6 57. LONG. 73 26. ELEV. 1200. YEARS OF DATA 5

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN	PRECIPITATION													ETCH	IRRIGATION REQUIREMENT **				
JAN	77.	3.	6.	14.	19.	24.	36.	50.	68.	91.	107.	125.	184.	244.	108.	102.	94.	89.	84.	72.
FEB	104.	47.	56.	69.	74.	79.	89.	99.	109.	121.	128.	136.	159.	179.	104.	48.	35.	30.	25.	15.
MAR	95.	5.	10.	21.	27.	34.	48.	66.	87.	114.	131.	152.	217.	283.	117.	107.	96.	90.	83.	68.
APR	186.	68.	85.	111.	121.	131.	151.	172.	194.	220.	235.	253.	303.	350.	98.	12.	-13.	-24.	-34.	-54.
MAY	234.	155.	170.	190.	197.	205.	218.	231.	244.	260.	268.	278.	305.	328.	103.	-67.	-86.	-94.	-101	-115.
JUN	204.	71.	90.	118.	130.	142.	164.	188.	213.	243.	261.	281.	340.	394.	95.	5.	-23.	-36.	-47.	-70.
JUL	135.	11.	19.	37.	46.	56	76.	100.	128.	164.	186.	213.	296.	378.	111.	91.	74.	65.	55.	35.
AUG	135.	25.	37.	57.	66.	75.	94.	114.	137	164.	181.	201.	260.	316.	115.	74.	59.	49.	40.	22.
SEP	126.	86.	93.	103.	107.	111.	117.	124.	131.	138.	142.	147.	160.	172.	106.	13.	3.	-1.	-4.	-11.
OCT	396.	124.	161.	217.	242.	265.	311.	359.	412.	474.	511.	553.	678.	793.	99.	-62.	-118.	-142.	-166.	-212.
NOV	341.	92.	124.	173.	195.	216.	259.	303.	353.	411.	446	487.	607.	718.	90.	-34.	-83.	-105.	-126.	-168.
DEC	189.	9.	19.	41.	53	66.	95.	129.	172.	227.	262.	305.	438.	572.	101.	82.	61.	49.	36.	7.
ANN	2271.	1236.	1410.	1641.	1735.	1823.	1989.	2153.	2325.	2520.	2633.	2767.	3121.	3439.	1249.	-161.	-392.	-486.	-574.	-740.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0111	.0622	.0105	.0240	.0438	0199	.0090	.0154	.1815	.0090	.0087	.0051	.0048
R	.855	6.468	1.006	4.450	19.686	4.063	1.208	7.073	22.807	3.447	2.958	.972	10.765
LNGAM	.1024	5.6055	- 0035	2.3846	38.4104	1.8717	-.0876	.0328	47.8711	1.2527	.6552	.0167	14.5551

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 8.10 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME NARANJAL CALDAS SER. NO. 50308. LAT. 4 57. LONG. 75 41. ELEV. 1400. YEARS OF DATA 14

PROBABILITY		95.	90	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN	PRECIPITATION													ETCH	IRRIGATION REQUIREMENT **				
JAN	111.	57.	64	81.	89	95	109	122.	137.	154.	164.	175.	208.	238	119.	55.	38.	31.	24.	11.
FEB	159.	48.	63.	85.	95.	105	124.	143.	165	191.	206	224.	276.	324.	117	49	26.	16.	7.	-12.
MAR	216.	151	163.	179.	186.	192	202.	213	224	236	243.	250.	271.	290.	122.	-41.	-57.	-63.	-69.	-80.
APR	321.	207.	228.	256	267	277.	296	315.	334	356.	368.	382.	421.	455.	103.	-125.	-153.	-164.	-174.	-193.
MAY	350.	231.	253.	282.	294	305	325	344	364.	387.	400	415	455.	490.	102.	-151	-180	-192.	-203	-223.
JUN	242.	122	142.	170	181	192.	212	232	253	278	292.	308.	350.	394.	104	-38.	-66	-77	-88.	-108.
JUL	193.	79.	97.	121.	132	142	61	181.	202	227.	241.	257.	305	348	119	22.	-3.	-13.	-23.	-43.
AUG	196.	61.	80.	107	119	131	154	178.	204	235.	253	274.	316	357.	124.	45	17	5.	-7	-30.
SEP	189	76.	94	118	129	138.	158	177.	198.	222.	236.	253	300.	343	116	23.	-2.	-12	-22.	-41.
OCT	316	155.	182	214	234	248	275	303	332	365.	384	407.	469	525	108	-74.	-111	-126.	-140.	-168.
NOV	255.	166.	183	204.	213	221	236	251	266.	283	292.	303	334.	360	96.	-87.	-109.	-117	-125.	-140.
DEC	206.	174	139	159	167	174	188	201	216	232	241.	251.	281	306	106	-33.	-53.	-61	-68.	-82.
ANN*	2774.	2127.	2426	2545	2591	2629	2705.	2774.	2843.	2919	2957.	1002.	3122.	3221.	1331.	-1095	-1215	-1260.	-1298.	-1375.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0390	.0210	.1200	0557	.0555	0342	0276	0180	.0275	.0242	.0721	.0661	.0413
R	5.100	1.346	25 847	17 454	19 444	8.268	5.330	3.530	5.204	7.648	18.411	13 653	114.629
LNGAM	3.3303	1.0351	57.6375	33 0882	37.6967	9.0707	3.6875	1.2938	3.8895	7.8234	34.6861	21.6525	14.5551

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 8.11 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME CHINCHINA CALDAS SER. NO. 50310. LAT. 4 58. LONG. 75 37. ELEV. 1360. YEARS OF DATA 18

PROBABILITY		95.	90.	80.	75	70.	60	50	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN	PRECIPITATION													ETCH	IRRIGATION REQUIREMENT **				
JAN	133.	42.	55	73	81	89	105	121.	138	159.	171	185.	227.	265.	121	66.	48.	40	32.	16.
FEB	142.	48.	61	81	89.	97	113	130	148.	169.	181.	196.	238.	277	116.	55.	35.	26.	18.	2.
MAR	204.	112.	129.	152.	161	169	186.	202.	219.	238.	249	262.	297.	329.	124.	-5	-27.	-36.	-45.	-61.
APR	271.	134.	157.	188.	201.	213	237	260.	285	313	329.	348.	401.	448.	104.	-53	-84.	-97	-109.	-133.
MAY	287.	141.	166	199	213	226	250	275	301.	331.	349	369.	425.	475.	106	-59.	-93.	-107.	-119.	-144.
JUN	210.	108	125.	149	159	167	185.	202.	220	240.	252.	266	304.	338	106	-20	-43.	-53.	-62	-79.
JUL	172.	66	82	104.	114	124	142	160.	180	203.	217	233	278.	319.	120.	38	15	6	-4	-22.
AUG	182.	63	80.	105	116	126	147.	168	190	217	232.	251.	303.	352.	128.	48	23.	12	2	-18.
SEP	176.	66.	82	106	116	125	144	163	184	208.	222	238.	285	328.	119	37.	13.	3.	-7.	-25.
OCT	310.	201.	221.	248	259	268	287	305	323	344	356	369.	406	439.	110.	-111.	-138	-149.	-158	-177.
NOV	273.	156	177.	204.	215	226	246	265	286	309.	322.	337.	379.	417.	98	-79	-106.	-118	-128.	-148.
DEC	214.	130	146.	167.	175	183.	198.	212	227.	244.	254.	265.	296.	323	110.	-36	-57.	-66	-73	-88.
ANN	2582.	2041.	2151	2288.	2341	2390	2480.	2567	2655	2751	2806	2867.	3033	3175.	1362	-789.	-926.	-980	-1029.	-1119.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0271	.0276	.0471	.0289	0270	0416	.0275	0223	.0263	.0548	0426	0620	.0217
R	3.593	3.907	9.819	7.833	7.760	8 712	4.725	4.070	4.610	18.727	11.620	13.498	55.924
LNGAM	1.1052	1.6765	12.3968	8 1907	8.0461	9 9933	2.7719	1.8804	2.6084	34.1571	16.5804	21.2557	140.0225

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 8.12 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME MERACILIO URIBE VALLE SER NO. 50700. LAT 4 17. LONG. 75 55. ELEV. 1550. YEARS OF DATA 13

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25	20.	10	5.		90.	80.	75.	70.	60.
MONTH	MEAN	PRECIPITATION													ETCH	IRRIGATION REQUIREMENT **				
JAN	91.	25.	34.	47.	53.	58.	70.	81.	94.	109	118.	129.	160.	189.	100.	66.	53.	47.	42.	31.
FEB	99.	24.	34.	48.	55.	61.	74.	87.	102.	120	130.	143	180	214.	100.	66.	52.	45.	39.	26.
MAR	143.	55.	68.	87.	95.	103.	118.	133.	150	169	180	193.	231.	265.	112.	44.	25.	16.	9.	-6.
APR	265.	165.	183.	207.	217.	226.	243.	259.	277	296.	307.	319	354.	384.	85.	-98	-122.	-132.	-141.	-158.
MAY	203.	111.	127.	148.	157	165.	181	196	212.	230	241.	253	287.	317.	98	-29.	-50.	-59.	-67.	-83.
JUN	159.	54.	69.	91.	101.	110.	128	146.	166.	190	203	220.	266.	309.	92.	23.	1.	-8.	-18.	-35.
JUL	92.	17.	25.	38.	45.	51.	64.	77.	93.	112.	123	137	177	215.	108.	83.	70.	64.	57.	45.
AUG	90.	20.	28.	41.	47.	53.	65.	78	92	109	120	132	168	202.	115.	87.	74.	68	62.	50.
SEP	135.	46.	59	77.	85.	93.	108	124.	141.	160.	172	186.	225	261.	107.	48.	29.	21.	14.	-2.
OCT	291.	120.	147.	185.	200	215.	244	274.	305	342	363.	388.	458.	523.	98.	-49	-87.	-102.	-117.	-146.
NOV	226.	118.	137.	162.	172.	181.	199.	217	236.	258	270	285.	325.	361.	82.	-55.	-80.	-90.	-100.	-118.
DEC	179.	92.	106.	126	134.	141.	156	170	185.	202	212.	223	255.	283.	85.	-21.	-41.	-49.	-56.	-70.
ANN	1969.	1478.	1575.	1698.	1747.	1791.	1873	1952.	2033.	2122.	2172	2229	2384.	2518.	1111.	-394.	-517.	-565.	-610.	-692.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0340	.0273	.0333	.0587	.0505	0250	.0225	0265	.0297	.0187	.0405	.0509	.0196
R	3.087	2.695	4.765	15.555	10.239	3.985	2.059	2.386	3.998	5.438	9.133	8.969	38.570
LNGAM	.7749	.4311	2.8299	26.6871	13.3426	1.7726	.0260	.2081	1.7890	3.8585	10.4894	10.5382	101.3997

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 8.13 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION, IN MM.

