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STATISTICAL ANALYSIS OF CARIBBEAN RAINFALL DATA: Formulating Linear Models Relating Dependable Rainfall To Mean Monthly Rainfall

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ABSTRACT

Monthly aggregate rainfall for 25 stations in the English-speaking Caribbean region were analysed using the computer software, RAINBOW in order to obtain rainfall values with different levels of probability. Most of the monthly aggregate rainfall data for the stations were homogeneous and log-normally distributed. The method to be used to obtain the rainfall values of different probabilities using the given parameters of the log-normal distribution is described. Simple linear regression models were developed to relate dependable rainfall at 20, 50 and 80% probability levels to mean monthly aggregate rainfall for individual stations as well as for the entire English-speaking Caribbean region. The dependable rainfall of some other 10 Caribbean stations estimated by the derived models were close to the published values. The use of these models is expected to remove the tedium involved in obtaining such rainfall probability data particularly for locations with insufficient recorded data.

1.0 INTRODUCTION

In the design of water resources engineering projects, estimates of random variables like rainfall are required. Such estimates are often needed for the prediction of extreme floods in watersheds and for the design of irrigation and drainage projects. Analysis of rainfall data involves selecting and subsequently fitting an appropriate probability distribution function to the available historical data. From the probability plot, estimates of the magnitude of the event to be expected for a selected probability of exceedance or return period are obtained.

For the programming of irrigation supply and simulation of irrigation management conditions, the concept of dependable rainfall is often employed (1). Dependable rainfall is defined as the amount of rainfall which can be exceeded over a given location for a fixed number of years out of given total number of years. For instance, the 80% dependable rainfall is normally used in calculating the capacity of storage reservoirs and of main irrigation canals. This dependable monthly or annual rainfall is the value that will be exceeded on the average four out of five years, that is with a probability of exceedance of 80%. For drainage projects, the 20% dependable rainfall is usually adopted. The rainfall in a given period is considered normal if the rainfall that fell within the period is 50% dependable, i.e., it will be exceeded on the average every other year.

However, rainfall values occurring at different probability levels are not readily available, especially in developing countries. Most of the time, only the mean monthly values for individual stations are available. The Food and Agriculture Organisation (FAO) (2,3,4) developed a data bank of rainfall data for many climatological stations of the world, but dependable rainfall values were computed only for a few stations. Smith (5) advocates the derivation of empirical formulae to relate dependable rainfall values to mean monthly rainfall in different locations. Renier (6) obtained simple formulae to relate the 20, 50 and 80% monthly dependable rainfall to mean monthly rainfall data for some climatological stations in Africa. Addarawatte (7) developed similar formulae for stations in Niger, Spain and Venezuela. To the knowledge of the authors, a similar analysis has not

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been carried out for the English-speaking Caribbean region.

This paper reports the result of a study undertaken to collect, collate and analyse monthly aggregate rainfall data from many climatological stations within the English-speaking Caribbean region. The data derived from the analysis were used to formulate simple linear regression models relating dependable rainfall values to mean monthly aggregate rainfall.

2.0 ANALYSIS OF RAINFALL DATA

Monthly aggregate rainfall data for 25 climatological stations in the Caribbean (**Table 1**) were analysed. The bulk of the rainfall data was extracted from monthly weather summaries published by the Caribbean Meteorological Institute, Husbands, St. James, Barbados. Other sources of rainfall data were the Water Resources Agency and Piarco Meteorological Services, both in Trinidad; as well as the Jamaica Meteorological services. Data collected between 1961 to 1991 were used, though most of the stations did not have the complete data for the 31 years involved (**Table 1**). Failure to analyse data for stations in islands like St. Kitts, Anguilla, Barbuda and the Grenadines was due to the unavailability of adequate quantities of published rainfall data.

