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An analysis of rainfall variability in St. Catherine for agricultural planning

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MINISTRY OF AGRICULTURE

Rural Physical Planning Division

Jamaica Soil Survey Project

22716

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1 INTRODUCTION

Detailed knowledge of the climatic conditions, soil characteristics and crop requirements is needed before starting on any agro-economic venture. A timely understanding of these features will reduce the risk of possible misconceptions in agricultural planning. Considering this, the computerized Jamaica Physical Land Evaluation System (JAMPLES) has been developed at the Rural Physical Planning Division (Batjes, Bouwman & Sinclair, 1986). It is specially designed for site assessments at scale 1:25,000 to 1:50,000.

A climatic data base is being developed within the framework of JAMPLES. The statistical analysis of this data base is discussed by Batjes (1986a & 1987). The results of these analyses, an interpretation of the variability and reliability of monthly and yearly rainfall totals in time at selected stations in Jamaica, are used for land evaluation.

Soil Survey Unit Staff has been carrying out soil surveys covering the parish of St. Catherine. As a result a fairly extensive climatic data base has been established for that parish using records from the Meteorological Service. This paper summarizes the results of the statistical analyses of monthly rainfall totals for 16 stations, 14 in St. Catherine and 2 neighbouring stations in St. Mary. Subsequently, an assessment of the probable length of the growing season at each of these stations has been made. This information can assist policy makers and planners in selecting suitable locations for growing specific crops in St. Catherine.

2 MATERIALS AND METHODS

Monthly rainfall totals from Bernard Lodge, Bog Walk, Dawkins, Enfield, Ewarton, Glengoffe, Guys Hill (St. Mary), Linstead, Old Harbour, New Hall (St. Mary), Point Hill, Riversdale, Sligoville, Spanish Town, Wakefield and Worthy Park are used for this study. Most of these stations have data records longer than 20 years.

The raw input files have first been eye checked for their reliability. Thereafter, data from individual stations have been entered into computer format using the ENTERAIN option of the JAMPLES menu. These files can be updated/corrected when

necessary using the RAINCOR option. The statistical analysis of the rainfall files is done with the POWSTAT module (Batjes, 1986a). The RAINSTAT module is used for the assessment of the probable length of the growing season (Batjes, 1987).

Monthly Potential Evapo-transpiration (Priestley & Taylor method) at each of the 16 stations is assessed from altitude using the regression equations developed by L'Homme & Eldin (IICA, 1983).

3 CLIMATIC ANALYSIS

3.1 Variability and reliability of monthly rainfall

The variability and reliability of periodic rainfall is a critical consideration in any agro-economic study as it allows for the assessment of the most suitable time of planting and harvesting, and for the selection of appropriate crops.

The results of the statistical analyses are presented in Appendix I. The following entities are shown for each location:

- 'N' the sample size (number of records) for month-i.
- 'Mean' the arithmetic mean for month-i in mm.
- 'CV' the coefficient of variation which is a measure for the variability of monthly rainfall in the given month in time.
- 'Minim.' the lowest total amount of rainfall that occurred in month-i within this data series.
- '10%-L', Lower 10% limit: in 9-out-of-10 years this amount should be exceeded in month-i. In 10 percent of the years total monthly rainfall should be less than the amount shown.
- '25%-L', Lower 25% limit: as above but the amount shown should be exceeded in 75% of the years.
- '50%-' in half of the years monthly rainfall will be lower or higher than the amount shown.
- '25%-U', Upper 25% limit: as above but this amount should be exceeded in 25 percent of the years.

- '10%-U', Upper 10% limit: as above but this amount should be exceeded in 10 percent of the years.

- 'Maxim.' the highest total rainfall for month-i for the given data series.

- 'PET' the potential evapotranspiration in mm/period.

The Appendices show that knowledge of only 'mean' rainfall is inadequate when planning for agriculture. What is needed is information about the variability and reliability of periodic rainfall in time and space. The following example illustrates this:

Riversdale, June: The minimum total rainfall that has been recorded over the 1950-1980 period is 30 mm and the maximum is 837 mm. In 80 percent of the years, total rainfall in June will be in the 72 to 415 mm range. In 75 percent of the years total rainfall will exceed 120 mm. Half of the time total rainfall will be in the 120 to 294 mm range, and in 10 percent of the years it will be more than 415 mm. There is an equal probability of having more or less than 194 mm of rain in June. Mean annual rainfall in June is 222 mm. The year to year variability of total rainfall in June is high (CV=73%). Average PET in June is 143 mm.

3.2 Probable length of the growing period

The length of the growing season is assessed on the basis of: a) the temperature requirements of the crop (Batjes, 1986b), and b) the likelihood of receiving adequate rainfall for growing the crop under rainfed conditions (Batjes, 1987).

The growing period is defined as the period during which rainfall exceeds half PET in at least 75 percent of the years. The 75 percent criterion generally is well related to a bearable risk in (rainfed) small scale farming.