STATION NAME LA FLORIDA CAUCA SER. NO. 50963, LAT. 2 26, LONG. 76 36, ELEV. 1789, YEARS OF DATA 15

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.	90.	80.	75.	70.	60.
MONTH MEAN	PRECIPITATION													ETCH	IRRIGATION REQUIREMENT **			
JAN	148.	42.	56.	78.	87.	96.	114.	133.	154.	178.	193.	210.	260.	307.	106.	50.	29.	19.	10.	-8.
FEB	142.	53.	64.	85.	94.	101.	116.	132.	149.	168.	180.	193.	231.	266.	104.	38.	19.	11.	3.	-12.
MAR	168.	57.	73.	96.	106.	116.	135.	154.	175.	200.	215.	232.	281.	326.	112.	39.	16.	6.	-4.	-22.
APR	182.	79.	96.	118.	128.	137.	154.	172.	190.	212.	225.	239.	280.	318.	95.	-1.	-23.	-33.	-42.	-59.
MAY	149.	62.	75.	95.	103.	111.	125.	140.	156.	175.	185.	198.	234.	266.	97.	21.	2.	-6.	-14.	-29.
JUN	98.	14.	22.	36.	43.	50.	64.	80.	98.	120.	134.	150.	199.	247.	100.	78.	64.	57.	50.	36.
JUL	37.	5.	8.	14.	16.	19.	24.	30.	37.	46.	51.	57.	76.	94.	117.	109.	103.	101.	98.	93.
AUG	35.	3.	5.	10.	12.	15.	20.	26.	34.	43.	49.	56.	78.	99.	127.	121.	117.	114.	112.	107.
SEP	92.	24.	33.	46.	52.	58.	69.	81.	95.	111.	120.	131.	164.	194.	124.	91.	78.	72.	66.	54.
OCT	273.	172.	191.	215.	225	234	251.	267.	284.	303.	314.	327.	361.	392.	110.	-81.	-105.	-115.	-124.	-141.
NOV	306.	213.	231.	254.	263.	271.	287.	302.	317.	335.	344.	355.	386.	412.	93.	-128.	-161.	-170.	-178.	-194.
DEC	299.	175.	197.	227.	239	250.	271.	291.	313.	337.	351.	367.	417.	451.	99.	-98.	-127.	-139.	-150.	-171.
ANN	1929.	1453.	1547.	1667.	1714.	1757.	1837.	1913.	1991.	2078.	2127.	2182.	2332.	2461.	1284.	-263.	-383.	-430.	-473.	-552.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0213	.0322	.0237	.0333	.0373	.0172	.0444	.0343	.0318	.0603	.0832	.0417	.0204
R	3.154	4.580	3.987	6.056	5.566	1.688	1.659	1.213	2.918	16.439	25.448	12.471	39.400
LNGAM	.8399	2.5658	1.7754	4.8827	4.0649	-.0983	-.1037	-.0890	.6190	29.1084	56.2216	18.6617	104.4322

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 8.14 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION, IN MM.

STATION NAME EL CARMEN HUILA SER. NO. 51460, LAT. 2 21, LONG. 75 31, ELEV. 1500, YEARS OF DATA 10

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.	90.	80.	75.	70.	60.
MONTH MEAN	PRECIPITATION													ETCH	IRRIGATION REQUIREMENT **			
JAN	56.	4.	8.	17.	21	25.	36.	47.	61.	79	91.	105.	147.	189.	110.	102.	94.	90.	85.	75.
FEB	78.	12.	18.	30.	35.	41.	52.	64.	78.	96.	106.	119.	157.	194.	103.	85.	73.	68.	63.	51.
MAR	106.	45	54.	68.	73.	79.	89.	100.	111.	124.	132.	140.	165.	188.	114.	59.	46.	40.	35.	24.
APR	158.	76.	89.	108.	116.	123.	137.	151.	166.	183.	193.	204	236.	265.	88.	-1.	-20.	-28.	-35.	-49.
MAY	150.	84.	95.	114.	119.	125.	135.	146.	156.	168.	175.	183.	205.	225.	92.	-7.	-21.	-27.	-33.	-43.
JUN	116.	31.	42.	59.	66.	74.	88.	103.	120.	140.	152	166.	207.	246.	85.	43.	26.	19.	11.	-3.
JUL	96.	41.	50.	62.	67.	72.	81.	90.	100.	112.	118.	126.	148.	168.	96.	46.	34.	29.	24.	15.
AUG	75.	48.	53.	59	62	64.	69.	73.	78	83.	86.	89.	98.	106.	105.	52.	46.	43.	41.	36.
SEP	63.	34.	39.	46.	49.	57.	56.	61.	66.	72.	76.	79.	90.	100.	104.	64.	57.	55.	52.	47.
OCT	157.	68.	82.	102.	110.	118.	133.	148.	165.	184.	195.	208.	244.	276.	103.	21.	1.	-7.	-15.	-30.
NOV	176.	80.	90.	103.	109	114	123.	133.	143.	154.	160.	167.	188.	206.	85.	-5.	-14.	-24.	-29.	-39.
DEC	113.	42.	53	68.	74.	81.	92.	104.	118	133.	142.	153.	183.	210.	88.	36.	20.	14.	8.	-4.
ANN	1314.	982.	1047	1131.	1163.	1193.	1249	1302.	1357.	1417.	1451	1490.	1595.	1685.	1173.	126.	42.	10.	-20.	-76.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0169	.0225	.0533	.0460	.0847	.0251	.0620	.2341	.1589	.0376	.0913	.0412	.0286
R	1.109	1.761	5.640	7.277	12.664	2.974	5.926	17.471	10.038	5.919	12.444	4.634	37.526
LNGAM	-.0537	-.0810	4.1858	7 1047	19.1443	.6245	4.6609	31.9986	12.8866	4.6492	18.5947	2.6419	97.6169

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 8.15 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION, IN MM.

STATION NAME CHAPETON TOLIMA SER. NO. 51709, LAT. 4 33, LONG. 75 8, ELEV. 1295, YEARS OF DATA 11

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.	90.	80.	75.	70.	60.
MONTH MEAN	PRECIPITATION													ETCH	IRRIGATION REQUIREMENT **			
JAN	87.	28.	35.	47.	52.	56.	66.	75.	86.	98	105.	113.	138.	160.	107.	72.	60.	55.	51.	41.
FEB	120.	43.	54.	70	77	84.	97.	111.	125.	142.	152.	164.	198.	229.	101.	47.	30.	23.	17.	4.
MAR	207.	86.	105.	132.	143	153.	174.	195.	217.	243.	258.	276.	325.	371.	110.	5.	-22.	-33.	-44.	-64.
APR	231.	144.	160.	181.	189.	197.	212.	226.	241.	257.	267.	278.	308.	334.	94.	-66.	-86.	-95.	-103.	-117.
MAY	204.	122.	134.	158	166	174.	189.	203.	218.	234.	244.	255.	286.	313.	100.	-37.	-58.	-66.	-74.	-88.
JUN	170.	16.	28.	51	63.	75.	100.	130.	164.	207.	234.	267.	355.	462.	103.	75.	52.	40.	28.	2.
JUL	115.	29.	40.	57.	64.	72.	86.	101.	119.	139.	151.	165.	207.	246.	114.	73.	57.	49.	42.	27.
AUG	137.	38.	51.	71.	80.	88.	105.	122.	142.	165.	179.	195.	242.	286.	124.	73.	53.	44.	36.	19.
SEP	177.	73.	82.	95.	100.	105	114.	123.	133.	143.	149.	156.	176.	193.	119.	37.	24.	19.	14.	5.
OCT	214.	95.	114.	141.	152	162.	182.	203.	225.	249.	264.	281.	328.	371.	105.	-9.	-36.	-47.	-57.	-78.
NOV	197.	116.	131.	150.	158	165.	179.	192.	206.	222.	231.	242.	270.	296.	88.	-43.	-62.	-70.	-78.	-91.
DEC	149.	58.	72	92	100.	108.	121.	139.	156.	175.	187	200	238.	273.	94.	22.	2.	-6.	-14.	-29.
ANN	1957.	1388.	1498.	1639.	1695	1746.	1841.	1933.	2028.	2133.	2193.	2261	2446.	2606.	1259.	-239.	-380.	-436.	-487.	-582.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0478	.0355	.0265	.0681	.0611	0078	0244	.0224	.0922	.0292	.0653	.0335	.0142
R	3.924	4.265	5.488	15 702	12.726	1 323	2.799	3.069	11.688	6.258	12.897	4.978	27.688
LNGAM	1.6975	2.1343	1 9389	27.0847	19.2971	-.1118	.5157	.7582	16.7436	5.2332	19.7273	3.1456	63.5237

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 8.16 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION, IN MM.

STATION NAME LIRANO TOLIMA SER. NO. 51726, LAT. 4 56, LONG. 75 3, ELEV. 1495, YEARS OF DATA 15

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.	90.	80.	75.	70.	60.
MONTH MEAN	PRECIPITATION													ETCH	IRRIGATION REQUIREMENT **			
JAN	90.	15.	23.	36.	42.	49.	61.	75.	91.	110.	122.	136.	177.	217.	95.	72.	59.	53.	46.	34.
FEB	139.	32.	45.	65.	75.	84.	102.	121.	143.	168.	184.	202.	256.	307.	89.	44.	23.	14.	5.	-13.
MAR	215.	88.	104.	136.	147.	158.	180.	202.	225.	252.	268.	286.	339.	386.	99.	-9.	-37.	-49.	-60.	-81.
APR	271.	136.	159.	191.	204.	216.	239.	262.	287.	315.	331.	350.	402.	449.	84.	-75.	-107.	-120.	-132.	-155.
MAY	252.	123.	145.	174.	186.	198.	220	242.	265.	291.	307.	324.	374.	419.	85.	-60.	-89.	-101.	-113.	-135.
JUN	162.	31.	45.	69.	80.	91.	113.	138.	165.	198.	218.	241.	312.	378.	90.	45.	21.	10.	-1.	-23.
JUL	121.	31.	45.	62.	70	78.	92.	109.	125	146.	158.	172.	214.	253.	108.	64.	46.	38.	31.	16.
AUG	130.	45.	76.	91.	97.	103.	114.	12[illegible].	136.	150.	157.	166.	191.	214.	116.	40.	25.	19.	13.	2.
SEP	194.	99.	115.	138.	147.	156.	173	190.	207.	228.	239.	253.	291.	325.	108.	-7.	-30.	-39.	-48.	-65.
OCT	311.	164.	189.	223.	237	251.	275.	300	326.	356.	373.	393.	448.	497.	92.	-97.	-131.	-145.	-158.	-183.
NOV	271.	99.	125.	161.	177	192.	221.	251.	283.	321.	343.	369.	443.	511.	78.	-46.	-83.	-99.	-114.	-143.
DEC	178.	99.	113.	131	139.	146.	159.	172.	186.	202.	211.	221.	250.	275.	85.	-27.	-46.	-54.	-61.	-74.
ANN	2341.	1730.	1850.	2003.	2063.	2118.	2220	2319.	2420.	2531.	2594.	2666.	2860.	3028.	1130.	-720.	-873.	-933.	-988.	-1090.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0213	.0182	0250	.0294	.0303	.0130	.0251	.0617	.0408	.0235	.0164	.0603	.0149
R	1.924	2.525	5.369	8.049	7.651	2.117	3.041	8.026	8.082	9.197	4.443	10.720	34.951
LNGAM	-.0301	.1024	3.7491	8.6240	7.8291	.0515	.7311	8.5784	8.6503	11.0280	2.3744	14.4502	88.4063

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 8.17 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME LLANOFS CALDAS SER. NO. 51745. LAT. 5 13. LONG. 75 9. ELEV. 1870. YEARS OF DATA 13

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	136.	47.	54.	74.	81	91.	107.	123.	141	163	175.	190	233.	277.	95.	40.	21.	13.	5. -11.
FEB	194.	120.	134.	151.	159.	165.	178.	190.	201.	217.	225.	235.	261.	281.	95.	-38.	-56.	-63.	-70. -82.
MAR	304.	154.	140.	215.	230.	243	264.	295.	321.	354.	372.	395	457.	505.	103.	-77.	-112.	-126.	-140. -166.
APR	329.	230.	249.	273.	284.	297.	308.	324.	341	359	370.	382.	414.	442.	91.	-157.	-182.	-192.	-200. -217.
MAY	330.	202.	226.	256.	268.	280.	301.	327.	344.	368.	383.	399.	445.	482.	96.	-129.	-160.	-172.	-184. -205.
JUN	167.	41.	57.	81.	92.	103.	124.	147.	172.	202	219.	240.	302.	360.	97.	40.	16.	5.	-6. -27.
JUL	124.	2.	4.	15.	21.	29.	47.	70.	101.	143	170.	204.	315.	429.	112.	107.	97.	90.	83. 65.
AUG	164.	67.	83.	105.	114.	123.	140.	158.	176	198.	211.	226.	268.	307.	118.	35.	13.	4.	-5. -22.
SEP	212.	125.	141.	167.	170.	178.	192.	207.	222	238	248.	259.	290.	317.	113.	-28.	-49.	-57.	-65. -80.
OCT	382.	179.	213	258.	277.	295.	310.	364.	401	442.	467.	495.	574.	645.	101.	-112.	-158.	-177.	-195. -229.
NOV	359.	211.	238.	273.	287.	300.	325	350.	376.	405.	421.	440.	493	540	85.	-152.	-187.	-202.	-215. -240.
DEC	294.	138.	163.	199.	214.	227	254.	281.	309.	342.	360.	382.	444.	499.	89.	-74.	-110.	-124.	-138. -165.
ANN	3003.	2139.	2306.	2521	2606.	2683	2828.	2948.	3112.	3271	3362	3465.	3745.	3987.	1196.	-1110.	-1324.	-1409.	-1487. -1632.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0261	0775	.0780	.0450	.0163	.0054	.0303	.0614	0184	.0353	.0236	.0094	
R	3.540	15.054	8.087	25 634	14.826	2.715	.669	5.107	13.019	7.024	12 684	6.941	28.315
LNGAM	1.2456	25.3347	8 7000	56.8201	24.7266	.4966	.3002	3.3401	20.0343	6.6239	19.1930	6.4694	65.6040

