REPORT OF THE CARIBBEAN AGROMETEOROLOGICAL INIATIVE (CAMI)

Rainfall Analysis Attachment
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In providing essential information to farmers, weather and its extremes need to be analyzed to provide information on such occurrences as dry spells and droughts, flooding potential, extremes in temperature as well as trends to determine the possibility of a changing climate. There were two statistical programs used in the training sessions at the Statistical Services Centre of the University of Reading, UK. These were InStat and GenStat.

Several methods were explored which included:

- Distribution-free analyses along with smoothing techniques
- Distribution fitting, which included exposure to the range of distributions and their applications
- Regression analysis and trends
- Markov chains

An initial review of some statistical terms gave a better understanding of statistics before beginning the actual analyses. Some of these terms included; standard deviation, variance and standard error that illustrate the degree of variability of the data; as well as significance tests.

Distribution Fitting

INSTAT and GENSTAT were used to find basic statistics (e.g. percentiles) on distribution free data, along with data smoothing. After this we were re-introduced to the normal distribution and its application and the circumstances under which events tend to normal distribution. Other distributions and their applications were re-introduced including the Poisson, exponential, binomial and the gamma.

The “Fit Distribution” menu of the GenStat program was used to fit a GEV (Generalized Extreme Value) Distribution to the values. This type of analysis was used to estimate the return periods and levels of extreme events (for example maximum rainfall, extremes in maximum and minimum temperature). The analyses were used to produce monthly and yearly return periods.

Return periods produced for 2, 5, 10, 20, 50 and 100 year periods. For example, the table below shows the return periods and confidence limits for January rainfall at three stations in the Caribbean.

Table 1: January Rainfall Return levels and confidence limits for Barbados, Belize and Guyana

Return Period	Barbados (CIMH)			Belize (Central Farms)			Guyana (Georgetown)		
	Level	Confidence Limits		Level	Confidence Limits		Level	Confidence Limits	
		Lower	Upper		Lower	Upper		Lower	Upper
2	12.75	8.1	17.39	29.42	20.22	38.6	42.1	31.47	52.8
5	23.1	14.39	31.82	46.64	31.55	61.7	68.1	51.20	85.0
10	32.39	15.79	48.98	59.29	36.27	82.3	88.0	60.50	115.5
20	43.69	12.03	75.35	72.47	37.03	107.9	109.3	62.82	155.9
50	62.84	-4.27	129.96	91.18	31.27	151.1	140.7	53.91	227.5
100	81.52	-29.1	192.14	106.53	21.16	191.9	167.3	36.69	298.0

Markov Chains

Markov chains, used normally to determine the likelihood of the occurrence of an event based on what has happened before, were used to analyze probabilities of having dry spells or rain. This was illustrated using the INSTAT software. Participants explored results based on producing zero, first and second order Markov Chains on daily rainfall data.

Table 2: First Order Markov Chains. The number of dry or rainy days given that the previous day was dry or wet (dd is dry given the previous day is dry, dr is dry given the previous day is rainy

dd	dr	rd	rr
57	54	58	110
70	55	53	102
74	54	55	97
99 etc.	48	46	87
93	45	47	95
102	50	46	82
121	47	48	64
108	56	54	60
134	51	48	47
130	46	52	52
125	57	51	47

This type of analysis incorporates smoothing distributions, in which the user has the choice to the degree of smoothing. The aim would be to obtain the best fit to the actual data (see Figure below).

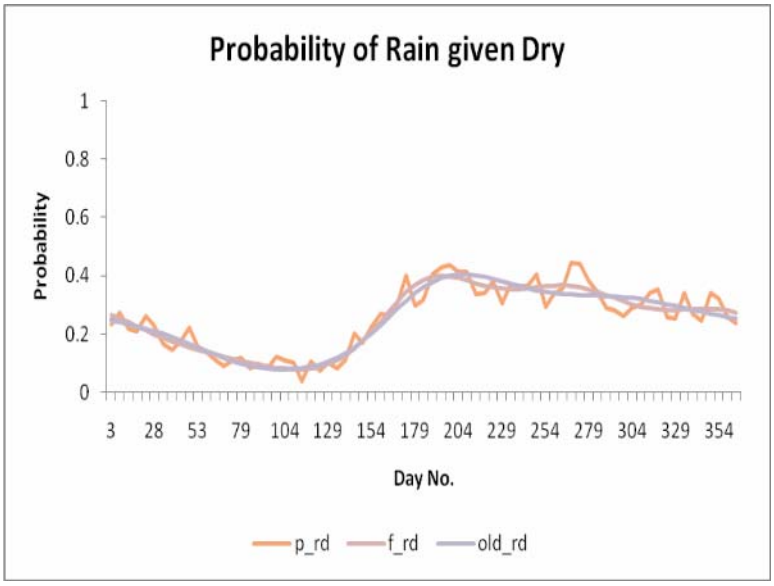

Figure 1: Probability of Rain given that the previous day was dry *[p_rd is the probability obtained from the actual data. old_rd is the fitted probability as a result of smoothing the data where as f_rd is the new fitted probability after smoothing a second time].*

Markov chains could also give probability of spell lengths within a given period as well as probability of a specified amount of rain within a given period.