At the beginning of the rainy season(s) rain falls on a soil that is mostly dry at the surface and will have a moisture deficit in its profile. If the soil moisture reserve in the surface layer is low, seedbed preparation, seed germination and initial crop growth will be entirely dependent on the reliability and amount of the early rains. Studies by FAO (1981) indicate that the reliability of the 'early' rains increases considerably once that the total monthly rainfall exceeds half of the monthly potential evapo-transpiration (PET). The risk of crop failure due to low and erratically distributed initial rainfall can thus largely be overcome if crops are planted once that total monthly

rainfall exceeds half PET. This criterion further accounts for the fact that the initial water requirement of young crops is well below the full PET rate (see FAO, 1979).

Total monthly rainfall can exceed PET during the rainy season. During this 'humid' period the water requirements of a fully established crop will be met and the soil moisture reserve replenished. The growing season ends once that monthly rainfall totals drop below half of the monthly PET.

The results of the 'agro-climatic' analysis are summarized in Table 1. 'M' refers to a moist period (Rain=> 0.5*PET), 'H' to a humid period (rain => PET), and '*' to a dry period (Rain < 0.5*PET). A growing season encompasses a period with at least two consecutive M's or H's. Rainfall during each growing period is adequate for obtaining satisfactory yields -not necessarily optimum yields- provided that the crops, soils and management practices have been selected with care.

Table 1: Probable length of the growing period at 16 stations located in St. Catherine and St. Mary (in 75% of the years).

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
Bernard Lodge	*	*	*	*	*	*	*	*	*	M	*	*
Bogwalk	*	*	*	*	M	M	M	M	M	H	M	*
Dawkins	*	*	*	*	*	*	*	*	*	M	*	*
Enfield	*	*	*	*	M	M	M	M	M	M	M	*
Ewarton	*	*	*	*	M	M	M	M	M	H	M	*
Glengoffe	*	*	*	M	M	M	M	H	H	H	M	M
Guys Hill	H	M	*	M	M	M	*	M	M	H	H	H
Linstead	*	*	*	*	M	M	M	M	H	H	M	*
New Hall	*	*	*	*	M	M	M	M	M	H	M	*
Old Harbour	*	*	*	*	*	*	*	*	*	M	*	*
Point Hill	*	*	*	*	H	M	M	M	H	H	M	*
Riversdale	*	*	*	M	M	M	M	M	H	H	M	M
Sligoville	*	*	*	M	M	M	M	H	H	H	H	*
Spanish Town	*	*	*	*	*	*	*	*	*	M	*	*
Wakefield	*	*	*	*	M	M	M	M	M	H	M	*
Worthy Park	*	*	*	*	M	M	M	M	H	H	M	*

Mapping of rainfall isohyets for St. Catherine on the basis of the results shown in Table 1 presently is not feasible due to the varied topography and micro-climatic influences. Isohyets, however, will be mapped in the near future with the new software that will be installed at the Rural Physical Planning Division (ESRI, 1985).

From Table 1 and 2 follows the fact that the southern plain is

semi-arid [Bernard Lodge, Dawkins, Old Harbour and Spanish Town] with a probable length of the growing period (PLG) of one month. The north-eastern part [Glengoffe, Guys Hill, Sligoville and Riversdale] of St. Catherine is humid with PLG of 8 to 9 months including 3 to 4 humid months. The Point Hill area is humid with PLG of 7 months which encompasses 3 humid months. The remaining areas are sub-humid [Bogwalk, Enfield, Ewarton, Linstead, New Hall, Wakefield and Worthy Park] with PLG of 7 months which mostly includes one to two humid months.

IND in Table 2 stands for the '25% expected rainfall' divided by annual PET. A value of IND of 0 to 0.3 is indicative for arid areas, 0.3 to 0.7 for semi-arid areas, 0.7 to 1.0 for sub-humid areas, and IND higher than unity for humid areas.

The Tables and Appendices show that a wide range in total seasonal rainfall occurs in St. Catherine. This variability in rainfall patterns in conjuction with the wide range in soil characteristics (Vernon, 1958; Campbell, Commissaris & de Wit, in press) implies that a wide range of crops can be grown in the parish. Suitable crops for each location will be discussed in the land evaluation section of the soil survey reports by Soil Survey Unit Staff.

Table 2: Variability of yearly rainfall totals and probable length of the growing period (PLG in 75% of the years) in St. Catherine.