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 8.18 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME ANOLAIMA CUNDINAMARCA SER. NO. 52005. LAT. 4 45. LONG. 74 29. ELEV. 1726. YEARS OF DATA 7

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5		90	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	71.	9.	14.	24.	29.	34	45.	56	70.	86	97.	109.	146.	182.	111.	97.	87.	82.	77. 66.
FEB	87.	30.	39.	51.	56	61.	70.	80.	91.	103.	110	119	144	166.	102	64	52.	47.	42. 32.
MAR	76.	37.	43.	52.	56.	59.	66.	72.	79.	87	92.	97	112.	125.	123	79.	71.	67.	64. 57.
APR	154.	65.	79.	99.	108.	116	132.	148	165	185	197.	210.	249.	283.	93	14.	-7.	-15.	-24. -39.
MAY	165.	79.	94.	113.	121.	129	143	158	173.	191.	201.	213.	246.	276	102	9.	-11.	-19.	-27. -41.
JUN	84.	23.	31	43.	49.	54.	65	76.	84.	103.	117.	122	152.	180.	100	69.	57.	51.	46. 35.
JUL	53.	28.	32.	38	41	43	47.	51.	56	61.	64.	67.	76	85	115.	83.	77.	74.	72. 68.
AUG	57.	25.	29.	35	38.	40.	45.	50.	55.	60.	64	67.	78.	88	122	93.	87.	85	82. 77.
SEP	94.	17.	26.	39.	46.	52.	65	79.	95.	115.	126.	140.	182.	221	119.	94.	80.	74.	67. 54.
OCT	179.	84.	105	125.	133	141.	156.	171.	187.	206.	216.	228.	262.	293	108.	3	-17.	-26.	-34. -49.
NOV	121.	36.	47.	65.	72.	80	94.	109	126	146	158	171.	211	248.	87.	39.	22.	14.	7. -8.
DEC	117.	50.	60.	74.	80.	85.	96	107.	118	131	139	147.	177.	195	89	29.	15.	9.	3 -7.
ANN	1253.	897.	966.	1055.	1090	1122	1181	1238	1298.	1363.	1400	1443.	1558.	1657.	1271.	305.	216.	181.	149. 90.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0220	.0481	.1011	.0741	.0449	0343	.1743	1376	.0219	.0454	.0271	.0561	.0233
R	1.558	4.168	7.640	5.365	7.400	2.922	9 274	7.159	2.059	8.119	3.293	6 312	29.180
LNGAM	-.1171	2.0063	7.8093	3.7423	7.3401	.6226	11 1963	6.8788	.0261	8.7669	.9794	5.3290	68.4926

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 8.19 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION IN MM.

STATION NAME TIRAFUY CUNDINAMARCA SER. NO 35. LAT. 4 21. LONG. 74 27. ELEV 1550. YEARS OF DATA 16

PROBABILITY	95.	90.	80.	75.	70.	60	50.	40.	30.	25.	20.	10.	5.		90	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	61.	15.	21.	29.	33.	37.	45.	53.	63.	74	80.	88.	111.	132.	117.	97.	84.	84.	80 72.
FEB	69.	12.	18.	28.	33.	38.	48.	58.	70.	85.	94	104	136.	166.	107.	88.	78	73	69. 59.
MAR	91.	24.	32.	45.	51.	57.	68.	80.	94.	110.	119.	130.	163.	193.	118.	86.	73.	67.	61. 50.
APR	123.	51.	62.	78.	86.	91	103.	115.	129.	144.	153.	164.	194.	221.	95.	33.	17.	10	4. -8.
MAY	116.	46.	57.	72.	79.	85.	96.	108.	121.	136	145	155.	184.	210.	97.	40	25.	19	13. 1.
JUN	67.	14.	21.	30.	35	39	48	58	68	81.	89.	98.	125.	151.	95	74.	64.	60.	56. 47.
JUL	41.	9.	13	19.	21	24	30	35	42	49.	54.	60	76.	91.	109.	97.	91.	88.	85. 80.
AUG	35.	7.	11.	16.	18.	20.	25	30	36	43	47.	52	66.	80.	117.	107.	102	99.	97. 92.
SEP	50.	10.	15.	22.	26.	29.	36.	43.	51.	61.	67.	74	94	114.	118.	103.	96.	92	89. 82.
OCT	172.	80	95	115.	124	132.	148	161.	180.	199.	210.	223	259.	292.	110	16.	-5.	-14.	-22. -37.
NOV	202.	73.	92.	120.	131.	143.	164.	187.	211.	240.	257.	276.	332.	383.	96.	4.	-24.	-35.	-47. -69.
DEC	104.	38	49.	62.	68.	74	85.	96.	108.	123.	131.	141.	169	195.	106.	58.	44.	38.	32 21.
ANN	1130.	426.	886.	961.	991	1019	1069.	1118	1169.	1224.	1256.	1291.	1389.	1472.	1284	400.	324.	294	267. 216.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0440	.0783	.1313	.0440	.0447	.0359	.0591	.0648	.0458	.0399	.0215	.0434	.0291
R	2.673	1.966	2.839	5.406	5.173	2.970	2.408	2.282	2.290	6.843	4.354	4.504	32.846
LNGAM	.4137	-.0140	.5495	3.8069	3.4418	.1974	.2219	.1437	.1481	6.7874	2.2531	2.4594	41.0231

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 8.20 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM

STATION NAME DOLORES TOLIMA SER. NO. 49. LAT. 3 32. LONG. 74 53. ELEV. 1590. YEARS OF DATA 6

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	69.	4.	7.	16.	20.	25.	35.	47.	62.	82.	94.	109.	155.	201.	120	112.	104.	100	95. 84.
FEB	94.	4.	14.	26.	33.	40.	54.	71.	91.	116.	132.	151.	209	266.	131.	117	105.	98	91 77.
MAR	133.	30.	43.	62.	71.	80.	97.	116	137.	162.	177.	194.	247.	296.	149	106.	87.	78.	69. 52.
APR	230.	83.	104.	136.	149.	162.	187.	213	241.	273.	293.	315	379	438	106.	2.	-30.	-41.	-56. -81.
MAY	167.	50.	66.	90.	100	110	130.	150.	171	200.	216.	234	288	338	116.	51.	27.	16	6. -13.
JUN	104.	15.	24.	40.	47.	55	70.	88.	108	132	147.	165	218	269.	123.	99.	83.	76.	68. 53.
JUL	41.	16.	20.	25.	27.	30.	34.	34.	43.	49.	52	56.	67.	77.	139.	120.	114.	112	110. 105.
AUG	40.	8.	11.	17.	20	23	28.	34.	41	49.	54.	60.	77.	93.	145.	133.	127.	125.	122. 116.
SEP	57.	15.	20	28.	31	34	40	47.	54.	62	67.	73.	90.	105.	146.	126.	119.	115.	112. 106.
OCT	248.	106.	133.	171.	188	204.	235.	267	301	341.	368.	392.	471.	543.	132.	-0.	-39.	-56.	-72. -103.
NOV	349.	218.	243.	274.	287	299	321	342.	365.	390	404.	421.	466.	506.	101.	-140.	-171.	-184.	-196. -218.
DEC	265.	120.	143.	175.	189.	207	226.	251.	277.	308.	325.	346.	404.	456.	109.	-34.	-66.	-80.	-93. -117.
ANN	1836.	1207.	1325.	1478	1540.	1596.	1702.	1804.	1911.	2030.	2098.	2175.	2388.	2573.	1520.	195.	42.	-20.	-76. -182.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0151	0128	.0186	.0187	.0203	.0158	.1145	.0538	.0646	.0155	.0452	.0244	.0105
R	1.024	1.221	2.472	4.310	3.375	1.704	4.727	2.163	3.343	4.452	15.791	6.461	19.304
LNGAM	-.0140	-.0911	.2642	2.1948	1.0654	-.0949	2.7746	.0772	1.0320	2.3880	27.3272	5.5930	37.2860

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9. 1 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION, IN MM.

STATION NAME ARPTO MONTERIA CORDOBA SER. NO. 10231, LAT. 8 45, LONG. 75 51, ELEV. 15, YEARS OF DATA 10

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN	PRECIPITATION													ETCH	IRRIGATION REQUIREMENT **				
JAN	5.	0.	0.	0.	0.	0.	0.	1.	2.	4.	5.	7.	15.	23.	57.	57.	57.	57.	57.	57.
FEB	22.	0.	0.	0.	0.	0.	1.	3.	6.	14.	20.	30.	66.	112.	58.	58.	58.	58.	58.	57.
MAR	24.	0.	0.	0.	1.	1.	3.	6.	12.	22.	29.	38.	72.	111.	68.	68.	68.	68.	67.	65.
APR	93.	18.	27.	40.	47.	53.	66.	79.	95.	114.	125.	138.	178.	216.	63.	36.	22.	16.	10.	-3.
MAY	176.	73.	89.	112.	121.	130.	148.	166.	185.	207.	219.	234.	277.	315.	60.	-29.	-52.	-61.	-70.	-88.
JUN	130.	46.	58.	76.	83.	91.	105.	120.	136.	155.	166.	179.	216.	250.	53.	-4.	-22.	-30.	-37.	-52.
JUL	160.	59.	74.	95.	105.	113.	131.	148.	168.	190.	203.	219.	263.	303.	58.	-16.	-37.	-47.	-55.	-73.
AUG	178.	82.	98.	119.	128.	137.	153.	170.	187.	207.	219.	232.	270.	305.	60.	-37.	-59.	-68.	-77.	-93.
SEP	165.	92.	104.	122.	129.	135.	147.	160.	172.	187.	195.	205.	231.	255.	57.	-47.	-64.	-71.	-78.	-90.
OCT	106.	13.	22.	37.	44.	52.	67.	84.	104.	129.	144.	163.	218.	271.	59.	37.	22.	15.	8.	-8.
NOV	74.	18.	25.	36.	41.	45.	55.	65.	76.	89.	97.	107.	134.	160.	53.	28.	17.	12.	7.	-2.
DEC	41.	4.	7.	12.	15.	18.	24.	31.	40.	50.	57.	65.	89.	112.	54.	48.	42.	39.	36.	30.
ANN*	1175.	954.	1003.	1062.	1085.	1103.	1141.	1175.	1209.	1247.	1266.	1289.	1348.	1397.	702.	-301.	-360.	-383.	-402.	-440.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0541	.0096	.0127	.0232	.0311	.0318	.0276	.0376	.0653	.0149	.0362	.0320	.0723
R	.265	.211	.312	2.164	5.485	4.140	4.421	6.704	10.753	1.578	2.675	1.319	85.033
LNGAM	1.2247	1.4683	1.0547	.0779	3.9339	1.9702	2.3452	6.0320	14.5256	-.1152	.4150	-.1112	.0000

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9. 2 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION, IN MM.