NAME OF COUNTRY	NAME OF STATION	NUMBER OF YEARS OF DATA AVAILABLE FROM 1961 - 1991
Trinidad & Tobago	St. Augustine	30
	Botanical Garden, Port of Spain	31
	Exchange, Couva	31
	Crown Point Airport, Tobago	22
	Grosvenor Estate, Sangre Grande	31
	Perseverance Estate, Cedros	31
	Piarco Airport	31
	Poole, Rio Claro	31
Jamaica	Claremont	26
	Frome	27
	Hope Bay	21
	Norman Manley Interl. Airport	30
	Marshall Pen	26
	Monymusk	23
	Morant Point Light House	22
	Orange River	27
	Port Antonio	29
	Worthy Park	29
Belize	Belize Airport	23
St. Vincent	Campden Park	23
Antigua	Coolidge	17
Barbados	Husbands	24
Dominica	Melville Hall Airport	21
Saint Lucia	Vigie Airport	21
	Winban	20

Table 1: **Details of the Caribbean Stations used in Rainfall Analysis**

Rainfall data were analysed using the RAINBOW computer software (8). A test for homogeneity of hydrologic data, based on the cumulative deviations from the mean (9), is included and different distribution assumptions (Gumbel, normal, log-normal) are available for executing a frequency analysis of historical rainfall data set using California, Hazen, Weibull or Gringorten plotting positions. Because monthly aggregate rainfall values were analysed, both normal and log-normal distributions were tested. The Gumbel distribution which is used for extreme rainfall events is not applicable to this study. The Gringorten plotting position was used. A total of 300 pieces of rainfall data were involved representing 12 months of the year for each of the 25 stations. The RAINBOW software has the capability of computing probability values and plotting them against values of inputted rainfall. It also draws a best-fit regression straight line through the plotted probability values that represents the chosen distribution using the method of least squares. This entails minimising the sum of squares of the differences between the plotted probability values estimated using the straight line. Magnitudes of the distributed events corresponding to the various probabilities and return periods are derived from the probability plot and displayed in Tables. The arithmetic mean, standard deviation for the inputted rainfall sample as well as for the population (past and future events) estimated using the regression line were obtained from a Table displayed by RAINBOW entitled "Information Table". Also displayed in this

MONTH	NORMAL DISTRIBUTION		LOG-NORMAL DISTRIBUTION	
	r^2	chi-square	r^2	chi-square
January	0.92	1.949	0.99	0.520
February	0.87	4.180	0.97	0.840
March	0.97	0.109	0.96	0.219
April	0.90	2.081	0.97	1.655
May	0.68	12.32	0.98	1.232
June	0.85	7.291	0.88	1.327
July	0.98	1.285	0.91	1.322
August	0.94	2.152	0.99	0.859
September	0.90	2.838	0.98	0.883
October	0.94	1.400	0.84	2.590
November	0.98	0.340	0.93	0.713
December	0.86	2.514	0.90	1.267

* The critical chi-square value at 0.05 significance level is 5.99.

Table 2: **The Chi-Square and Coefficient of Determination (r^2) Values for the Botanical Garden Station, Port of Spain, Trinidad.**

information table is the coefficient of determination (r^2) which indicates the percentage of the total variation in the plotted probability values accounted for by the regression straight line. High values of r^2, therefore, indicate that the plotted rainfall data can be approximated by the chosen probability distribution. From these two tables, the 20, 50 and 80% dependable rainfall values for each station were extracted for the 12 months of the year and regressed against the corresponding values of sample mean monthly rainfall using a spreadsheet programme. The equations were of the form:

$$D_{prob} = a + bR \quad (1)$$

Where D_{prob} is the dependable rainfall with 20, 50 or 80% probability; a and b are empirically derived constants and R is the mean monthly aggregate rainfall of the inputted sample. This analysis was carried out for each station, Trinidad and Tobago, Jamaica and the entire English-speaking Caribbean region.

3.0 RESULTS AND DISCUSSION

Results showed that for the 300 pieces of rainfall data analysed, 231 or 77% were better represented by the log-normal distribution (i.e., had higher r^2 values) while the remaining 69 or 23% were better represented by the normal distribution. The use of r^2 for choosing a better distribution to adopt was compared with the most widely used distribution selection method, the chi-square test (10) for one of the rainfall stations (**Table 2**). Results confirmed the use of r^2 because both chi-square and r^2 values showed that the log-normal distribution better fitted the rainfall data for 8 of the 12 months of the year for the station. Most monthly rainfall data are greater than zero in magnitude, and cannot be expected to be normally distributed because the range of any random normally distributed variable is the entire real line, that is $-\infty$ to ∞ (8). In many countries, including those in the Caribbean, the log-normal distribution is the most widely used (11). It performs well using rainfall data for most stations in Trinidad (12) and this study has shown that its use in the entire English-speaking Caribbean is reliable. Also, the analysis showed that the monthly aggregate rainfall data for most individual stations were all homogeneous at the 99% probability levels for the entire duration of record utilised in the study. The non-homogenous values are the June, July, October and December rainfall values for Melville Hall Airport, Crown Point Airport, Worthy Park and Poole stations respectively.