Station	elev. (m)	PLG length	PLG start	expected rainfall (mm) 10%	25%	50%	75%	90%	IND
Bernard L.	15	1	Oct.	341	537	757	985	1199	0.3
Dawkins	20	1	Oct.	410	626	859	1092	1308	0.4
Spanish Town	29	1	Oct.	502	668	847	1026	1192	0.4
Old Harbour	21	1	Oct.	551	779	1025	1271	1499	0.5
Ewarton	231	7	May	1072	1210	1376	1563	1756	0.8
Bogwalk	88	7	May	1263	1386	1518	1649	1772	0.9
Worthy Park	380	7	May	1083	1297	1527	1757	1971	0.8
Enfield	122	7	May	1110	1346	1602	1858	2094	0.9
Wakefield	97	7	May	1158	1375	1613	1854	2082	0.9
Linstead	111	7	May	1110	1365	1640	1914	2170	0.9
New Hall	228	7	May	1146	1399	1671	1943	2195	0.9
Point Hill	609	7	May	1286	1543	1819	2095	2352	1.1
Sligoville	639	8	Apr.	1332	1616	1921	2226	2510	1.2
Riversdale	153	9	Apr.	1262	1526	1810	2095	2359	1.0
Glengoffe	345	9	Apr.	1148	1513	1906	2300	2665	1.0
Guys Hill	487	10	Apr.	1440	1874	2342	2810	3244	1.3

IND: expected '25% yearly rainfall' divided by annual PET.

4 CONCLUSIONS AND RECOMMENDATIONS

The need for in depth studies of rainfall characteristics in areas selected for agricultural development follows clearly from the discussions in Section 3. Parallel to these studies, the soil conditions, suitable crops and socio-economic feasibility of the project should be investigated. Such studies allow for the timely assessment of the agro-ecological and economic suitability of a site for the envisaged use.

This paper provides information that can be used when planning for rainfed and irrigated agriculture in St. Catherine. In using these results the following should be understood:

- The present assessments are for monthly periods. The effect of dry spells within the growing period therefore could not be studied.

- The PET values have been calculated with the Priestley & Taylor method. However, PET varies with the calculation method. This in turn will affect the assessment of the probable length of the growing season.

- Part of the rainfall will runoff, that is rainfall can only in part be used by the crop or stored in the soil.

- The better the soil's water storage/release characteristics are, the longer the length of the growing period in a given location will be.

- Individual crops show different water requirements in time, which allows for the selection of agro-climatically adapted crops.

- Micro-climatic influences will alter the overall rainfall pattern in each location (e.g. orographic effects).

Suitable crops can be assessed at the Rural Physical Planning Division with the JAMPLES software package (Batjes, 1987; Bouwman, 1986) if site specific information on soils and climate is available.

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Appendix I: Listings of the RAINSTAT module for 16 stations located in St. Catherine and St. Mary.

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JAMPLES: rainstat

The RAINSTAT option gives you:

1] *Listings of the climatic files (monthly rainfall totals and PET) in mm/period.*
2] *The probability of exceeding a given amount of rainfall in 1/10, 2.5/10, 5/10, 7.5/10 and 9/10 years.*
3] *The probable length of the growing period in 3 out of 4 years.*

The following stations have been analyzed:

1 } BERNARD LODGE
2 } BOG WALK
3 } DAWKINS
4 } ENFIELD
5 } EWARTON
6 } GLENGOFFE
7 } GUYS HILL
8 } LINSTEAD
9 } NEW HALL
10 } OLD HARBOUR
11 } POINT HILL
12 } RIVERSDALE
13 } SLIGOVILLE
14 } SPANISH TOWN
15 } WAKEFIELD
16 } WORTHY PARK

Ref.: Batjes, N.H. (1986) Technical Soils Bulletin No. 4 & 7.
Jamaica Soil Survey Project
Rural Physical Planning Division
Ministry of Agriculture

CLIMATIC ANALYSIS FOR BERNARD LODGE

Table 1 : Extremes and variability of monthly and annual rainfall totals and potential evapotranspiration for BERNARD LODGE in mm. [Data base: 1950 - 1985]

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
N	33	35	34	35	35	35	34	35	35	35	33	30	29
Mean	21	22	25	44	86	83	33	72	95	189	72	39	764
CV (%)	101	99	133	122	107	136	128	79	123	80	73	76	41
Minim.	0	0	0	0	0	0	0	4	2	10	3	0	208
10%-L	0	0	0	4	0	0	0	11	8	35	11	0	341
25%-L	6	7	4	12	22	11	5	32	26	84	34	18	537
50%-	18	18	16	30	68	47	22	64	64	163	67	39	757
25%-U	33	33	36	61	132	116	50	104	129	266	105	60	985
10%-U	49	50	64	103	204	213	85	147	220	383	144	79	1199
Maxim.	91	95	172	298	452	470	149	277	638	701	267	109	1550
PET	105	111	142	146	154	148	158	147	127	125	107	105	1576

Table 2 : Probable length of the growing period (LGP) at BERNARD LODGE in 3 out of 4 years [data base: 1950 - 1985].

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	R>75%
LGP	*	*	*	*	*	*	*	*	*	M	*	*	536

LGP = H [Humid period (Rain=>PET)] + M [Moist period (Rain=>.5*PET)] ; * = Dry period (Rain<.5*PET)

In 8 out of 10 years total annual rainfall is in the 341 - 1198 mm range.

Mean annual rainfall is 757 mm/year, and in 3 out of 4 years annual rainfall exceeds 536 mm/year (R>75%).