STATION NAME ARPTO CARTAGENA BOLIVAR SER. NO. 1032 , LAT. 10 26, LONG. 75 30, ELEV. 2, YEARS OF DATA 10

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN	PRECIPITATION													ETCH	IRRIGATION REQUIREMENT **				
JAN	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	2.	3.	131.	131.	131.	131.	131.	131.
FEB	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	128.	128.	128.	128.	128.	128.
MAR	1.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	1.	3.	5.	143.	143.	143.	143.	143.	143.
APR	14.	0.	0.	0.	0.	1.	2.	4.	7.	13.	18.	23.	44.	68.	138.	138.	138.	138.	137.	136.
MAY	101.	7.	13.	26.	32.	39.	55.	73.	94.	122.	139.	160.	225.	290.	158.	145.	133.	126.	119.	103.
JUN	71.	22.	29.	39.	43.	47.	56.	65.	74.	86.	92.	100.	123.	144.	127.	98.	88.	84.	80.	71.
JUL	64.	22.	29.	38.	43.	47.	54.	62.	71.	82.	88.	95.	115.	134.	147.	118.	108.	104.	100.	92.
AUG	100.	5.	11.	23.	29.	36.	51.	69.	92.	120.	138.	160.	228.	297.	147.	136.	125.	118.	111.	96.
SEP	107.	16.	25.	41.	48.	55.	71.	87.	107.	130.	145.	162.	213.	262.	138.	113.	97.	90.	81.	67.
OCT	184.	53.	71.	98.	110.	121.	144.	168.	195.	227.	245.	268.	332.	391.	144.	74.	46.	34.	23.	-0.
NOV	116.	9.	17.	32	40.	48.	66.	87.	111.	141.	161.	184.	255	325.	124.	107.	92.	84.	76.	58.
DEC	34.	0.	0.	1.	1.	2.	5.	10.	18.	31.	41.	54.	99	150	123.	123.	123.	122.	121.	118.
ANN	802.	306.	381.	488.	531	576.	661.	747.	840.	948.	1011.	1085.	1296.	1489.	1650.	1269.	1162.	1117.	1073.	989.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.3285	1.3023	.2006	.0207	.0111	.0481	.0554	.0102	.0168	.0165	.0105	.0100	.0059
R	.227	.247	.215	.314	1.122	3.434	3.749	1.014	1.785	3.098	1.222	.341	4.737
LNGAM	1.3916	1.2989	1.4493	1.0480	-.0588	1.1288	1.5328	-.0079	-.0752	.7858	-.0914	.9613	2.7902

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9. 3 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION, IN MM.

STATION NAME ARACATACA MAGDALENA SER. NO. 10420, LAT. 10 33, LONG. 74 13, ELEV. 40, YEARS OF DATA 10

PROBABILITY		95.	90	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN	PRECIPITATION													ETCH	IRRIGATION REQUIREMENT **				
JAN	3.	0.	0	0.	0.	0.	0.	0.	0.	1.	2.	3.	8.	15.	128.	128.	128.	128.	128.	128.
FEB	10.	0.	0.	0.	0.	0.	0.	1.	2.	5.	7.	11.	29.	53.	121.	121.	121.	121.	121.	120.
MAR	11.	0.	0.	0.	0.	1.	2.	4.	8.	12.	16.	34.	55.	162.	162.	162.	162.	162.	162.	161.
APR	62.	14.	20	29.	33.	37.	45.	54.	64.	75.	82.	90.	114.	137.	152.	132.	123.	119.	115.	106.
MAY	182.	90.	105.	126.	135.	143.	159.	174.	191.	209.	220.	233.	268.	300.	141.	36.	15.	6	-2.	-17.
JUN	147.	49.	63.	83.	92.	101.	117.	134.	153.	175.	189.	201.	246.	286.	122.	59.	38.	30.	21.	5.
JUL	110.	34.	45.	61.	67.	74.	87.	100.	115.	132.	143.	155.	189.	221.	137.	92.	77.	70.	63.	50.
AUG	151.	36	50.	73.	82	92	112.	133.	156.	183.	200.	219.	277.	331.	138.	88.	66.	56.	46.	26.
SEP	213.	74.	94.	123.	136.	148.	172	196.	223	254.	272.	294.	355.	412.	128.	34.	5.	-8.	-20.	-44.
OCT	294.	97.	126.	167.	186	203.	237.	273.	317.	357.	384.	416.	507.	590.	120.	-5.	-47.	-65.	-83.	-117.
NOV	163.	70.	31.	56.	67	79	103.	130.	161.	200.	223.	252.	339.	422.	109.	76.	53.	42.	30.	6.
DEC	20.	0.	0.	0.	0.	0.	1.	2.	5.	12.	17.	26.	60.	104.	125.	125.	125.	125.	125.	125.
ANN	1377.	755	861	1007	1066.	1121.	1225.	1328.	1437.	1559.	1630.	1711.	1937.	2138.	1583.	721.	576.	517.	462.	358.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0603	.0167	.0219	.0405	.0431	.0266	.0319	.0173	.0190	.0125	.0094	.0097	.0076
R	.166	.164	.247	2.509	7.837	3.898	3.428	2.613	4.056	3.733	1.534	.194	10.405
LNGAM	1.7222	1.7354	1.3009	.7911	8.1977	1.6656	1.2321	.3672	1.8625	1.4673	-.1190	1.5554	13.7232

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9. 4 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION, IN MM.

STATION NAME ROBLES MAGDALENA SER. NO. 11159, LAT. 10 24, LONG. 73 10, ELEV. 720, YEARS OF DATA 12

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN	PRECIPITATION													ETCH	IRRIGATION REQUIREMENT **				
JAN	15.	0.	0.	0.	1.	1.	2.	5.	8.	14.	18.	24.	43.	65.	151.	151.	151.	150.	150.	149.
FEB	34.	0.	1.	4.	5	7.	12.	18	27.	38.	46.	55.	86.	119.	137.	136.	134.	132.	130.	125.
MAR	41.	1.	2.	6.	8.	11.	17.	25.	34	48.	57.	67.	102.	134.	170.	168.	164.	162.	159.	153.
APR	125.	36	44	66.	74	82.	97.	113.	131.	152.	164.	179.	221.	261.	154.	105.	87.	79.	71.	56.
MAY	222.	103.	123.	150.	161.	171.	191.	211	233.	258.	272.	289.	335.	377.	172.	49.	23.	11.	1.	-19.
JUN	149.	72.	85	102.	109.	116	129.	142.	156.	172.	181.	192.	222.	249.	169.	84.	67.	59.	53.	39.
JUL	87.	38.	45.	55.	59.	63.	70.	78.	86	95.	100.	106.	123.	139.	198.	153.	143.	139.	135.	128.
AUG	115.	41.	52.	68.	74.	81.	93.	106.	120	136.	146.	157.	189.	218.	184.	132.	117.	110.	104.	91.
SEP	187.	99.	113.	132.	140	148.	162.	176.	190	207.	216.	227.	258.	285.	145.	32.	12.	4.	-3.	-17.
OCT	285.	184.	203	227.	237	246.	263.	279.	297.	316.	327.	339.	374.	404.	113.	-89.	-114.	-124.	-133.	-150.
NOV	154.	62.	77.	97.	105.	113	129.	145.	162	181.	193.	206.	245.	279.	119.	42.	22.	14.	6.	-10.
DEC	37.	0.	0.	1.	2.	3.	7.	12.	22.	36.	46.	59.	105.	156.	124.	124.	123.	122.	121.	117.
ANN	1441.	1135.	1197.	1274.	1304.	1332.	1383.	1432.	1482.	1536.	1567.	1602.	1696.	1777.	1836.	639.	562.	532.	504.	453.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0234	.0188	.0178	.0257	.0310	.0500	.0432	.0177	.0553	.0629	.0340	.0103	.0377
R	.349	.630	.731	3.188	6.884	7.441	6.792	4.328	10.048	17.918	5.240	.378	54.317
LNGAM	.9389	.3529	.2246	.8734	6.3632	7.4194	6.1939	2.2151	17.9111	33.2656	3.5451	.8551	161.5934

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9. 4 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME TOLU IAA BOLIVAR SER. NO. 71. LAT. 9 31. LONG. 75 36. ELEV. 4. YEARS OF DATA 8

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	1.	0.	0.	0.	0.	0.	0.	0.	1.	1.	2.	5.	8.	45.	45.	45.	45.	45.	45.
FEB	6.	0.	0.	0.	0.	0.	0.	0.	1.	3.	5.	7.	18.	37.	45.	45.	45.	45.	45.
MAR	9.	0.	0.	0.	0.	0.	0.	1.	2.	5.	7.	11.	28.	49.	56.	56.	56.	56.	56.
APR	47.	16.	20.	27.	30.	32.	38.	43.	49.	56.	60.	65.	79.	92.	47.	37.	30.	27.	25.	19.
MAY	69.	12.	18.	28.	32.	37.	46.	57.	69.	83.	97.	102.	133.	162.	58.	40.	30.	25.	21.	11.
JUN	104.	14.	26.	50.	61.	76.	104.	137.	176.	225.	247.	294.	410.	524.	52.	26.	2.	-11.	-24.	-52.
JUL	126.	14.	23.	41.	49.	58.	77.	98.	123.	154.	173.	196.	266.	313.	53.	30.	12.	4.	-5.	-24.
AUG	150.	18.	30.	51.	62.	72.	94.	119.	147.	183.	205.	231.	310.	386.	54.	24.	3.	-8.	-18.	-40.
SEP	135.	17.	27.	46.	56.	65.	85.	107.	133.	165.	184.	208.	278.	347.	51.	24.	5.	-4.	-14.	-34.
OCT	193.	35.	53.	81.	94	107.	134.	162.	195.	235.	259.	288.	372.	453.	49.	-4.	-32.	-45.	-58.	-85.
NOV	89.	2.	4.	12.	17.	22.	35.	52.	74.	103.	122.	146.	222.	301.	44.	40.	32.	27.	22.	9.
DEC	17.	0.	0.	0.	0.	0.	1.	3.	5.	10.	14.	16.	36.	56.	45.	45.	45.	45.	45.	44.
ANN	1021.	229.	324.	474.	547.	608.	743.	886.	1047.	1240.	1356.	1493.	1895.	2275.	609.	285.	135.	67.	0.	-134.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.1369	.0298	.0188	.0278	.0289	.0064	.0119	.0103	.0115	.0107	.0080	.0237	.0029
R	.205	.178	.174	3.914	1.965	1.185	1.431	1.543	1.555	2.054	.707	.289	2.451
LNGAM	1.5007	1.6444	1.6736	1.6847	-.0149	-.0809	-.1210	-.1183	-.1174	.0236	.2527	1.1353	.2511

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9. 6 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME RAJO CL MA VALLE SER. NO. 20520. LAT. 3 59. LONG. 76 52. ELEV 40. YEARS OF DATA 11