The information table of the RAINBOW computer software displays values of the computed mean and standard deviation of the population as well as those for the inputted rainfall data. For the log-normal distribution, the computed monthly aggregate rainfall for the population is given by an equation:

$$\text{Log}_{10}\,(\text{event}) = cZ + d \quad (2)$$

Where c and d are the standard deviation and mean of the logs of the monthly rainfall values of the estimated population respectively. Z is the standard normal variate. Values of Z (**Table 3**) for different probability values can be obtained in standard Statistics texts.

Tables 4 - 6 detail values of c, d, as well as the mean and standard deviation of the inputted rainfall values for all the stations analysed. From the data shown in **Tables 4 - 6**, it is possible to estimate rainfall values for any given probability level. For example, to

PROBABILITY VALUES (%)	RETURN PERIOD (YRS)	Z
1	100	2.32
4	25	1.75
5	20	1.64
10	10	1.28
20	5	0.84
50	2	0
80	1.25	-0.84

Table 3: **Selected Values of the Standard Normal Variate, Z**

estimate the 80% dependable rainfall for August in St. Augustine, Trinidad, the following steps should be taken: From **Table 4**, the value of c is 0.127 and d is 2.32. From Table 3, Z is -0.84. From equation (2):

$$\text{Log}_{10}(\text{Event}) = 0.127 \times -0.84 + 2.32 = 2.213$$

$$\text{Event} = 10^{2.211} = 163 \text{ mm.}$$

This agrees with the 80% dependable rainfall value displayed in the information table of RAINBOW for this station for the month of August.

The values of the coefficient of determination, r^2, for the equations relating dependable rainfall with mean monthly aggregate rainfall ranged from 0.72 to 1.00 and were all significant at the 1% level (**Table 7**). The values of the regression coefficients (1.27, 0.97 and 0.75) which Renier (6) obtained for equations involving D_{20}, D_{50} and D_{80} respectively for some climatological stations in Africa (Nigeria, Ivory Coast, Mali, Chad, Mozambique and Central Africa Republic and Sudan) are almost the same as the corresponding values of 1.25, 0.97 and 0.75 obtained for the Trinidad and Tobago (**Table 7**). Both areas lie within the equatorial zone, latitude 0° to 30° and have marked dry and wet seasons.

In order to evaluate the efficiency of the models displayed in **Table 7**, they were used to estimate the values of 20, 50 and 80% dependable rainfall values for 10 Caribbean rainfall stations not originally used in the analysis using the published (3) mean monthly rainfall for the stations (**Table 8**). The dependable rainfall values for St. Clair, Trinidad were estimated using the models derived for Trinidad and Tobago while those for Negril Point, Jamaica and Bridgetown, Barbados were estimated using equations derived for Jamaica and Barbados respectively. The models derived for the entire Caribbean were used for the other seven stations in **Table 8**. The dependable rainfall values estimated by the models were regressed against the published values for the stations obtained from the FAO Publication (3). The linear regression equations obtained are of the form:

$$Y = e + fX \quad \text{.........................} (3)$$

Where Y is the estimated and X is the published dependable rainfall. **Table 7** details the values of e and f of the equations obtained. To determine whether or not the models' performance is acceptable, the closeness of the derived regression lines to Y = X was examined. This was done by comparing the regression intercepts (e) and slopes (f) to 0 and 1 respectively using student 't' tests. The 't' values (Table 8) for all the stations were not significant at 0.001 level indicating the closeness of the estimated values to be published ones. All the coefficients of determination (r^2) were also significant at 0.001 level confirming the reliability of the derived models for estimating dependable rainfall values in the Caribbean.