CLIMATIC ANALYSIS FOR BOGWALK

Table 1 : Extremes and variability of monthly and annual rainfall totals and potential evapotranspiration for BOGWALK in mm. [Data base: 1950 - 1976]

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
N	20	19	23	19	21	20	21	19	18	16	15	17	12
Mean	48	56	67	151	170	164	143	186	158	242	121	69	1518
CV (%)	75	117	82	156	55	61	38	45	38	42	62	114	11
Minim.	0	0	2	0	0	47	70	53	76	108	21	0	1299
10%-L	0	0	6	12	38	65	71	68	85	133	24	5	1263
25%-L	22	10	26	35	102	97	103	125	114	172	65	19	1386
50%-	48	36	58	91	170	146	140	186	152	226	116	47	1518
25%-U	74	82	99	200	238	211	180	247	196	296	173	97	1649
10%-U	98	144	145	376	302	292	220	304	243	378	229	168	1772
Maxim.	125	222	228	1123	349	534	288	340	301	548	316	315	1832
PET	104	109	139	143	151	146	155	145	125	123	105	104	1550

0.84

Table 2 : Probable length of the growing period (LGP) at BOGWALK in 3 out of 4 years [data base: 1950 - 1976].

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	R>75%
LGP	*	*	*	*	M	M	M	M	M	H	M	*	1385

LGP = H [Humid period (Rain=>PET)] + M [Moist period (Rain=>.5*PET)] ; * = Dry period (Rain<.5*PET)

In 8 out of 10 years total annual rainfall is in the 1263 - 1771 mm range.

Mean annual rainfall is 1517 mm/year, and in 3 out of 4 years annual rainfall exceeds 1385 mm/year (R>75%).

CLIMATIC ANALYSIS FOR DAWKINS

Table 1 : Extremes and variability of monthly and annual rainfall totals and potential evapotranspiration for DAWKINS in mm. [Data base: 1950 - 1979]

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
N	29	29	29	29	28	29	29	29	29	29	28	28	27
Mean	25	26	27	50	94	80	56	88	115	198	90	41	859
CV (%)	101	89	122	102	95	133	99	77	92	85	66	88	38
Minim.	0	0	0	0	1	0	0	5	4	20	9	0	231
10%-L	0	0	0	5	7	0	2	9	21	34	21	0	410
25%-L	6	9	4	17	31	10	16	38	47	82	47	15	626
50%-	21	23	18	39	75	41	43	80	91	162	82	41	859
25%-U	39	39	41	72	138	108	84	130	159	278	125	66	1092
10%-U	59	57	71	115	213	216	133	182	248	420	171	90	1308
Maxim.	88	86	149	254	372	371	212	272	580	737	278	107	1659
PET	109	113	142	147	155	150	158	146	126	127	105	105	1583

Table 2 : Probable length of the growing period (LGP) at DAWKINS in 3 out of 4 years [data base: 1950 - 1979].

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	R>75%
LGP	*	*	*	*	*	*	*	*	*	M	*	*	626

LGP = H [Humid period (Rain=>PET)] + M [Moist period (Rain=>.5*PET)] ; * = Dry period (Rain<.5*PET)

In 8 out of 10 years total annual rainfall is in the 409 - 1308 mm range.

Mean annual rainfall is 858 mm/year, and in 3 out of 4 years annual rainfall exceeds 626 mm/year (R>75%).

CLIMATIC ANALYSIS FOR ENFIELD

Table 1 : Extremes and variability of monthly and annual rainfall totals and potential evapotranspiration for ENFIELD in mm. [Data base: 1950 - 1980]

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
N	31	31	31	31	31	31	31	31	31	31	31	30	30
Mean	66	62	59	115	173	197	155	159	174	217	133	91	1602
CV (%)	74	88	84	67	53	55	49	48	58	73	59	74	22
Minim.	2	10	0	0	0	33	17	10	33	36	35	6	674
10%-L	0	12	8	10	48	67	56	66	68	51	54	14	1110
25%-L	31	26	24	60	108	121	101	105	106	108	81	44	1346
50%-	66	49	50	115	173	189	154	154	159	193	121	85	1602
25%-U	101	84	84	170	238	265	208	208	227	302	172	133	1858
10%-U	132	128	124	220	298	341	258	261	300	423	231	182	2094
Maxim.	171	228	252	315	335	553	402	442	589	757	442	258	2256
PET	101	106	134	138	146	142	151	141	122	120	102	101	1504

Table 2 : Probable length of the growing period (LGP) at ENFIELD in 3 out of 4 years [data base: 1950 - 1980].

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	R>75%
LGP	*	*	*	*	M	M	M	M	M	M	M	*	1345

LGP = H [Humid period (Rain=>PET)] + M [Moist period (Rain=>.5*PET)] ; * = Dry period (Rain<.5*PET)

In 8 out of 10 years total annual rainfall is in the 1109 - 2093 mm range.

Mean annual rainfall is 1601 mm/year, and in 3 out of 4 years annual rainfall exceeds 1345 mm/year (R>75%).