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90	80	75	70.	60
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	349.	151.	182.	225.	249.	260.	293.	326	361.	402	426	453	531.	602.	53.	-129.	-172	-190	-207.	-240.
FEB	264.	94.	119.	155.	170.	185.	214.	244.	276	314.	336	362.	416	505	49	-70.	-106	-122	-136	-165.
MAR	325.	111.	142.	187.	206.	225	261	298.	339.	387.	415.	448.	542.	629	55	-87	-132	-151	-170	-206.
APR	468.	247.	285	336.	357.	377	414	452.	491.	535.	561.	591.	674.	748.	57.	-234	-286.	-307	-327	-364.
MAY	612.	335.	383.	448.	475.	499.	546	592.	641.	696	728	765.	867	957	51	-132	-397	-424	-448	-495.
JUN	515.	186.	234.	304.	334	363	419	476	538	611	654	704	846.	978.	48.	-186.	-256	-286	-315.	-371.
JUL	475.	132.	177.	246	276	305.	363	424	492	571	619	675.	837	989	52	-125.	-193	224	-253	-311.
AUG	520.	261.	305.	364.	388	411.	455.	499	545.	597	628	663	761	850.	52	-253	-312	-337	-360.	-404.
SEP	609.	284.	337.	410	441.	470	525	580	639	706	745	791.	918.	1033.	51	-286.	-359	-390	-419.	-476.
OCT	592.	241.	297	374	406	437	496	556.	620.	695.	739.	789.	933.	1064.	18.	-249	-326.	-358	-388.	-447.
NOV	588	319	366.	429	455	479	524.	569.	616	670	701	736.	835	923.	45	-321.	-384.	-403	-431.	-478.
DEC	490	277	270	129.	354	377.	421	466	514.	569	600	636.	740	833	46.	-224	-283.	-308	-331	-375.
ANN	5807.	3460.	3883	4442.	4667	4877	5271.	5658	6064	6518	6780	7079.	7907.	8636.	600.	-3283	-3842	-4067	-4277	-4671.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0177	0160	.0123	.0197	.0167	.0084	.0065	.0158	.0113	.0091	0171	0139	.0023
R	6.090	4.233	4.009	9 224	10.240	4.337	3 076	8 195	5 904	5.388	10.034	6.823	13.357
LNGAM	4.9423	2.0923	1 8036	11.0877	13.3458	2.2306	.7642	8.9204	6.3998	3.7750	12 8775	6.2493	20.8929

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9. 7 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM

STATION NAME ANDAGOYA CHOCO SER. NO. 20652. LAT. 5 5. LONG. 76 43. ELEV. 60. YEARS OF DATA 12

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25	20.	10	5.		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	521.	272.	314.	372.	396.	418.	460	502.	547	597	626	660	753	837.	52.	-263	-320.	-344.	-366	-408.
FEB	548.	308.	351.	407.	430	452.	492	532	574	622	649	680	768	845	50	-301.	-357	-380.	-402.	-442
MAR	564.	359.	397.	447.	467.	485.	519	553	588	627	650	675.	745.	807.	55.	-342	-392.	-411	-430	-464
APR	611.	387.	429	481.	505	526	564	601	640.	683	708.	736.	814.	883.	55.	-373.	-428.	-450	-470	-508.
MAY	634.	380.	426	487.	511.	534.	577.	618	662	712	740.	772.	852.	921.	54	-372	-433.	-457.	-480	-523.
JUN	632.	440.	477	524	543.	560.	593.	624	656	692	712.	735	798	853.	50.	-427	-474.	-493	-510.	-542.
JUL	622.	364.	415	475.	499.	527.	565.	607	650	700	724	761	850	930	55	-360	-420	-445	-467	-510.
AUG	581	425.	456	495	511	525	552.	577	603	632	649	67.	714	762.	58	-398	-438.	-453	-468	-494
SEP	575.	339.	381	438	460.	481	521	560	602	648	674	704	789	863.	56.	-326	-382	-405	-426.	-466.
OCT	550.	431	455.	485.	497	508	528	547.	566	588	600	613	650	682	57.	-398	-429.	-440	-451	-471.
NOV	517.	288	328.	382.	414	424	463	501	542	587	613.	644	727	802	49.	-279.	-333.	-355	-376.	-414.
DEC	520	287	328	382.	405	425	465.	504	545	591.	618	649	734	810.	49	-279.	-334.	-356	-377.	-416.
ANN	6882	5586	5950	6181.	6311	6428	6644.	6850	7060.	7289	7419	7564	7957	8291.	638	-5212.	-5543.	-5672	-5790.	-6006

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0172	.0202	.0300	.0266	.0215	.0397	.0210	0552	.0223	.0947	0207	.0201	.0101
R	8.974	11.059	16.926	16 295	13.608	25 091	11 088	32 194	12.807	52.127	10.731	10.450	69 846
LNGAM	10.5479	15.2424	30 4643	28.7117	21.5379	55 0744	20.2086	79 7635	19.5001	152.9102	14.4747	13.8251	229 5377

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9. 8 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME QUIBDO CHOCO SER. NO. 80. LAT 5 41. LONG. 76 40. ELEV. 43. YEARS OF DATA 6

PROBABILITY	95.	90.	80	75.	70.	60	50.	40.	30.	25	20	10	5		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	441.	277.	307.	347.	363.	377.	405	432.	460.	491	509	530	586.	636	50.	-257.	-296.	-312.	-327.	-355.
FEB	526.	180.	230.	303.	334.	364	423.	483	549	626.	672	725.	878	1018.	47.	-183	-256.	-287.	-317	-376.
MAR	384.	37.	65.	117	143.	171.	228.	294	371	468	528.	600	821	1036.	55	-10.	-63.	-89.	-116.	-174.
APR	447.	67.	104.	169.	200.	231.	295.	366	447.	547	608	680.	898.	1107.	54	-50.	-115.	-146.	-177.	-241.
MAY	542.	410.	437.	470.	483	495.	517.	538.	560	584	597.	613	654.	690.	54.	-383	-416.	-429.	-441.	-463.
JUN	682.	523.	554.	595.	610.	625.	651.	677.	703	732	748.	767	817.	859.	55.	-500.	-540.	-556	-570.	-597.
JUL	725.	339.	402.	489.	525	559.	625.	690.	760	840	887	941	1092	1229.	55.	-347.	-434.	-470.	-504.	-569.
AUG	667.	227.	290.	382.	422	460	535.	612	696	794	852.	920.	1116.	1295	57.	-233.	-325.	-365.	-403.	-478.
SEP	550.	365.	400.	445.	463.	480.	511.	541.	573	608	628.	650	713	767	55.	-345.	-391.	-409.	-425.	-456.
OCT	479.	340.	367.	401.	415.	428	451.	474	497	523	537.	554.	599	638	52.	-315.	-349.	-363.	-376.	-399.
NOV*	453.	369.	387.	410.	418	426	440	453.	466.	480.	488.	496	519.	537.	47.	-340.	-363.	-371.	-378.	-393.
DEC	460.	312.	340.	376	391.	404	429.	453.	478	506	522	540.	589.	632.	47	-293.	-330	-344.	-357.	-382.
ANN	6357.	4375.	4754.	5242	5436.	5614.	5946.	6268.	6602.	6971	7187	7421	8076.	8644	627.	[illegible]				

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0365	.0076	.0035	0039	.0748	.0648	.0096	.0060	.0365	.0578	.0298	.0481	.0037
R	16.116	4.024	1.347	1.752	40.601	44.209	6.929	3.971	20.063	27.697	95.070	22.133	23.762
LNGAM	28.7167	1.8219	-.1149	-.0838	108.8465	122.3273	6.4464	1.7557	39.5282	63.5559	14.4747	45.7874	50.8557

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9. 9 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME EST JARAMILLA CORDOBA SER. NO. 40718. LAT. 6 55. LONG. 75 43. ELEV. 1450. YEARS OF DATA 15

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	80.	19.	26.	38.	43.	49.	59.	70.	82.	97.	106.	116.	147.	176.	120.	94.	82.	77.	72.	62.
FEB	105.	24.	33.	49.	56.	63.	77.	91.	108.	128.	140.	154.	195.	235.	119.	85.	70.	63.	56.	42.
MAR	144.	62.	75.	93.	101.	108.	122.	136.	151.	169.	179.	191.	224.	254.	132.	57.	39.	31.	24.	10.
APR	238.	141.	159.	182.	191.	200.	216.	232.	249.	267.	278.	290.	325.	355.	111.	-48.	-71.	-80.	-89.	-105.
MAY	322.	146.	175.	214.	230.	246.	276.	306.	338.	374.	396.	421.	491.	554.	116.	-58.	-98.	-114.	-130.	-160.
JUN	231.	97.	118.	147.	160	172.	194.	217.	242.	270.	287.	306.	361.	411.	117.	-1.	-31.	-43.	-55.	-78.
JUL	173.	45.	61.	86.	98.	108.	130.	153.	179.	209.	227.	248.	310.	368.	131.	70.	45.	33.	22.	1.
AUG	237.	75	98.	131.	146.	160.	187.	215.	247.	283.	305.	330.	404.	471.	140.	42.	5.	-5.	-19.	-47.
SEP	213.	104.	122.	147.	157.	167.	185	204.	224.	246.	259.	274.	317	355.	122.	0.	-25.	-35.	-45.	-64.
OCT	315.	174.	199.	232.	245.	256.	282.	305.	330.	358.	374.	392.	444.	489.	105.	-94.	-127.	-140.	-153.	-176.
NOV	232.	108.	128.	156.	168	179	200.	221.	243	269.	284.	301.	349.	393.	96.	-32.	-60.	-71.	-82.	-103.
DEC	143.	57.	71.	92.	101.	109	125.	142.	160.	181.	193.	208.	249.	286.	102.	31.	11.	2.	-7.	-23.
ANN	2443.	1644.	1795	1991.	2069.	2141.	2275.	2405.	2540.	2690.	2775.	2872.	3139.	3371.	1912.	-383.	-579.	-657.	-729.	-863.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0322	.0233	0405	.0555	.0202	.0243	.0165	.0153	.0355	.0336	.0299	.0298	.0088
R	2.577	2.449	5.834	13 213	6.515	5.608	2.849	3.624	7.565	10.570	6.918	4.564	21.419
LNGAM	.3407	.2495	4.5067	20.5258	5.6889	4.1330	.5582	1.3404	7.6615	14.1010	6.4259	2.5431	43.6056

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9.10 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME S JERONIMO ANTIOQUIA SER. NO. 40818. LAT. 6 26. LONG. 75 44. ELEV. 703. YEARS OF DATA 9

PROBABILITY	95.	90.	80.	75.	70	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	27.	4.	6.	10.	12.	14.	18.	22.	27.	33.	36.	41.	54.	66.	63.	56.	53.	51.	45.	45.
FEB	51.	8.	13.	20.	24.	27.	34.	42.	51.	62.	69.	77.	101.	123.	61.	48.	40.	37.	33.	26.
MAR	51.	19.	24.	31.	34	36.	42.	47.	53.	60.	64.	69.	81.	96.	71.	47.	40.	37.	34.	29.
APR	111.	57.	67.	79.	84.	89.	98.	107.	117.	127.	134.	141.	161.	179.	65.	-2.	-14.	-20.	-24.	-33.
MAY	145.	98.	114	137	146.	154.	171.	187.	204.	224.	235.	248.	285.	318.	64.	-50.	-72.	-82.	-90.	-107.
JUN	115.	35.	48.	68.	76.	85.	102.	120.	140.	163	177.	194.	242.	288.	60.	12.	-8.	-16.	-25.	-42.
JUL	102.	36.	46.	60.	66	71.	83	94.	106.	121.	129	139.	168.	194.	63.	17.	3.	-3.	-8.	-20.
AUG	106.	34.	44	59	66.	72.	84.	97.	111.	127	137.	148.	181.	211.	67.	23.	8.	2.	-4.	-17.
SEP	145.	83.	94.	108.	114	120.	130.	141.	151.	164.	171.	179.	201.	221.	63.	-31.	-46.	-52.	-57.	-68.
OCT	202.	100	117.	140.	150	159.	176.	193.	211.	232	244.	258.	297.	333.	54.	-58.	-81.	-91.	-100.	-117.
NOV	143.	74.	86	102.	108.	115	126.	138	150.	164.	173.	182.	208.	231.	54.	-32.	-48.	-54.	-60.	-72.
DEC	60	12	18	27.	31.	35	43	51.	61.	73.	80	88.	113.	136.	57.	39.	30.	26.	22.	14.
ANN	1327.	945	1019.	1114.	1152.	1186.	1250.	1312.	1376.	1446.	1486.	1531.	1655.	1763.	745.	-274.	-369.	-406.	-441.	-505.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0658	0368	.0893	.0787	.0422	.0711	.0417	.0345	.0800	.0390	.0609	.0379	.0213
R	1.761	1.877	4.554	8.750	8.214	2.852	4.246	3.666	11.580	7.864	8.736	2.265	28.307
LNGAM	-.0816	-.0469	2.5290	10.0735	8.9596	.5609	2.1086	1.3891	16.4842	8.2532	10.0443	.1336	65.5779