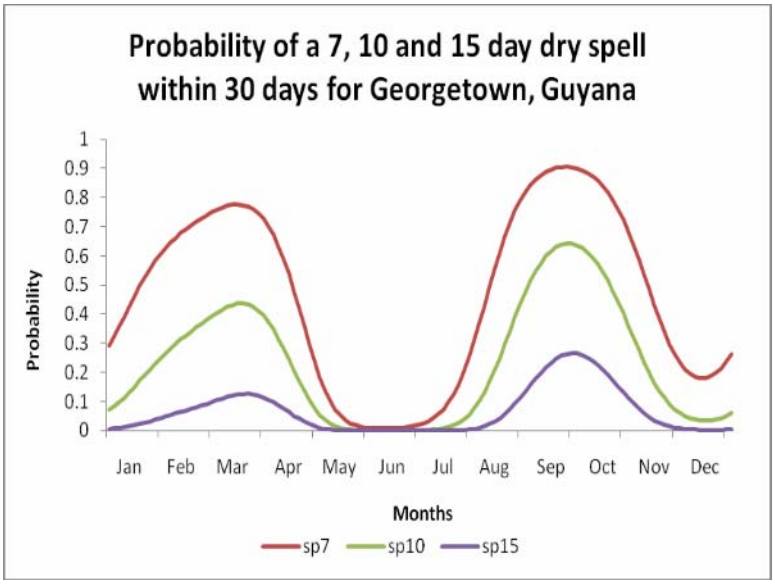

Figure 2: Probability of having a 7, 10 and 15 day dry spell within 30 days for Georgetown, Guyana for a 1st order Markov Chain analysis.

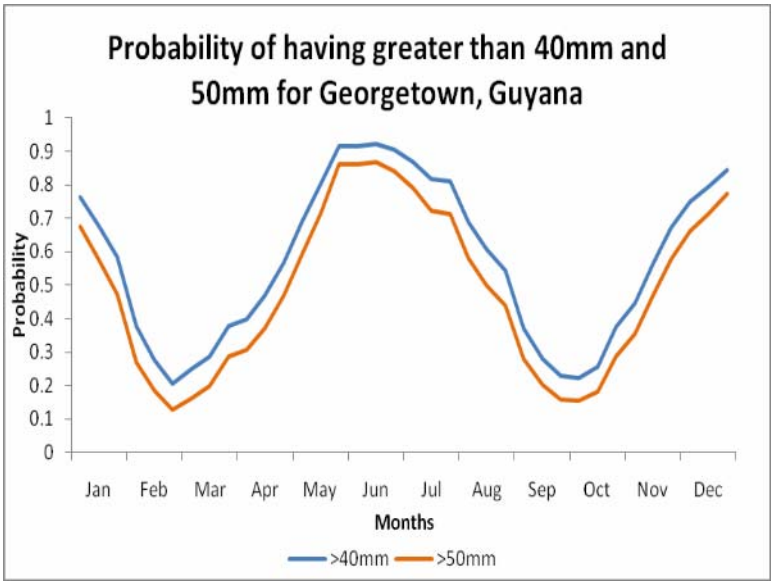

Figure 3: Probability of having greater than 40mm and 50mm of rainfall for Georgetown, Guyana

Trends

Regression analysis is very important in climate analysis, especially for detecting trends in data, and thereby inferring to the possibility of changing climates. Regression analyses were done, using the GenStat package. Here, changes in monthly or annual temperature or rainfall can be detected along with the levels of significance. The program gives the significance of the test (see Figure 4 below). The p-values for mean maximum, mean minimum and mean annual temperature were observed to be <0.001, 0.164 and < 0.001 respectively for the Guyana stations in Figure 4. This means that the increase in mean maximum and mean annual temperature is significant while there is no evidence of increase in the mean minimum temperature.

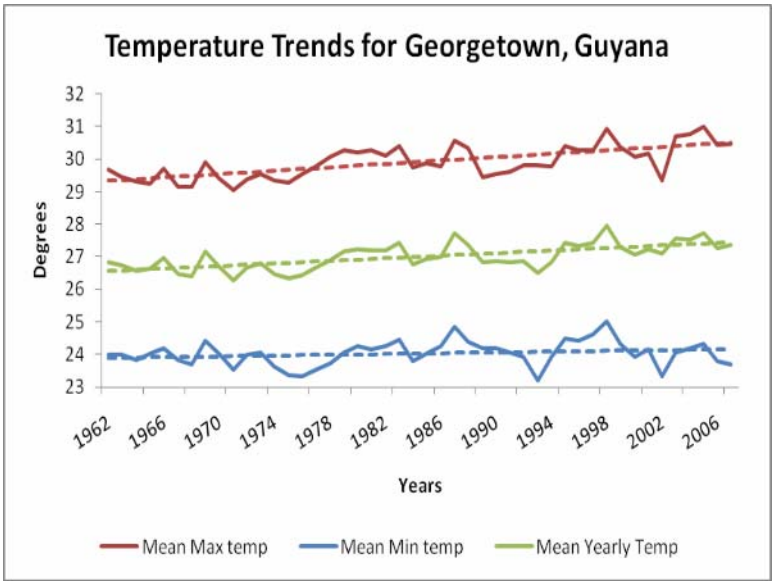

Figure 4: Temperature trends for Georgetown, Guyana

The use of the training and the analyses began at the SSC of the University of Reading will continue for the duration of the project for multiple stations across the Caribbean. The results of these analyses will be presented to and discussed with farmers during the project's farmers for a.