CLIMATIC ANALYSIS FOR EWARTON

Table 1 : Extremes and variability of monthly and annual rainfall totals and potential evapotranspiration for EWARTON in mm. [Data base: 1950 - 1980]

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
N	25	25	22	21	21	21	23	24	23	21	20	17	12
Mean	44	56	86	93	151	159	122	137	151	188	101	72	1395
CV (%)	60	87	148	69	70	47	42	49	58	44	76	91	17
Minim.	8	11	3	1	35	29	36	41	58	34	25	6	1128
10%-L	8	10	9	4	48	55	51	57	58	75	32	11	1072
25%-L	25	22	23	47	79	105	85	88	90	127	51	27	1210
50%-	44	44	54	93	128	159	122	129	136	186	83	56	1376
25%-U	63	77	112	139	199	213	159	178	198	246	132	100	1563
10%-U	80	121	202	182	290	264	193	230	270	303	199	160	1756
Maxim.	107	189	644	205	490	310	221	357	443	388	371	226	1844
PET	100	105	132	136	144	140	149	140	121	118	100	100	1486

Table 2 : Probable length of the growing period (LGP) at EWARTON in 3 out of 4 years [data base: 1950 - 1980].

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	R>75%
LGP	*	*	*	*	M	M	M	M	M	H	M	*	1210

LGP = H [Humid period (Rain=>PET)] + M [Moist period (Rain=>.5*PET)] ; * = Dry period (Rain<.5*PET)

In 8 out of 10 years total annual rainfall is in the 1072 - 1755 mm range.

Mean annual rainfall is 1376 mm/year, and in 3 out of 4 years annual rainfall exceeds 1210 mm/year (R>75%).

CLIMATIC ANALYSIS FOR GLENGOFFE

Table 1 : Extremes and variability of monthly and annual rainfall totals and potential evapotranspiration for GLENGOFFE in mm. [Data base: 1950 - 1979]

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
N	27	26	27	26	25	26	25	26	27	25	26	22	16
Mean	74	64	66	144	273	180	139	226	248	272	192	125	1906
CV (%)	78	81	87	72	91	67	56	46	48	64	74	83	28
Minim.	0	0	4	9	28	39	0	56	68	32	20	12	1217
10%-L	8	8	6	28	60	50	31	82	85	82	42	19	1148
25%-L	33	27	26	69	120	96	83	151	163	151	92	52	1513
50%-	68	56	57	130	221	163	139	226	248	248	169	106	1906
25%-U	110	93	98	205	370	247	195	302	332	370	269	179	2300
10%-U	153	134	143	285	561	339	247	371	410	504	381	263	2665
Maxim.	258	233	221	505	1131	572	335	471	504	762	571	437	3050
PET	99	103	131	134	142	139	148	138	120	117	99	99	1469

Table 2 : Probable length of the growing period (LGP) at GLENGOFFE in 3 out of 4 years [data base: 1950 - 1979].

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	R>75%
LGP	*	*	*	M	M	M	M	H	H	H	M	M	1512

LGP = H [Humid period (Rain=>PET)] + M [Moist period (Rain=>.5*PET)] ; * = Dry period (Rain<.5*PET)

In 8 out of 10 years total annual rainfall is in the 1147 - 2664 mm range.

Mean annual rainfall is 1906 mm/year, and in 3 out of 4 years annual rainfall exceeds 1512 mm/year (R>75%).

CLIMATIC ANALYSIS FOR GUYS HILL

Table 1 : Extremes and variability of monthly and annual rainfall totals and potential evapotranspiration for GUYS HILL in mm. [Data base: 1951 - 1980]

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
N	29	29	27	28	27	27	27	28	28	27	28	26	23
Mean	190	142	118	159	205	181	112	162	203	271	300	239	2342
CV (%)	54	85	79	66	62	60	60	55	78	51	53	41	27
Minim.	29	9	14	15	28	25	25	27	35	48	67	53	1194
10%-L	49	16	21	15	30	40	19	50	65	80	80	103	1440
25%-L	117	58	53	84	114	103	64	99	106	171	185	168	1874
50%-	190	124	102	159	205	177	112	158	171	271	300	239	2342
25%-U	263	208	167	233	296	255	161	222	265	371	414	310	2810
10%-U	330	301	242	302	380	328	205	284	384	462	519	376	3244
Maxim.	423	467	411	470	508	456	274	414	883	699	725	521	4073
PET	95	98	123	126	134	133	141	133	115	113	94	95	1401

Table 2 : Probable length of the growing period (LGP) at GUYS HILL in 3 out of 4 years [data base: 1951 - 1980].

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	R>75%
LGP	H	M	*	M	M	M	*	M	M	H	H	H	1874

LGP = H [Humid period (Rain=>PET)] + M [Moist period (Rain=>.5*PET)] ; * = Dry period (Rain<.5*PET)

In 8 out of 10 years total annual rainfall is in the 1440 - 3243 mm range.

Mean annual rainfall is 2342 mm/year, and in 3 out of 4 years annual rainfall exceeds 1874 mm/year (R>75%).