4.0 CONCLUSION AND APPLICABILITY OF RESULTS

The use of the equations with results displayed in **Table 7** removes the tedium involved in obtaining dependable rainfall values for the design of irrigation and other water resources engineering projects in the Caribbean region. Because of the high variability in the monthly rainfall in the region as shown by high values of standard deviations in relation to the sample means (**Tables 4 - 6**), the use of mean rainfall rather than 80% dependable rainfall for irrigation design may result in insufficient water provision for the crops. For irrigation planning, Doorenbos and Pruitt (13) suggested the use of monthly 75 or 80% dependable rainfall. Two popular irrigation scheduling software - CROPWAT (5) produced by the FAO and the IRSIS (14) produced by the Katholieke Universiteit, Leuven, Belgium in consultation with the FAO, both have dependable

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Station	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
St. Augustine	50/34.0* 1.62/0.287	32/18.3 1.46/0.291	27/23.8 1.38/0.288	45/44.5 1.51/0.411	97/79.8 1.87/1.319	204/93.9 2.26/0.229	232/72.0 2.34/0.149	219/65.4 2.32/0.127	201/58.9 2.28/0.138	188/100.7 2.23/0.203	192/76.3 2.24/0.199	124/55.5 2.05/0.216
Botanical Garden	53/27.8 1.67/0.231	32/21.7 1.41/0.295	30/17.8 1.40/0.256	72/56.2 1.71/0.398	68/62.7 1.71/0.319	135/93.4 2.03/0.323	188/84.5 2.22/0.238	214/89.5 2.30/0.182	179/88.9 2.21/0.205	157/71.2 2.14/0.237	188/78.2 2.23/0.207	112/48.5 1.99/0.242
Exchange	59/41.7 1.67/0.327	35/22.8 1.48/0.306	28/23.0 1.42/0.325	45/50.9 1.45/0.443	84/70.2 1.80/0.353	202/84.0 2.26/0.203	211/72.1 2.30/0.151	216/73.3 2.31/0.161	175/53.8 2.20/0.188	146/72.4 2.12/0.191	178/75.9 2.21/0.204	114/54.4 2.01/0.200
Crown Point	53/35.8 1.61/0.339	42/31.4 1.56/0.298	40/36.5 1.45/0.366	44/46.1 1.48/0.422	88/115.2 1.77/0.367	151/71.2 2.12/0.239	174/82.6 2.19/0.234	171/49.4 2.21/0.139	163/80.4 2.14/0.283	182/82.1 2.22/0.192	200/71.4 2.28/0.148	138/68.1 2.09/0.228
Grosvenor Estate	153/77.9 2.13/0.237	98/37.7 1.95/0.203	91/56.9 1.89/0.307	98/102.0 1.85/0.387	159/119.9 2.14/0.251	285/95.9 2.44/0.160	299/92.3 2.46/0.127	299/97.2 2.45/0.163	282/112.7 2.41/0.191	327/135.9 2.48/0.178	377/115.4 2.55/0.143	316.9/140.6 2.46/0.201
Perseverance Estate	92/61.8 1.87/0.382	56/43.2 1.59/0.486	48/37.5 1.55/0.384	57/57.4 1.65/0.327	80/56.0 1.78/0.354	116/68.7 2.18/0.194	181/57.2 2.23/0.143	190/67.2 2.24/0.183	108/63.7 1.96/0.274	117/51.0 2.03/0.206	166/66.5 2.17/0.205	166/68.7 2.18/0.194
Piarco Airport	71/44.6 1.76/0.295	43/23.9 1.55/0.291	35/30.5 1.47/0.341	52/68.7 1.51/0.414	114/68.8 2.00/0.225	248/95.4 2.36/0.185	264/66.7 2.41/0.117	253/72.5 2.39/0.134	198/43.2 2.28/0.102	197/98.5 2.23/0.248	230/74.1 2.34/0.147	154/75.9 2.14/0.195
Poole	143/87.2 2.08/0.274	94/54.5 1.90/0.286	86/57.7 1.82/0.347	89/86.0 1.80/0.376	178/118.1 2.18/0.246	325/154.5 2.46/0.224	315/90.1 2.48/0.131	291/94.0 2.44/0.147	245/101.5 2.34/0.221	273/168.5 2.35/0.290	323/101.8 2.49/0.140	304/133.1 2.45/0.185

* First line of data indicates the means and standard deviations of the inputted rainfall values. Second line of data shows the same parameters for the logs of the estimated population.