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9.11 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME FAC AGRON MED ANTIOQUIA SER. NO. 40925. LAT. 6 16. LONG. 75 35. ELEV. 1450. YEARS OF DATA 9

PROBABILITY	95.	90.	80.	75.	70.	60	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	34.	5.	4.	14.	17.	20.	25.	32.	39.	48.	54.	60.	80.	100.	60.	52.	46.	43.	41.	35.
FEB	53.	14.	19.	27.	30.	33	40.	47.	54.	63	69.	75.	93.	111.	54.	38.	31.	27.	24.	18.
MAR	75.	29.	36.	45	50	54	62.	70.	79.	88.	94.	101.	120	134.	67.	31.	21.	16.	12.	5.
APR	164.	72.	87.	107	116	124	139	155.	177	191.	203.	216.	253.	287.	63.	-24.	-44.	-53.	-61.	-77.
MAY	179.	112.	124	141	147	153.	164.	175.	187.	199.	207.	215.	234.	254.	62.	-62.	-78.	-84.	-90.	-102.
JUN	152.	43.	58.	79.	89	98	117	136.	158	183.	198.	215.	267.	315.	61.	3.	-19.	-28.	-38.	-56.
JUL	127.	60.	70	84.	90	96.	106.	117.	128.	140.	148.	156.	180.	201.	65.	-5.	-19.	-25.	-30.	-41.
AUG	132.	46.	58.	76	84	92	106	121.	137	157.	168	181.	219.	253.	66.	8.	-10.	-18.	-25.	-40.
SEP	124.	43	55	72.	79	86.	100.	114.	130	148.	159	171.	207.	240.	64.	10.	-7.	-15.	-22.	-36.
OCT	177.	102.	115	133	140	147	160	172.	185.	200.	208.	218.	245.	269.	61.	-55.	-72.	-79.	-86.	-99.
NOV	117.	59.	69	82.	88.	93	102.	112.	123.	134.	141.	149.	171.	191.	56.	-13.	-27.	-32.	-37.	-47.
DEC	82.	40	47.	56.	60	64.	71.	78.	86.	94.	100.	105.	122.	136.	56.	9.	-0.	-4.	-8.	-15.
ANN	1415.	984.	1067.	1173	1214.	1254.	1326.	1396.	1469.	1549.	1594.	1646.	1787.	1910.	739.	-328.	-435.	-477.	-515.	-588.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0419	.0566	0655	.0370	.0892	0207	.0645	.0513	.0326	.0677	.0705	.0917	.0177
R	1.631	2.974	4.916	6.065	15 958	3.145	7.851	4.176	4.049	11.986	8.244	7.504	25.078
LNGAM	-.1082	.6692	3 0518	4.8982	27.7849	.8309	8 2265	1.9519	1.8542	17.4682	9.0217	7.5413	55.0357

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9.12 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME SONSON ANTIOQUIA SER. NO. 41000. LAT. 5 42. LONG. 75 18. ELEV. 2530. YEARS OF DATA 14

PROBABILITY	95	90.	80.	75	70.	60.	50.	40.	30	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	79.	13.	20.	32	37.	42.	54.	66.	80.	96.	107.	119.	155.	190.	46.	26	15.	9.	4.	-7.
FEB	90.	20.	37.	49	55.	60	71.	82.	94.	108.	116.	126.	154	180.	43.	6.	-7.	-12.	-18.	-28.
MAR	132.	72.	83.	97.	102.	108.	118.	128.	138.	150.	157.	165.	187.	207.	48.	-35.	-49.	-54.	-60.	-70.
APR	193.	134	149.	162.	164	172.	182.	190	199.	209.	215.	222.	239.	254.	46.	-102	-116.	-121.	-126.	-135.
MAY	275.	175.	192.	166.	176.	185	202.	218.	236	256.	268.	281.	318.	350.	47.	-96.	-119.	-129.	-138.	155.
JUN	197.	52.	71	99.	112.	124.	149	175.	203.	237.	257.	281.	351.	415.	47.	-24	-53.	-65.	-78.	102.
JUL	141.	51.	64.	83.	92	100.	115.	131.	148	167.	179.	193.	232.	268.	51.	-14.	-32.	-41.	-49.	-64.
AUG	183.	87.	103.	125.	134.	142.	158.	175.	192.	212.	224.	237.	274.	308.	53.	-50.	-71.	-80.	-89.	-105.
SEP	204.	117.	132.	153.	161.	169.	184.	198.	214.	231.	240.	252.	283.	311.	50.	-82.	-103.	-111.	-119.	-133.
OCT	265.	154.	174.	200.	211	221.	239	258.	277.	298.	311.	325.	364.	399.	45	-129.	-155.	-165.	-175.	-194.
NOV	220.	109	128.	153	164	174.	192.	211.	231.	254.	267.	282.	324.	367.	41.	-86.	-112.	-122.	-132.	-151.
DEC	134.	71.	82	97.	103.	108.	119.	129	140.	153	160.	169	192.	213.	43.	-39.	-54.	-60.	-65.	-76.
ANN	2063.	1562.	1661.	1787.	1837.	1882.	1966.	2046.	2128.	2219.	2270.	2328.	2485.	2621.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0243	.0393	.0769	.1529	.0470	.0149	.0308	.0393	.0675	.0470	.0361	.0705	.0198
R	1.916	3 547	10.160	29.434	10.591	2.927	4.349	7.195	11.743	12.427	7.954	9.467	40.867
LNGAM	-.0331	1.2481	13.1630	69.3467	14.1495	.6768	2.7466	6.9472	16.8768	18.5532	8.4324	11.5733	109.8287

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9.13 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION, IN MM.

STATION NAME EL CENTRO SANTANDER SER. NO. 41400, LAT. 6 57, LONG. 73 45, ELEV. 135, YEARS OF DATA 12

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	65.	0.	0.	1.	1.	2.	6.	14.	28.	53.	72.	98.	192.	302.	62.	62.	62.	61.	60. 56.
FEB	129.	3.	8.	20.	27.	35.	54.	79.	110.	151.	178.	212.	318.	427.	59.	52.	40.	32.	24. 5.
MAR	195.	107.	122.	143.	151.	159.	174.	189.	205.	222.	232.	249.	277.	306.	69.	-53.	-74.	-82.	-90. -105.
APR	275.	170.	190.	215.	225.	234.	252.	269.	287.	307.	318.	331.	368.	399.	65.	-125.	-150.	-160.	-169. -187.
MAY	365.	197.	227.	266.	282.	297.	325.	353.	383.	416.	435.	458.	520.	575.	66.	-161.	-200.	-216.	-231. -259.
JUN	270.	162.	182.	204.	218.	227.	245.	263.	282.	302.	314.	328.	366.	399.	62.	-120.	-146.	-156.	-166. -184.
JUL	171.	44.	61.	85.	97.	107.	129.	152.	177.	207.	225	246.	307.	365.	66.	6.	-19.	-30.	-41. -63.
AUG	245.	110.	131.	161.	174.	186.	209.	232.	257	285.	301.	321.	375.	423.	69.	-63.	-93.	-105.	-117. -140.
SEP	329.	174.	200.	236.	251.	265.	291.	317.	345.	376	394	415.	473.	525.	65.	-135.	-171.	-186.	-201. -226.
OCT	447.	203.	243.	297.	320.	342.	383.	425.	469.	520.	550.	584.	681.	769.	61.	-179	-234.	-257.	-278. -320.
NOV	376.	180.	206	240.	254	267	292.	316.	342.	371.	388.	407.	460.	508.	57.	-149.	-183.	-197.	-210. -235.
DEC	138.	50.	63.	82.	90.	98.	112.	128.	144.	164.	175.	188.	226.	261.	58.	-5.	-24.	-32.	-39. -54.
ANN	2955.	2091.	2258.	2472.	2557	2635.	2780.	2919.	3064	3224	3314.	3417.	3699.	3942.	[illegible]				

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0044	.0059	.0519	.0559	0271	.0514	.0166	.0259	.0281	.0146	.0321	.0319	.0093
R	.282	.759	10.148	15 363	9.893	13.456	2.842	6.338	9.252	6 516	10.469	4.403	27.354
LNGAM	1.1602	.1938	13.1355	26.1672	12.5624	22.1771	.5520	5.3750	11.1476	5.6921	13.4682	2.3202	62.4256

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9.14 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION, IN MM.

STATION NAME UBATE CUNDINAMARCA SER. NO. 41617, LAT. 5 19, LONG. 73 49, ELEV. 2600, YEARS OF DATA 9

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10	5.		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	39.	9.	12.	17.	19.	21.	25.	30	34	40	43.	47.	58.	69.	52.	39.	34.	32.	30 26.
FEB	49.	6.	10.	17.	20	23.	31.	39	44.	59.	66.	75.	101.	126.	50.	40.	33.	30.	26. 19.
MAR	71.	33.	40.	46.	52	55.	61.	68.	75.	82.	87.	92.	107.	120.	54.	19	11.	7.	4. -2.
APR	74.	31.	38.	49.	53.	57.	65.	73	82	92.	98.	105	125.	143	56.	17.	7.	3.	-2. -10.
MAY	94.	60.	67.	76.	79.	83	89.	95	102	109.	113.	118.	131	143	56.	-11.	-20.	-24.	-27. -34
JUN	61.	23.	29.	37.	40.	44.	50.	56.	63.	71	76.	82.	98.	112.	52.	23.	15.	11.	8. 2.
JUL	37.	10	14.	19	22	24.	28.	33	38	44.	48	52	65.	76.	53.	39.	33.	31.	29. 24.
AUG	33.	5.	8.	13.	15.	18.	23.	28.	34.	41	45	50.	66.	81.	56.	47.	42.	40.	38. 33.
SEP	58.	17.	23	31.	35	38.	45	53.	61	70.	76.	83.	102.	120.	55	33.	24	21	17. 10.
OCT	133.	49.	61.	79	87	94.	109.	123.	139.	158.	168.	181.	217.	251	55	-6	-24.	-32.	-39. -53.
NOV	95.	45	53.	64.	69	73	82.	90	99	109	115.	122.	142.	159.	51.	-2.	-14.	-18.	-23. -31.
DEC	16.	0.	1.	3.	4	6	11	17	27	40	49	60.	97	137.	51.	51.	49.	47	46. 41.
ANN	782.	570.	611.	664.	685.	704.	739.	774.	809	848	870.	895.	963.	1021.	644.	33.	-20.	-41.	-60. -95.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0342	.0316	0989	.0652	.1518	0742	.0456	.0563	.0558	.0335	.0762	.0145	.0411
R	3.116	1.536	7.038	5.100	14.812	4.800	3.152	1.879	3.262	4.458	7.204	.527	32.163
LNGAM	.4024	-.1189	6.6500	3.3298	24 6891	2.8806	.8377	-.0464	.4476	2 3960	6.4653	.5209	78.6558

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9.15 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION, IN MM.