CLIMATIC ANALYSIS FOR LINSTEAD

Table 1 : Extremes and variability of monthly and annual rainfall totals and potential evapotranspiration for LINSTEAD in mm. [Data base: 1951 - 1977]

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
N	27	27	26	27	27	27	27	27	27	27	27	27	26
Mean	55	52	55	91	217	187	166	169	178	232	123	97	1640
CV (%)	69	88	69	81	58	62	40	41	38	65	46	93	23
Minim.	7	4	5	7	25	10	8	71	52	56	34	1	838
10%-L	10	8	6	0	42	53	75	86	85	85	45	8	1110
25%-L	27	21	28	38	127	104	119	120	130	132	83	33	1365
50%-	51	43	54	88	217	174	166	162	178	202	123	78	1640
25%-U	79	74	81	141	308	257	213	212	226	300	164	142	1914
10%-U	108	112	108	193	392	346	257	263	271	422	202	219	2170
Maxim.	155	167	154	244	516	585	312	391	312	631	254	367	2671
PET	103	109	138	142	150	145	154	144	124	122	104	103	1540

Table 2 : Probable length of the growing period (LGP) at LINSTEAD in 3 out of 4 years [data base: 1951 - 1977].

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	R>75%
LGP	*	*	*	*	M	M	M	M	H	H	M	*	1364

LGP = H [Humid period (Rain=>PET)] + M [Moist period (Rain=>.5*PET)] ; * = Dry period (Rain<.5*PET)

In 8 out of 10 years total annual rainfall is in the 1109 - 2169 mm range.

Mean annual rainfall is 1639 mm/year, and in 3 out of 4 years annual rainfall exceeds 1364 mm/year (R>75%).

CLIMATIC ANALYSIS FOR NEW HALL

Table 1 : Extremes and variability of monthly and annual rainfall totals and potential evapotranspiration for NEW HALL in mm. [Data base: 1950 - 1980]

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
N	31	31	31	31	31	31	31	31	31	31	31	30	30
Mean	57	51	60	103	204	183	177	185	189	236	124	91	1671
CV (%)	77	90	76	54	44	58	50	35	52	63	56	81	22
Minim.	3	0	0	16	36	68	50	91	45	41	28	10	920
10%-L	6	5	4	26	82	77	73	101	63	91	44	16	1146
25%-L	25	18	27	63	139	111	113	138	118	138	74	38	1399
50%-	52	42	56	103	202	161	166	182	184	208	115	76	1671
25%-U	84	74	89	143	268	231	230	228	255	304	164	128	1943
10%-U	117	113	123	180	331	319	298	275	325	422	218	193	2195
Maxim.	170	193	173	220	450	539	455	394	431	786	374	276	2448
PET	99	103	131	134	142	139	148	139	120	117	99	99	1471

Table 2 : Probable length of the growing period (LGP) at NEW HALL in 3 out of 4 years [data base: 1950 - 1980].

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	R>75%
LGP	*	*	*	*	M	M	M	M	M	H	M	*	1399

LGP = H [Humid period (Rain=>PET)] + M [Moist period (Rain=>.5*PET)] ; * = Dry period (Rain<.5*PET)

In 8 out of 10 years total annual rainfall is in the 1146 - 2195 mm range.

Mean annual rainfall is 1670 mm/year, and in 3 out of 4 years annual rainfall exceeds 1399 mm/year (R>75%).

CLIMATIC ANALYSIS FOR OLD HARBOUR

Table 1 : Extremes and variability of monthly and annual rainfall totals and potential evapotranspiration for OLD HARBOUR in mm. [Data base: 1951 - 1980]

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
N	28	27	29	30	28	26	29	29	29	28	28	28	21
Mean	39	36	46	53	138	86	55	106	118	224	103	49	1025
CV (%)	80	69	83	66	77	134	102	90	67	68	88	75	33
Minim.	0	1	0	0	7	0	0	0	7	41	6	4	395
10%-L	7	2	0	11	22	0	0	0	10	16	9	0	551
25%-L	17	19	19	28	62	13	15	38	62	116	39	23	779
50%-	34	36	46	50	123	51	55	106	118	224	89	49	1025
25%-U	56	54	72	75	199	122	95	173	174	333	153	75	1271
10%-U	81	71	97	101	282	222	132	235	226	433	224	99	1499
Maxim.	164	86	124	159	511	485	174	307	281	592	414	145	1844
PET	105	111	142	146	154	148	158	147	127	125	107	105	1574

Table 2 : Probable length of the growing period (LGP) at OLD HARBOUR in 3 out of 4 years [data base: 1951 - 1980].

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	R>75%
LGP	*	*	*	*	*	*	*	*	*	M	*	*	778

LGP = H [Humid period (Rain=>PET)] + M [Moist period (Rain=>.5*PET)] ; * = Dry period (Rain<.5*PET)

In 8 out of 10 years total annual rainfall is in the 550 - 1498 mm range.

Mean annual rainfall is 1024 mm/year, and in 3 out of 4 years annual rainfall exceeds 778 mm/year (R>75%).

