Assessment of the Influence of Maximum air temperature on Rainfall generation, in the tropical region of Imo State, South Eastern Nigeria.

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DOI: 10.31364/SCIRJ/v11.i4.2023.P0423945
http://dx.doi.org/10.31364/SCIRJ/v11.i4.2023.P0423945

Abstract – This report assesses the influence of the climatic factor of maximum air temperature on rainfall generation for a period of nine years (2008-2016) in the tropical region of Imo State, Southeastern Nigeria. The region has continually been noted for intense heat waves and the rains that fall have continually been devastating leading to destruction of lives and properties. In this study, the monthly rainfall amounts, as dependable variable were correlated and regressed with the monthly maximum air temperature values, using the IBM SPSS Statistics Software. The rainfall amounts correlated negatively with the maximum air temperature values in all the years (2008-2016), with an average R^2 value of 63.95%. In the light of these observations, the maximum air temperature contributed to about 64% of the changes in the rainfall amounts through the years, (2008-2016). The maximum air temperature could rightly be seen as an index for the evaporation of moisture into the atmosphere that subsequently fall as rains. The best single parameter predictor model for the rainfall amounts was a non-linear, exponential model: 109701871.0 – 0.429MaxTemp 2012, with a standard error of estimate SE value of 0.430. According to the model, a change in the Maximum air temperature contributes about 81% to changes in the rainfall amounts.

Keywords: climatic factor, Maximum air temperature, influence, rainfall, generation.

I. INTRODUCTION

The region of South Eastern has remained unique in the Nigeria Federation, being occupied by Intellectuals of high repute. This notwithstanding, activities in this region has continually been marred by devastating rainfall during the wet season. In the opinion that blockages to drainage basins could be causing it, Government instituted monthly environmental sanitation. Still to the displeasure of many, this had not been able to stop the devastating rainfall from causing mayhem in the destruction of lives and properties. It is continually noted that the rain falls after series of intense heat waves has been experienced [1]; [2]. This has to be scientifically proven. Non the less, heat waves have been identified to contribute to increases in air temperature, climate change and global warming. The part played by temperature in the evaporation of moisture from land masses and seas cannot be overemphasized. [3]; [4]; [5]. Usually, the more the evaporative demand of the atmosphere, the more the resultant rainfall. [6]

Globally, abnormal rise in the temperature of the environment has been referred to as a threat to human habitation in terms of erosion and flooding quite often associated with it. [7]; [8]; [9]; [10]; [11]. In the light of this, the study will attempt to unravel on the role played by temperature in the evaporation of moisture into the atmosphere that consequently fall as rain. This stands out as the main objective of the study. It is being envisaged that the result(s) of the findings of this study will highlight in no small measure the need for people to know and to adopt policies and strategies as well as methods that will heat up the environment.

II. MATERIALS AND METHODS

A. Description of the Study Area

The study area lies between Latitude 4^0 45^1 and 6^0 15^1 N and Longitude 6^0 30^1 and 8^0 9^1E. The area is bounded in the East by Cross River State, in the West by River State, in the South by Akwa Ibom State and in the North by Anambra and Enugu States, while its characterized by the tropical rain forest climate with soils of sedimentary formation.

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Table 1: The Monthly Maximum Air Temperature (^{0}C) of Imo State

Year	January	February	March	April	May	June	July	August	September	October	November	December
2008	33.5	36.9	35.0	33.3	32.1	31.2	30.3	30.5	30.9	32.3	33.9	34.2
2009	33.8	34.3	34.6	33.5	33.2	32.2	30.1	29.6	30.9	31.6	33.4	36.1
2010	34.6	34.8	34.5	33.8	32.0	30.7	29.6	29.2	29.5	30.9	31.8	33.6
2011	33.5	33.0	33.6	33.1	31.9	30.2	29.3	28.7	28.7	30.0	32.5	23.6
2012	32.9	32.7	34.6	32.7	31.7	30.0	28.7	28.6	29.6	30.7	32.0	33.3
2013	-	33.6	33.3	33.0	31.8	30.2	28.9	28.5	29.4	30.7	31.8	32.0
2014	33.7	34.7	33.2	32.5	31.9	30.4	29.0	28.7	29.8	30.8	31.9	33.2
2015	33.5	34.2	33.5	33.6	32.6	29.9	29.3	29.0	30.3	31.2	33.1	33.7
2016	34.6	36.8	33.9	33.5	32.6	31.0	29.6	29.3	30.2	31.8	33.5	34.1

[12]