STATION NAME FAC AGRONOMIA CALDAS SER NO. 50320, LAT 5 4, LONG. 75 31, ELEV. 2153, YEARS OF DATA 10

PROBABILITY	95.	90.	80	75.	70.	60.	50	40.	30.	25.	20.	10.	5		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	87.	6.	11	22	27.	33.	46.	60	78	100.	114	131	183	234	109.	97.	87	81.	76. 63.
FEB	145	44	58.	78.	87.	96	113.	131	151.	174	188	204.	251	294.	98.	41.	20	11.	2. -15.
MAR	137.	89	97	108.	112.	116	123	130.	137.	145	150	155.	170	182.	109	12.	1.	-3.	-7. -14.
APR	193.	122.	135.	157	159	166	178	189	202.	216.	224	233	257	279	87	-48	-65	-72	-78. -90.
MAY	197.	121	135.	153	160	167.	180	192	205	220	228	238	264.	288.	92.	-43.	-61.	-68.	-75. -88.
JUN	120.	42.	53.	70.	77.	83.	97	110	125.	142	152	164	198	229.	90	36	20.	13	6. -7.
JUL	70.	16.	22.	33.	37.	42.	51	61	72.	85	93	102	130	156	107.	84.	74.	69	65. 56.
AUG	95.	36.	45	57	63.	68.	78	88	99	112	120	129	154	177	114.	70.	57.	51	46. 36.
SEP	125.	57.	68.	83.	90	96	107	119.	131	145	154	163.	190	215	104.	36	20.	14.	8. -3.
OCT	257.	171.	187	208	217	224	239	253	267	284	293	303.	332	357	95.	-92	-113.	-122.	-129. -144.
NOV	233.	124.	143.	168	178.	188	207.	225.	244	266.	279	293.	334.	370.	88.	-55.	-80.	-90.	-100. -119.
DEC	186	97	117	133	141	149	164.	179	195	213	224	236	270	300.	99.	-13.	-33.	-42.	-50. -65.
ANN*	1836	1487	1564.	1657.	1693.	1723.	1782.	1836	1890.	1949	1979.	2015.	2104.	2185.	1192.	-372.	-465.	-501.	-530. -590.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0142	0234	.1620	.0831	.0754	0349	.0350	0491	.0527	.0794	0405	.0475	.0415
R	1.168	3.396	21.404	16 070	14.842	4.174	2 456	4.656	6.602	20.404	9.445	8.853	76.217
LNGAM	-.0756	1.0885	43 5599	28.0909	24 7707	2.0151	.2541	2.6729	5.4454	40.5450	11.5683	10 2920	252.8286

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9.16 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION, IN MM.

STATION NAME LA BELLA CALDAS SER. NO. 50420, LAT. 4 31, LONG. 75 38, ELEV. 1450, YEARS OF DATA 13

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80	75.	70.	60.
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	115.	34	49.	65.	72	79	92.	104.	120.	138.	148	160	195	227.	51.	2.	-14.	-21.	-28. -41.
FEB	131.	14.	23.	41.	50.	59.	79.	101.	127	159.	174.	204.	277.	349.	49.	26.	8.	-1.	-11. -30.
MAR	155.	67.	81.	100.	109	116	131	146	163.	181.	197.	205.	241.	273.	56.	-24.	-44.	-52.	-60. -75.
APR	275.	133.	157	189.	202.	215.	234.	263.	288	317.	334.	353.	408.	457.	51.	-106.	-138.	-151.	-164. -187.
MAY	217.	105	123.	149.	160.	169.	188.	207.	228.	251	264.	280.	323.	367.	52.	-71	-97.	-107.	-117. -136.
JUN	134.	30.	43	67.	71.	80.	98.	117.	138.	163.	178.	196	249	299.	49.	6.	-13.	-22.	-31. -49.
JUL	70.	10.	16.	26.	31.	36.	46.	57.	70	86.	95.	107.	142	175.	53.	37.	27.	22.	18. 7.
AUG	67.	11.	17.	27	32.	36.	46	56.	68.	82	91	101.	132.	161.	58.	41.	31.	27.	22. 13.
SEP	120.	43	55.	71	74	85	98.	111.	125	142	152	164.	197.	228.	54.	-0	-17.	-24.	-30. -44.
OCT	242.	153	177.	209.	222.	234.	258	281.	306	334	350.	369	420.	467.	53.	-124.	-156.	-169.	-182. -205.
NOV	136.	208	231.	262	274.	286.	307.	329.	351.	375	389	406.	450.	489.	48.	-114.	-215.	-227	-238. -260.
DEC	288.	131.	156.	192.	206.	220.	247.	273.	302.	334.	353	375.	437.	493.	48	-108.	-143.	-158.	-172. -198.
ANN	2200.	1707.	1806.	1930.	1979.	2024.	2106	2185.	2265	2354.	2404.	2460	2613.	2764.	623.	-1182.	-1207.	-1356.	-1400. -1482.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0330	.0107	.0379	.0775	0343	.0183	.0743	.0288	.0361	.0312	.0451	.0229	.0221
R	3.806	1.394	5.877	7.556	7.452	2.459	1.698	1.934	4.330	9.117	15.163	6.578	48.806
LNGAM	1.5537	-.1197	4.5742	7.6444	7.4407	.2561	-.0963	-.0264	2.2215	10.8554	25.6250	5.8020	138.7577

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9.17 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME SANTANDER CAUCA SER. NO. 50917. LAT. 3 1. LONG. 76 28. ELEV. 1112. YEARS OF DATA 16

PROBABILITY	95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	139.	30.	43.	63.	72.	91.	100.	120.	142.	168.	185.	204.	260.	313.	57.	14.	-6.	-15.	-24. -43.
FEB	125.	32.	44.	62.	70.	78.	94.	111.	129	151.	165.	180.	226.	268.	53.	9.	-9.	-17.	-25. -41.
MAR	150.	76.	89.	106.	113.	119.	132.	144.	158.	173.	182.	192.	220.	245.	61.	-28.	-45.	-52.	-59. -71.
APR	202.	84.	102.	128.	139.	149.	169.	190.	211.	236.	251.	268.	317.	361.	59.	-44.	-70.	-80.	-91. -111.
MAY	166.	53.	68.	92.	102.	112.	131.	151.	173.	198.	214.	231.	283.	330.	57.	-12.	-35.	-45.	-55. -74.
JUN	94.	14.	22	35.	42.	48.	62.	77.	94	115	127.	143.	188.	232.	54.	32.	19.	12.	6. -8.
JUL	60.	5.	8.	15.	18.	22.	29.	38.	48.	61.	69.	79.	109.	138.	59.	51.	44.	40.	37. 29.
AUG	77.	1.	2.	7.	11.	15.	25.	38.	56.	81.	98.	119.	187.	259.	64.	62.	57.	54.	50. 40.
SEP	94.	32.	41.	55.	61.	67.	78.	90	103	118.	128.	138.	169.	197.	65.	24.	10.	4.	-2. -14.
OCT	242.	115.	136.	165.	177.	188.	210.	231.	254.	281.	296.	313.	363.	408.	64.	-72.	-101.	-113.	-124. -146.
NOV	239.	92.	114.	146.	159.	172.	197.	222.	250.	282	300.	322	384	441.	56.	-58.	-90.	-103.	-116. -141.
DEC	164.	3.	9.	24.	33	44.	69	100.	141.	196	232.	276.	414	564.	57.	48.	33.	24.	14. -11.
ANN	1746.	1255.	1351.	1473	1521.	1565.	1640.	1727	1809.	1899.	1950.	2009.	2167.	2304.	706.	-645.	-767.	-816.	-860. -942.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0170	.0225	.0551	.0273	.0218	0187	.0257	0084	.0366	.0295	.0202	.0043	.0170
R	2.357	2.816	8.284	5.496	3.618	1.756	1.292	606	3.629	7.161	4.821	.729	29.751
LNGAM	.1890	.5305	9 1030	3.9514	1 3335	-.0830	-.1068	.3885	1.3457	6.8825	2.9121	.2269	70.4150

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9.18 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME OBS MET NAL CUNDINAMARCA SER. NO. 52145. LAT. 4 38. LONG. 74 6. ELEV. 2560. YEARS OF DATA 103

PROBABILITY	95	90.	80.	75.	70.	60.	50.	40	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	53.	5.	9.	16.	20.	23.	31.	40	51.	65.	73.	83.	114	144.	112.	104.	96.	93.	89. 81.
FEB	56.	10.	15.	23	27.	31	39	47.	57.	68	75	83.	108.	131.	104.	89.	80.	77.	73. 65.
MAR	87.	18.	26.	39.	45	51.	63.	75	89	106	116.	128.	164.	197.	113.	87.	74.	68.	62. 51.
APR	127.	41.	53	71.	79.	86.	101.	116.	133	152	164.	177.	216.	252.	88.	35.	17.	9.	2. -13.
MAY	108.	42.	52.	66.	72.	78.	89.	101.	113.	127.	136.	145.	173.	199.	92.	40.	26.	20.	14. 3.
JUN	60.	14.	19.	28	32	36.	44	52.	62.	73.	80	88.	111	133.	93.	73.	65.	61.	57. 49.
JUL	48.	17.	21.	28.	31	34.	39	44	50	57	61.	66	80.	92	99.	77.	71.	68.	65 60.
AUG	50.	15.	20	27.	30.	33	38	45.	52	60.	64.	70.	86	101.	111.	91.	84.	81.	78. 72.
SEP	56.	13.	18	26.	30	34.	41.	49	58	69	75	82	104.	125.	101.	83.	75.	71.	67. 60.
OCT	153.	63.	77	97	105	113	128	144.	161.	180.	191	205.	242.	276.	90.	13.	-7.	-15.	-23 -38.
NOV	124.	42.	55	72.	80	88	102.	117.	133.	153.	164.	177.	215.	251.	88.	33.	16.	8.	0. -14.
DEC	75	17.	24.	35.	40	45	55.	65.	77	91.	100.	110	140	168.	101.	77.	66.	61.	56. 46.
ANN	1002.	685	785	823.	854.	883.	936.	988.	1041.	1100.	1134.	1173.	1278.	1369.	1192.	447.	369.	338.	309. 256.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0251	0369	0267	0291	.0452	0413	.0865	.0687	.0943	.0350	.0300	.0325	.0229
R	1 330	2.060	2.325	3.708	4 873	2.482	4.161	3.415	2.502	5.362	3.842	2.447	22.972
LNGAM	-.1127	0266	.1691	1.4379	2.4884	.2721	1.9968	1.1079	.2863	3.7371	1.5969	.2479	48.3831

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9.19 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME PARAGUAYCITO CALDAS SER. NO. 62. LAT 4 24. LONG. 75 47. ELEV. 1250. YEARS OF DATA 4

PROBABILITY	95.	90.	80	75	70	60.	50.	40.	30.	25.	20	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	73.	27.	34	44.	48.	52	60	67	76	86	92.	99	118	136	129	95	86.	82.	78 70.
FEB	117.	4	10	22	30.	37	55	77	104	139	162	189.	277	364	117.	107.	94.	87.	79. 61.
MAR	152.	88.	97	107.	112	115	123	130.	137	146	150	156	170.	183.	130.	33.	22	18	14. 7.
APR	284.	109	136	174	191	206	237	268	302.	341.	364	391	464	539	100.	-36.	-75.	-91.	-107. -137.
MAY	190.	93.	109	131	140.	149.	166	182	200	220	231.	245	282	316.	111	2.	-20.	-29.	-38. -54.
JUN	91.	12	19	32.	38	45	58	73	90	112	125	141	189	235.	113	94.	81.	75.	68. 55.
JUL	57.	7.	12	20	24.	28	36	46.	57	70	78	88.	119	148.	126.	115.	107.	103.	99. 90.
AUG	77.	49.	53	60	63	66.	71	76.	81	86	89	93	103	112	131.	78	71.	68.	65. 60.
SEP	89	53	60	68	72	75	81	87	93	100	104	109	121	132.	119	59.	50.	47.	44. 38.
OCT*	212.	175.	183	193	96	200	206	212	217.	224.	227	230	240	248.	117.	-66.	-76.	-79.	-83. -89.
NOV	311	245	259	276	283	289	300	311	322	334.	341	349	370.	388.	96	-163.	-180.	-186.	-193. -204.
DEC	197.	83	100	125	136	146	165	185	206.	230.	244.	261	308	350	110.	9.	-16.	-26.	-36. -56.
ANN*	1837.	1556	1618	1693	1722	1745	1793	1837	1880.	1928	1952.	1980.	2055.	2117.	1399.	-219	-294.	-323.	-346. -394.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0630	0076	1576	0161	0400	0172	.0271	.2009	.1521	.5947	1667	.0285	.0877
R	4.582	.891	20 803	4 648	7.608	1 569	1 557	15 522	13.544	115.262	57.180	5.598	161.062
LNGAM	2.4690	0733	41.7471	2 6677	7.7459	-.1160	- 1172	26.5956	21.3736	3.7371	153.1211	4.1159	48.3831

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9.20 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION. IN MM.