CLIMATIC ANALYSIS FOR POINT HILL

Table 1 : Extremes and variability of monthly and annual rainfall totals and potential evapotranspiration for POINT HILL in mm. [Data base: 1951 - 1979]

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
N	25	26	25	28	27	28	28	28	27	27	27	27	21
Mean	84	63	94	108	237	202	145	198	212	308	148	91	1819
CV (%)	70	74	72	68	62	99	42	49	51	48	69	70	21
Minim.	0	7	12	4	21	11	39	36	86	123	5	4	945
10%-L	2	0	11	13	35	25	61	69	102	149	8	13	1286
25%-L	42	30	45	55	132	72	101	128	141	207	75	45	1543
50%-	84	63	89	105	237	157	145	195	195	287	148	87	1819
25%-U	126	97	139	158	342	286	189	265	266	387	221	133	2095
10%-U	166	128	188	208	439	446	229	331	347	498	288	178	2352
Maxim.	210	177	249	346	555	848	249	510	657	757	352	265	2640
PET	93	95	119	121	130	129	138	130	112	110	91	92	1360

Table 2 : Probable length of the growing period (LGP) at POINT HILL in 3 out of 4 years [data base: 1951 - 1979].

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	R>75%
LGP	*	*	*	*	H	M	M	M	H	H	M	*	1542

LGP = H [Humid period (Rain=>PET)] + M [Moist period (Rain=).5*PET)] ; * = Dry period (Rain<.5*PET)

In 8 out of 10 years total annual rainfall is in the 1286 - 2351 mm range.

Mean annual rainfall is 1818 mm/year, and in 3 out of 4 years annual rainfall exceeds 1542 mm/year (R>75%).

CLIMATIC ANALYSIS FOR RIVERSDALE

Table 1 : Extremes and variability of monthly and annual rainfall totals and potential evapotranspiration for RIVERSDALE in mm. [Data base: 1950 - 1980]

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
N	27	27	27	28	28	29	29	28	28	29	29	27	22
Mean	71	55	57	120	229	222	212	203	235	255	140	129	1810
CV (%)	70	81	71	55	56	73	68	33	50	64	65	59	21
Minim.	14	14	0	12	0	30	66	125	113	84	18	29	1095
10%-L	2	13	1	30	53	72	85	131	125	78	37	25	1262
25%-L	35	25	28	73	137	120	123	158	163	142	75	75	1526
50%-	71	45	57	120	229	194	182	195	216	233	129	129	1810
25%-U	107	75	86	168	320	294	266	239	285	346	193	184	2095
10%-U	140	112	112	211	405	415	372	287	369	470	261	234	2359
Maxim.	180	196	158	251	479	837	698	471	628	722	408	289	2884
PET	102	107	136	140	148	143	152	142	123	121	103	102	1519

Table 2 : Probable length of the growing period (LGP) at RIVERSDALE in 3 out of 4 years [data base: 1950 - 1980].

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	R>75%
LGP	*	*	*	M	M	M	M	H	H	H	M	M	1525

LGP = H [Humid period (Rain=>PET)] + M [Moist period (Rain=>.5*PET)] ; * = Dry period (Rain<.5*PET)

In 8 out of 10 years total annual rainfall is in the 1262 - 2358 mm range.

Mean annual rainfall is 1810 mm/year, and in 3 out of 4 years annual rainfall exceeds 1525 mm/year (R>75%).

CLIMATIC ANALYSIS FOR SLIGOVILLE

Table 1 : Extremes and variability of monthly and annual rainfall totals and potential evapotranspiration for SLIGOVILLE in mm. [Data base: 1950 - 1980]

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
N	27	28	27	29	29	29	29	29	29	29	27	29	25
Mean	52	55	65	131	209	186	155	223	251	324	157	97	1921
CV (%)	69	73	74	61	55	70	45	49	40	55	54	92	22
Minim.	2	3	8	23	20	52	49	32	95	92	51	2	830
10%-L	9	13	13	21	51	64	69	86	131	133	52	11	1332
25%-L	26	26	30	74	127	99	105	144	179	200	96	34	1616
50%-	48	47	57	131	209	155	149	215	240	295	151	76	1921
25%-U	75	75	91	188	291	239	199	294	313	419	212	138	2226
10%-U	102	109	131	242	367	351	251	374	390	562	275	216	2510
Maxim.	151	178	197	314	480	563	334	579	634	841	376	366	2632
PET	92	94	117	119	128	128	136	129	111	109	90	91	1346

Table 2 : Probable length of the growing period (LGP) at SLIGOVILLE in 3 out of 4 years [data base: 1950 - 1980].

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	R>75%
LGP	*	*	*	M	M	M	M	H	H	H	H	*	1615

LGP = H [Humid period (Rain=>PET)] + M [Moist period (Rain=>.5*PET)] ; * = Dry period (Rain<.5*PET)

In 8 out of 10 years total annual rainfall is in the 1331 - 2510 mm range.

Mean annual rainfall is 1921 mm/year, and in 3 out of 4 years annual rainfall exceeds 1615 mm/year (R>75%).