Table 2: The Monthly Rainfall Amounts (mm) of Imo State

Year	January	February	March	April	May	June	July	August	September	October	November	December
2008	13.6	0.0	117.5	215.4	209.7	473.9	630.2	289.6	449.8	382.9	9.2	26.2
2009	38.6	71.4	71.2	242.8	441.5	239.0	497.9	539.2	485.3	236.8	115.4	0.0
2010	0.0	62.6	34.1	164.2	297.5	255.2	252.0	453.8	258.4	306.6	184.0	1.6
2011	0.0	133.7	84.4	114.8	528.3	192.0	305.2	506.7	366.0	241.2	49.7	24.8
2012	TR	74.1	22.1	158.0	249.2	284.2	430.2	316.0	483.1	178.9	113.2	0.0
2013	-	40.0	130.9	190.5	253.2	188.7	254.1	409.1	279.0	101.1	48.6	132.4
2014	0.0	21.4	110.2	157.0	289.4	236.2	139.3	336.3	355.6	220.7	91.3	30.0
2015	12.4	72.2	61.0	61.4	236.6	364.7	325.8	359.2	352.9	324.3	78.1	0.0
2016	0.0	29.4	192.5	143.9	157.4	272.6	378.1	409.4	423.8	144.7	12.2	TR

[12]

B. Method of Data Analysis

The analysis was done using the IBM SPSS Statistics software [13]**.** The Rainfall Amounts (mm), as dependable variables were correlated with the Maximum air temperature (^{0}C), as independent variables. The strength and nature of relationships were noted. Then the correlations that were significant at 0.05 (1-tailed) were selected and regressed upon using both linear and non-linear (curve estimation) methods. Also noted were the strength and nature of the relationship. The respective model equations were gathered. The model equations were then observed to identify the model equation that comparatively predicted the Rainfall Amounts, with least error of estimate (SE).

III. RESULTS AND DISCUSSIONS

A. Results

Table 3: Correlation Analysis of the Maximum Air Temperature (^{0}C) and Rainfall Amounts (mm)

Year	Correlation	P-Value*
2008	-0.844	0.001
2009	-0.849	0.000

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2010	-0.843	0.001
2011	-0.706	0.008
2012	-0.872	0.001
2013	-0.729	0.005
2014	-0.736	0.005
2015	-0.721	0.006
2016	-0.872	0.000

*Correlation is significant at 0.05 level (1-tailed)

Table 4: Strength and nature of relationship between Maximum air temperature (^{0}C) and Rainfall Amounts (mm)

Year	R	Nature of the Relationship	R^2	Strength of the Relationship
2008	-0.844	Negative	71.23	Very Good
2009	-0.849	Negative	72.08	Very Good
2010	-0.843	Negative	71.06	Very Good
2011	-0.706	Negative	49.84	Almost Average
2012	-0.872	Negative	76.03	Very Good
2013	-0.729	Negative	53.14	Average
2014	-0.736	Negative	54.17	Average
2015	-0.721	Negative	51.98	Average
2016	-0.872	Negative	76.04	Very Good

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Table 5 : Model Gathering (Maximum air temperature versus Rainfall amounts)

Year	Model Equations	R^2	Standard error of estimation
2008	Power: Rainfall amount= 3.404E+35 -22.106 In(Max. temp 2008)	0.532	1.085
2009	Exponential: Rainfall amount=233709101.0- 0.431MaxTemp 2009	0.641	0.581
2010	Exponential: Rainfall amount=739630870.1 - 0.491MaxTemp 2010	0.392	1.328
2011	Exponential: Rainfall amount=68762705.18 - 0.411MaxTemp 2011	0.576	0.667
2012	Exponential: Rainfall amount=109701871.0 - 0.429MaxTemp 2012	0.810	0.430
2013	Power: Rainfall amount=4.693E+14 – 8.365 ln(Max Temp)	0.441	0.572
2014	Exponential: Rainfall amount=21943152.74 – 0.382MaxTemp 2014	0.597	0.627
2015	Exponential: Rainfall amount=230000685.9 - 0.451 Max Temp 2015	0.644	0.685
2016	Power: Rainfall amount=9.365E+20 - 12.481 ln(Max Temp 2016)	0.575	0.808

* Rain Amount=109701871.0 – 0.429MaxTemp2012 is hereby selected.