Table 4: **Values of Mean Rainfall and Standard Deviation of the Inputted Rainfall Values and Their Logs for Stations analysed in Trinidad and Tobago**

Station	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Claremont	140/85.8 2.07/0.279	134/124.4 1.90/0.498	114/84.8 1.92/0.391	134/103.6 1.99/0.361	218/203.1 2.19/0.384	186/240.3 2.11/0.340	81/64.1 1.83/0.336	111/103.4 1.89/0.393	186/152.2 2.13/0.368	205/146.9 2.23/0.256	289/204.8 2.35/0.340	192/128.2 2.19/0.296
Frome	64/47.8 1.69/0.340	66/42.5 1.72/0.301	89/51.4 1.87/0.278	140/115.3 1.99/0.412	302/104.4 2.45/0.174	269/175.4 2.36/0.236	254/88.6 2.37/0.173	288/105.1 2.40/0.237	250/78.9 2.37/0.156	272/95.6 2.40/0.150	103/62.4 1.94/0.256	74/85.5 1.67/0.437
Hope Bay	265/168.3 2.31/0.353	143/113.5 2.03/0.399	125/72.4 2.01/0.360	229/156.6 2.25/0.335	208/188.5 2.15/0.412	174/134.8 2.08/0.422	238/189.4 2.25/0.352	182/78.6 2.20/0.260	202/166.9 2.17/0.370	227/213.3 2.21/0.378	449/183.8 2.59/0.263	415/381.3 2.45/0.417
Manley Int. Airport	22/40.0 1.25/0.358	18/12.8 1.29/0.202	17/17.1 1.2/0.329	28/30.4 1.37/0.351	76/88.1 1.73/0.492	73/83.8 1.66/0.485	32/33.9 1.43/0.379	82/60.1 1.76/0.421	155/128.7 1.88/0.418	146/126.2 2.04/0.363	73/74.0 1.67/0.463	38/34.7 1.47/0.389
Marshall Pen	60/34.7 1.69/0.295	61/58.4 1.68/0.412	144/205.3 1.91/0.469	187/105.1 2.19/0.292	233/168.6 2.24/0.363	199/151.5 2.16/0.387	99/59.7 1.93/0.250	167/84.9 2.17/0.228	231/99.4 2.33/0.177	284/166.7 2.38/0.260	122/95.1 1.98/0.305	69/49.0 1.73/0.331
Monymusk	42/28.8 1.50/0.356	29/29.6 1.42/0.318	40/40.2 1.47/0.415	58/68.6 1.61/0.492	140/142.8 1.94/0.467	126/151.8 1.83/0.555	126/151.8 1.83/0.555	82/76.3 1.75/0.440	117/146.4 1.94/0.333	190/155.5 2.17/0.314	101/102.0 1.80/0.459	41/41.4 1.52/0.342
Morant Point Light House	100/59.1 1.92/0.277	79/64.1 1.77/0.397	55/56.7 1.55/0.421	72/45.0 1.77/0.308	158/117.5 2.05/0.406	111/108.6 1.86/0.431	85/56.6 1.83/0.308	122/70.1 2.03/0.211	202/182.8 2.17/0.379	270/180.9 2.35/0.269	223/150.9 2.23/0.354	123/104.2 1.97/0.337
Orange River	187/106.4 2.19/0.291	133/88.0 2.03/0.304	123/110.6 1.93/0.400	151/100.0 2.06/0.367	116/82.6 1.96/0.313	108/83.0 1.94/0.303	53/38.0 1.59/0.367	123/70.6 2.01/0.287	127/88.1 2.01/0.289	182/136.7 2.16/0.301	261/158.1 2.34/0.272	238/146.7 2.30/0.281
Port Antonio	2.34/167.2 2.26/0.320	137/98.3 2.00/0.401	98/76.6 1.85/0.390	154/183.3 2.03/0.388	227/164.4 2.21/0.411	267/194.3 2.34/0.319	211/121.6 2.26/0.255	292/197.3 2.38/0.274	253/180.6 2.27/0.380	367/213.9 2.50/0.249	387/166.2 2.54/0.225	271/266.3 2.29/0.362
Worthy Park	64/73.4 1.66/0.320	59/40.1 1.65/0.352	48/28.1 1.65/0.262	83/62.1 1.84/0.301	200/157.3 2.16/0.396	180/217.3 2.09/0.363	115/52.5 2.02/0.200	154/85.3 2.13/0.236	181/126.0 2.18/0.246	219/106.3 2.30/0.185	133/90.9 2.04/0.287	79/66.0 1.79/0.306

* First line of data indicates the means and standard deviations of the inputted rainfall values. Second line of data shows the same parameters for the logs of the estimated population.