STATION NAME PALMIRA EA VALLE SER NO. 63. LAT. 3 31. LONG. 76 19. ELEV. 1006. YEARS OF DATA 6

PROBABILITY	95.	90	80.	75.	70	60	50	40.	30	25	20.	10.	5		90.	80.	75.	70.	60.
MONTH	MEAN						PRECIPITATION							ETCH	IRRIGATION REQUIREMENT **				
JAN	83.	37.	44.	55.	59	63	71	79	87.	97.	103.	109.	128.	145.	131.	87.	76.	72.	68. 60.
FEB	84.	24.	32	45	50.	56	67.	78.	91.	105	114	125.	155.	184.	122.	90.	77.	71.	66. 55.
MAR	94.	42.	50.	62	67	71.	80	89.	98.	109	115	123.	143.	162.	136.	86.	75.	70.	65. 56.
APR	152.	86.	97.	113.	119	125.	136.	147.	159	172.	179.	188.	212.	233.	117.	19.	4.	-3.	-8. -20.
MAY	154.	96.	108	123.	129.	134	145	155	166	178	185.	193.	215.	235.	117.	10.	-6.	-12	-17. -28.
JUN	92.	23.	31.	45.	51	57.	68.	81	94	111.	121.	132.	166.	198.	114.	82.	69.	63.	57. 45.
JUL	42.	13.	17.	23.	26.	28	33.	38.	44.	51.	54.	59.	72.	85.	135.	118.	112.	109.	107. 102.
AUG	31.	6.	9.	14.	16	18	22	27.	32.	38	42	46.	59	72.	141.	131.	127.	125.	123. 118.
SEP	55.	15.	20.	28.	31.	35	42	49.	57.	66.	72.	79.	98.	116.	135.	115.	107.	103.	100. 93.
OCT	179.	104.	118	135.	143.	149.	162	174.	187	202.	210.	220.	247.	270.	126.	8.	-9.	-17.	-23. -36.
NOV	155.	53.	68	89	98	107.	124.	142.	162.	184	198.	213.	258.	299.	116.	48.	26.	17.	8. -9.
DEC	75.	55.	59.	64.	66	67.	71.	74.	77	81	83.	85	92.	97.	117.	58.	53.	51.	49. 46.
ANN*	1204.	965.	1018	1082.	1106.	1126.	1167.	1204.	1241.	1282.	1302.	1326.	1390.	1443.	1504.	487.	423.	398.	378. 337.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0746	.0349	.0678	.0739	.0887	.0295	.0827	.0772	.0528	.0490	0261	.4413	.0699
R	6.208	3.011	6.342	11.715	14.027	2.702	3.490	2.265	2.497	12.359	4.041	33.012	84.120
LNGAM	5.1467	.7032	5.3819	15.6133	22.6220	.4366	1.1895	.1333	.6006	18.3852	1.8431	81.5996	287.4223

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBU ED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9.21 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION, IN MM.

STATION NAME AMBALEMA TOLIMA SER. NO. 64, LAT. 4 46, LONG. 74 50, ELEV. 250, YEARS OF DATA 6

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN	PRECIPITATION													ETCH	IRRIGATION REQUIREMENT **				
JAN	35.	0.	0.	1.	2.	3.	7.	13.	22.	35.	49.	56.	98.	144.	67.	67.	66.	65.	64.	60.
FEB	56.	0.	0.	1.	2.	3.	7.	15.	28.	49.	65.	86.	162.	249.	64.	64.	63.	62.	61.	57.
MAR	58.	8.	13.	22.	26.	30.	38.	47.	58.	71.	78.	88.	116.	143.	74.	61.	52.	48.	44.	36.
APR	133.	23.	35.	54.	63.	72.	91.	111.	134.	162.	179.	199.	259.	316.	70.	35.	16.	7.	-2.	-21.
MAY	243.	59.	82.	117.	133.	149.	180.	213.	250.	294.	321.	352.	444.	530.	67.	-15.	-51.	-67.	-82.	-114.
JUN	101.	10.	17.	31.	38.	45.	60.	78.	98.	123.	139.	158.	215.	271.	65.	48.	34.	27.	20.	5.
JUL	54.	4.	7.	15.	18.	22.	30.	40.	52.	67.	76.	87.	121.	156.	71.	64.	57.	53.	49.	41.
AUG	65.	13.	19.	29.	33.	37.	46.	56.	67.	80.	87.	97.	129.	150.	75.	56.	46.	42.	37.	28.
SEP	110.	50.	59.	73.	79.	84.	94.	104.	115.	128.	135.	144.	168.	189.	71.	12.	-2.	-7.	-13.	-23.
OCT	210.	63.	83.	113.	126.	139.	164.	190.	218.	252.	272.	296.	364.	427.	67.	-16.	-46.	-59.	-72.	-97.
NOV	126.	33.	45.	63.	71.	79.	95.	112.	130.	152.	165.	181.	226.	269.	61.	18.	0.	-8.	-16.	-32.
DEC	54.	3.	6.	13.	16.	20.	29.	39.	51.	66.	76.	88.	125.	163.	64.	58.	51.	48.	44.	35.
ANN	1246.	498.	612.	775.	844.	910	1037.	1166.	1305.	1466.	1561.	1671.	1984.	2268.	81A.	206.	43.	-26.	-92.	-219.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0117	.0058	.0300	.0149	.0109	.0136	.0213	.0336	.0589	.0160	.0226	0188	.0041
R	.410	.320	1.734	1.973	2.646	1.367	1.166	2.197	6.480	3.370	2.853	1.033	5.115
LNGAM	.7123	1.0297	-.0883	-.0112	.3925	-.1171	-.0747	.0954	5.6267	1.0600	.561A	-.0182	3.3533

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9.22 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION, IN MM.

STATION NAME POPAYAN UNIV CAUCA SER NO. 66, LAT. 2 26, LONG. 76 37, ELEV. 1760, YEARS OF DATA 6

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN	PRECIPITATION													ETCH	IRRIGATION REQUIREMENT **				
JAN	191.	72.	90.	116.	127	137.	157.	178.	200.	226.	241.	259.	309.	355.	54	-36.	-62.	-73	-83.	-103.
FEB	127.	43.	55.	73.	81.	88	102.	117.	133.	151.	167.	175.	212.	246.	52.	-3.	-21.	-28.	-36.	-50.
MAR	205.	119.	135.	155.	163.	171.	185.	200.	215.	231	241.	252.	283	310	59.	-76.	-96.	-104.	-112.	-127.
APR	157.	65.	79	98.	106.	114.	128.	143.	159.	177.	188	201.	236.	268	56	-22.	-42.	-50	-57.	-72.
MAY	135.	66.	78	94.	100.	106.	118.	130.	142.	156.	164.	174.	200.	224.	55.	-23	-39	-46.	-52.	-63.
JUN	78.	19.	27.	38.	43.	48.	58.	69.	81.	95	103.	113	143	170	53	26.	15.	9.	4.	-6.
JUL	44.	27.	30.	34.	36.	37.	40	43.	46.	49	51.	53	59	64	58	28.	24	22.	21	16.
AUG	36.	7.	10.	15.	18.	20	25.	31.	37.	44.	49.	54	70	85.	64.	54.	49	47.	44.	39.
SEP	86.	17.	25.	37.	43.	49.	61.	73.	88	105.	115.	127.	164	198	61	38	25.	20.	14.	2.
OCT	254.	130.	152.	181.	193.	205.	227	248.	271.	298	313	330.	380	424.	58.	-93.	-123.	-135.	-147.	-168.
NOV	323.	239.	255	276.	285.	292.	306	320.	334.	349	358.	368.	395.	418.	52.	-203.	-224.	-233	-240	-254.
DEC*	229.	208.	213.	219.	221.	222.	226.	229.	232.	236	237.	239.	245.	249	54.	-159	-165.	-167.	-168.	-172.
ANN	1866.	1387.	1481.	1601.	1648	1692	1772.	1849.	1929.	2015	2064.	2120	2273	2403	67A.	-803.	-923.	-970	-1013.	-1093.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0246	.0315	0598	.0385	.0572	.0341	.3454	.0570	.0255	.0315	.1081	1.8114	.0194
R	4 694	4.001	12.279	5.843	7.746	2 673	15.173	2 067	2.197	8.147	34.921	414.664	36.198
LNGAM	2.7284	1.7936	18.1861	4.5222	8.0176	.4134	25.6554	.0296	0929	8.8236	88.3003	-.0182	92.8448

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED

TABLE 9.23 PRECIPITATION AND POTENTIAL IRRIGATION REQUIREMENTS FOR GIVEN PROBABILITY LEVELS BASED ON GAMMA DISTRIBUTION, IN MM.

STATION NAME FUNZA CUNDINAMARCA SER. NO. 72, LAT. 4 42, LONG. 74 11, ELEV. 2550, YEARS OF DATA 6

PROBABILITY		95.	90.	80.	75.	70.	60.	50.	40.	30.	25.	20.	10.	5.		90.	80.	75.	70.	60.
MONTH	MEAN	PRECIPITATION													ETCH	IRRIGATION REQUIREMENT **				
JAN	11.	6.	9.	13.	15.	17.	22.	27.	32.	38.	42.	47.	61.	74.	49.	40.	35.	33.	31.	27.
FEB	43.	7.	11.	17.	20.	23.	29.	36.	43.	53.	58.	65.	85.	104.	46.	35.	29.	26.	23.	17.
MAR	52.	27.	31.	37.	39.	42.	46.	50.	54.	59.	62.	65.	75.	83.	53.	21.	16.	13.	11.	7.
APR	84.	42.	50.	60.	64.	68	76.	84.	92.	101.	107.	113.	130.	146.	51	1.	-9.	-13.	-17.	-25.
MAY	105.	80.	85.	91.	94.	96.	100.	104.	108.	113.	116.	118.	126.	133.	51.	-33.	-40.	-42.	-45.	-49.
JUN	64.	33.	39.	47.	50.	54.	60.	66.	73.	80.	84.	90.	104.	117.	49.	10.	2.	-1.	-4.	-11.
JUL	44.	24.	28.	33.	36.	38.	42.	46.	50.	55	58.	62.	71.	80.	50.	22.	17.	14.	12.	8.
AUG	31.	15.	18.	22.	23.	24.	27.	30.	33.	36.	38.	40.	46.	52.	53.	35.	31.	29.	28.	25.
SEP	46.	20.	24.	30.	32.	34.	39.	43.	48.	53.	57.	60.	71.	81.	51.	27.	22.	19.	17.	12.
OCT	98.	36.	45.	58.	64.	69.	80.	91.	103.	116.	125.	134.	161.	186.	50.	5.	-8.	-14.	-19.	-30.
NOV	111.	65.	73	84.	89.	93.	101.	108.	116.	125.	130.	136.	153.	167.	46.	-28.	-39.	-43.	-47.	-55.
DEC	42.	8.	17.	18.	21.	24	29.	36.	43.	51.	56.	62.	80.	98.	47.	35.	29.	26.	23.	17.
ANN	765.	612.	643	682.	697.	711.	736.	761.	786.	813.	828.	845.	892.	931.	595.	-48.	-87.	-102.	-116.	-141.

PARAMETERS FOR GAMMA DISTRIBUTION

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LAMBA	.0652	.0446	.1759	.0853	.3917	.1030	.1620	.2433	.1274	.0443	.1138	.0507	.0811
R	2.051	1.425	9.126	7.482	41.135	7.130	7.795	7.608	5.825	4.342	12.657	2.129	62.046
LNGAM	.0223	-.0297	10.6746	7.4999	110.8220	6.8238	8.1153	7.7491	4.4911	2.2506	19.1253	.0596	192.9304

* PRECIPITATION FOR MONTH OR YEAR IS NORMALLY DISTRIBUTED ** NEGATIVES INDICATE NO REQUIREMENT **** GAMMA PARAMETERS UNDEFINED