CLIMATIC ANALYSIS FOR SPANISH TOWN

Table 1 : Extremes and variability of monthly and annual rainfall totals and potential evapotranspiration for SPANISH TOWN in mm. [Data base: 1951 - 1979]

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
N	29	29	27	27	26	26	29	29	24	27	24	24	21
Mean	27	26	32	54	120	89	51	82	106	221	75	46	847
CV (%)	88	95	95	73	89	145	101	80	69	65	70	87	29
Minim.	0	0	0	0	0	0	0	16	0	23	8	0	346
10%-L	0	0	0	0	3	1	0	8	11	63	13	1	502
25%-L	10	8	10	26	43	12	14	35	53	119	37	17	668
50%-	25	25	28	54	106	47	45	74	104	200	70	41	847
25%-U	43	42	50	82	183	118	83	121	157	302	108	70	1026
10%-U	60	59	74	108	265	231	120	170	207	414	147	102	1192
Maxim.	92	82	129	143	466	546	166	227	261	679	250	160	1468
PET	105	111	142	146	153	148	157	146	126	124	107	105	1571

Table 2 : Probable length of the growing period (LGP) at SPANISH TOWN in 3 out of 4 years [data base: 1951 - 1979].

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	R>75%
LGP	*	*	*	*	*	*	*	*	*	M	*	*	668

LGP = H [Humid period (Rain=>PET)] + M [Moist period (Rain=>.5*PET)] ; * = Dry period (Rain<.5*PET)

In 8 out of 10 years total annual rainfall is in the 502 - 1191 mm range.

Mean annual rainfall is 847 mm/year, and in 3 out of 4 years annual rainfall exceeds 668 mm/year (R>75%).

CLIMATIC ANALYSIS FOR WAKEFIELD

Table 1 : Extremes and variability of monthly and annual rainfall totals and potential evapotranspiration for WAKEFIELD in mm. [Data base: 1950 - 1980]

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
N	31	30	30	31	30	31	31	31	31	31	31	30	27
Mean	48	61	71	105	191	178	150	175	195	261	117	80	1616
CV (%)	76	100	83	71	51	74	32	39	58	56	55	100	20
Minim.	3	1	11	3	26	13	87	31	59	84	23	0	1031
10%-L	5	8	16	3	56	49	88	83	86	107	29	6	1158
25%-L	21	21	32	52	121	89	115	126	122	159	71	24	1375
50%-	44	46	58	105	191	151	147	173	174	233	117	60	1613
25%-U	71	85	96	157	261	240	182	222	246	334	162	115	1854
10%-U	100	138	145	206	326	351	215	269	335	456	204	187	2082
Maxim.	149	248	302	265	411	656	271	394	682	690	281	314	2592
PET	103	109	138	142	150	145	154	144	124	122	104	103	1538

Table 2 : Probable length of the growing period (LGP) at WAKEFIELD in 3 out of 4 years [data base: 1950 - 1980].

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	R>75%
LGP	*	*	*	*	M	M	M	M	M	H	M	*	1375

LGP = H [Humid period (Rain=>PET)] + M [Moist period (Rain=>.5*PET)] ; * = Dry period (Rain<.5*PET)

In 8 out of 10 years total annual rainfall is in the 1157 - 2081 mm range.

Mean annual rainfall is 1612 mm/year, and in 3 out of 4 years annual rainfall exceeds 1375 mm/year (R>75%).

CLIMATIC ANALYSIS FOR WORTHY PARK

Table 1 : Extremes and variability of monthly and annual rainfall totals and potential evapotranspiration for WORTHY PARK in mm. [Data base: 1950 - 1980]

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	YEAR
N	31	31	31	31	31	31	31	31	30	30	30	30	29
Mean	50	56	52	81	187	173	116	153	180	272	109	86	1527
CV (%)	61	66	64	71	64	76	40	48	44	48	54	71	21
Minim.	14	6	3	4	17	24	54	53	41	110	34	18	795
10%-L	19	13	8	16	36	39	60	64	82	130	38	21	1083
25%-L	29	29	28	39	100	81	83	101	122	181	67	42	1297
50%-	44	52	51	73	180	147	111	146	173	251	103	74	1527
25%-U	65	79	75	115	268	238	144	199	231	341	146	117	1757
10%-U	90	108	99	160	355	348	180	253	290	447	191	168	1971
Maxim.	164	170	138	237	518	572	272	422	477	599	283	241	2218
PET	93	96	121	120	124	123	130	121	105	102	93	93	1321

Table 2 : Probable length of the growing period (LGP) at WORTHY PARK in 3 out of 4 years [data base: 1950 - 1980].

Period	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	R>75%
LGP	*	*	*	*	M	M	M	M	H	H	M	*	1296

LGP = H [Humid period (Rain=>PET)] + M [Moist period (Rain=).5*PET)] ; * = Dry period (Rain<.5*PET)

In 8 out of 10 years total annual rainfall is in the 1083 - 1970 mm range.

Mean annual rainfall is 1526 mm/year, and in 3 out of 4 years annual rainfall exceeds 1296 mm/year (R>75%).