Table 5: **Values of Mean Rainfall and Standard Deviation of the Inputted Rainfall Values and Their Logs for Stations analysed in Jamaica**

Station	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Belize Airport	147/95.2 2.08/0.306	69/47.5 1.72/0.359	59/56.1 1.62/0.433	44/36.9 1.61/0.300	128/134.3 1.92/0.436	2.54/186.6 2.27/0.386	224/110.5 2.27/0.297	189/63.8 2.25/0.159	293/104.6 2.44/0.103	247/136.9 2.33/0.247	205/113.7 2.23/0.301	197/117.5 2.19/0.340
Campden Park	116/49.2 2.02/0.207	75/42.7 1.80/0.266	63/31.5 1.78/0.217	85/82.3 1.77/0.389	116/75.0 1.58/0.360	187/106.6 2.20/0.268	241/123.9 2.33/0.225	256/101.1 2.38/0.140	247/98.3 2.36/0.192	273/119.7 2.39/0.215	210/76.6 2.29/0.159	156/41.1 2.18/0.119
Coolidge	55/25.1 1.70/0.206	38/28.1 1.49/0.303	46/31.1 1.57/0.272	60/51.8 1.63/0.369	150/148.1 1.95/0.488	50/42.2 1.58/0.328	77/48.5 1.79/0.318	103/39.1 1.98/0.173	136/89.1 2.04/0.300	160/67.2 2.16/0.197	151/154.5 2.05/0.364	107/59.5 1.96/0.267
Husbands	58/29.4 1.70/0.259	45/29.9 1.56/0.310	44/30.0 1.55/0.305	54/46.0 1.59/0.405	50/42.3 1.58/0.360	79/54.8 1.79/0.319	120/68.1 2.01/0.264	176/73.7 2.21/0.194	150/64.7 2.14/0.185	210/127.2 2.26/0.230	182/94.7 2.20/0.247	91/49.9 1.90/0.248
Melville Hall Airport	152/114.4 2.10/0.243	104/50.9 1.95/0.254	135/63.6 2.08/0.212	111/67.5 1.97/0.274	213/195.4 2.18/0.371	179/101.7 2.19/0.258	187/76.9 2.23/0.197	245/91.9 2.36/0.173	306/109.4 2.46/0.164	339/127.8 2.49/0.192	391/191.2 2.54/0.239	251/168.7 2.32/0.244
Vigie Airport	125/61.7 2.03/0.264	74/48.2 1.78/0.304	72/37.1 1.80/0.253	54/22.5 1.68/0.236	106/76.8 1.94/0.274	145/80.8 2.10/0.234	187/97.4 2.21/0.245	221/69.3 2.32/0.154	247/94.1 2.37/0.141	281/140.6 2.40/0.222	243/101.2 2.35/0.177	132/45.0 2.10/0.140
Winban	153/70.2 2.13/0.239	88/51.5 1.85/0.333	88/51.1 1.87/0.272	80/74.3 1.77/0.356	105/64.9 1.94/0.277	140/75.4 2.06/0.234	223/116.6 2.30/0.223	245/55.6 2.38/0.096	270/96.4 2.40/0.163	293/110.8 2.44/0.172	271/122.4 2.39/0.205	158/67.2 2.16/0.182

* First line of data indicates the means and standard deviations of the inputted rainfall values. Second line of data shows the same parameters for the logs of the estimated population.

Table 6: **Values of Mean Rainfall and Standard Deviation of the Inputted Rainfall Values and Their Logs for other Caribbean Stations Analysed**

STATION	D_{20}			D_{50}			D_{80}		
	a	b	r^2	a	b	r^2	a	b	r^2
St. Augustine	11.0	1.24	0.99	-9.8	0.97	0.99	-17.6	0.75	0.96
Botanical Garden	7.7	1.32	0.99	-8.3	0.93	0.99	-16.2	0.67	0.97
Couva	13.0	1.24	1.00	-11.9	0.98	1.00	-21.7	0.76	0.99
Crown Point Airport	10.1	1.28	0.99	-13.6	0.98	0.99	-20.6	0.73	0.94
Grosvenor Estate	23.8	1.21	0.99	-19.2	0.99	1.00	-35.7	0.79	0.98
Perseverance Estate	18.8	1.21	0.99	-19.3	1.03	1.00	-32.7	0.84	0.97
Piarco Airport	13.1	1.21	0.99	-12.7	1.00	1.00	-22.7	0.80	0.96
Poole	24.4	1.23	0.98	-21.5	0.99	0.99	-37.2	0.77	0.93
TRINIDAD & TOBAGO	13.5	1.25	0.99	-12.3	0.97	0.99	-22.1	0.75	0.96
Claremont	4.7	1.44	0.98	-21.6	0.87	0.95	-13.0	0.46	0.83
Frome	15.9	1.26	0.99	-17.6	0.97	0.99	-26.7	0.73	0.94
Hope Bay	11.4	1.45	0.99	-9.1	0.80	0.94	-13.5	0.44	0.78
Intenational Airport	-1.3	1.50	1.00	-3.1	0.69	0.97	-10.6	0.40	0.91
Marshall Pen	4.0	1.41	0.98	-10.1	0.86	0.95	-13.8	0.54	0.80
Monymusk	-3.1	1.41	0.97	-20.4	0.69	0.75	-12.7	0.36	0.75
Morant Point	1.3	1.46	0.99	-5.6	0.81	0.97	-6.5	0.45	0.86
Orange River	8.6	1.39	0.99	-9.9	0.87	0.99	-13.0	0.53	0.95
Port Antonio	28.8	1.33	0.99	-36.9	0.94	0.97	-50.6	0.64	0.88
Worthy Park	4.1	1.37	0.98	-1.1	0.82	0.94	-4.6	0.51	0.76
JAMAICA	3.0	1.42	0.99	-15.3	0.86	0.95	-16.6	0.53	0.83
Belize Airport	21.7	1.30	0.94	-13.6	0.90	0.96	-22.3	0.61	0.81
Campden Park	-9.4	1.35	0.94	-25.8	1.00	0.94	-23.8	0.73	0.88
Coolidge	-2.5	1.46	0.98	3.1	0.77	0.90	3.1	0.43	0.72
Husbands	8.7	1.31	1.00	-7.2	0.93	1.00	-11.9	0.64	0.97
Melville Hall Airport	6.3	1.33	0.99	-10.4	0.92	0.98	-15.3	0.64	0.90
Vigie Airport	10.6	1.27	0.99	-7.3	0.95	0.99	-13.9	0.70	0.95
Winban	22.1	1.21	0.99	-16.3	0.99	1.00	-19.7	0.70	0.90
CARIBBEAN	18.0	1.33	0.98	-8.1	0.92	0.96	-17.9	0.63	0.84

Table 7: **Derived Linear Models relating Dependable Rainfalls (D's) to Mean Rainfall, R in the form: Dprob = a + bR**

rainfall values as inputs. Raes et al (15) and De Goes et al (16) recently inputted values of dependable rainfall in IRSIS while scheduling irrigation in projects in France and Brazil respectively. Similar work can be carried out in the Caribbean region. For the prediction of the dependable rainfall values at locations in Trinidad and Jamaica where rainfall values were not analysed, it is suggested that the equation for the closest analysed station or the general equation derived for the particular country be used. For other locations in countries like St. Kitts where rainfall data were not analysed, the overall equation derived for the Caribbean region can be used. The evaluation of the derived linear models show that they can predict reliable, dependable rainfall values in the region. The dependable rainfall values with the three probability values analysed can be plotted on probability paper and rainfall values with other probability values read off as required.

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STATION	e	f	COEFFICIENT OF DETERMINATION	t1*	t2
St. Clair, Trinidad	-4.82	1.011	0.993	-2.16	0.73
Bridgetown, Barbados	-2.18	0.998	0.997	-2.01	-0.20
Georgetown, Guyana	9.09	0.957	0.964	1.34	-1.36
Lamentin, Martinique	-17.84	1.093	0.967	-3.03	2.68
Les Cayes, Haiti	10.06	0.948	0.988	3.00	-2.95
Nassau, Bahamas	1.97	0.989	0.996	1.61	-1.10
Negril Point, Jamaica	-14.81	1.039	0.960	-3.08	1.05
Paramaribo, Suriname	-6.13	1.023	0.948	-0.75	0.56
Puerto Plata, Dominican Repupublic	9.89	0.946	0.988	3.26	-3.05
San Juan, Puerto Rico	-8.90	1.090	0.977	-2.43	3.20

*t1 and t2 are student t values for testing e, intercept = 0 and slope, f=1 respectively.
The critical t at 0.001 level of significance is 3.35.

Table 8: **Model Evaluation Equations relating Estimated, Y and Published Dependable Rainfall, X in the form: $Y = e + fX$**

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