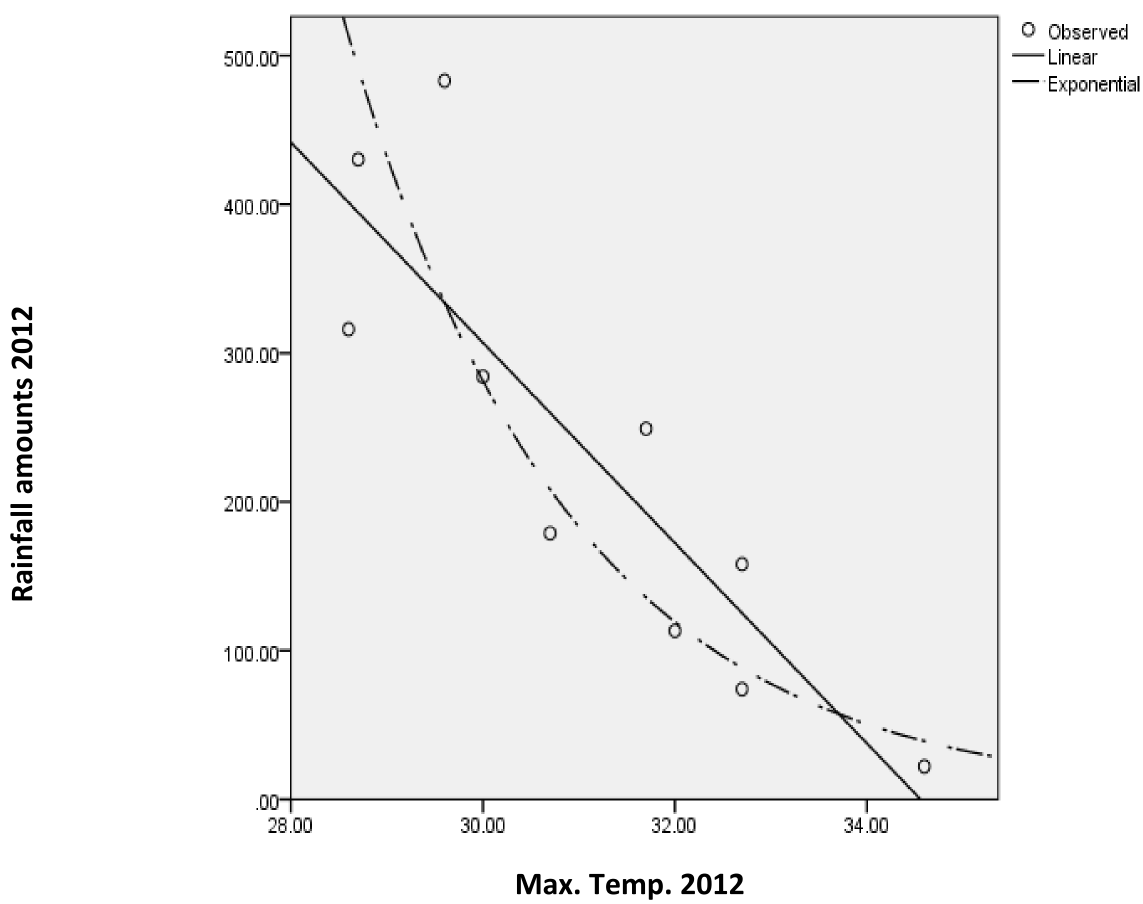

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Figure 1; Maximum air temperature(^{0}C) versus Rainfall amounts

3.2 Discussions

Tables 1 and 2 showed that the study had been carried out within the following ranges of the climatic factors: Maximum air temperature (28.5^{0}C to 36.9^{0}C) and Rainfall amounts (1.6mm to 630.2mm).The results of the correlation analysis carried out between the Maximum air temperature and the Rainfall amounts in all the years of study (2008 to 2016) as indicated in Table 3 were all significant at 0.05 level. Nevertheless, the Maximum air temperatures correlated negatively with the Rainfall amounts in all the years of study (2008 to 2016). The implication of this is that as the maximum air temperature thins down, releasing the embodied heat waves and energy to the evaporative medium available in the land and seas, there were increases in the production of moisture laden air in the atmosphere. The result of this will be more rainfall. Another notable observation as postulated in Table 4 was that the strength of the relationship between the Maximum air temperatures and the Rainfall amounts throughout the period (2008 to 2016) were to a great extent, very good. Even in the few cases where the strength of the relationship appeared to be at average level, the Maximum air temperature still contributed to about 52.28% changes in the rainfall amount.

Through the regression analyses carried out using linear and non-linear (Curve fit) methods as could be seen in figure 1 as well as in the appendices 1 to 9, it became clearer how the Maximum air temperature was able to impinge on the available moisture on the land masses and seas, producing moisture laden air transport into the atmosphere. The best single parameter predictor model for the rainfall amounts produced following this study was a non linear, exponential model: 109701871.0 – 0.429Max Temp 2012, with a standard error of estimate ,SE, value of 0.430. It predicted the range for the rainfall amounts to be 2.00mm to 690.95mm while the observed rainfall amounts ranged from 1.6mm to 630.2mm.

4. CONCLUSIONS

The influence of Maximum air temperature on rainfall generation has been noted and cannot be over emphasized at this junction. Maximum air temperature has been identified as an embodiment of heat transfer which transmits to water bodies of land and seas to produce moisture laden air transport into the atmosphere. The consequent of this is the production of rainfall. The study revealed that the Maximum air temperatures for the period of study (2008 to 2016) contributed to about 63.95% to changes in the Rainfall amounts.

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APPENDICES

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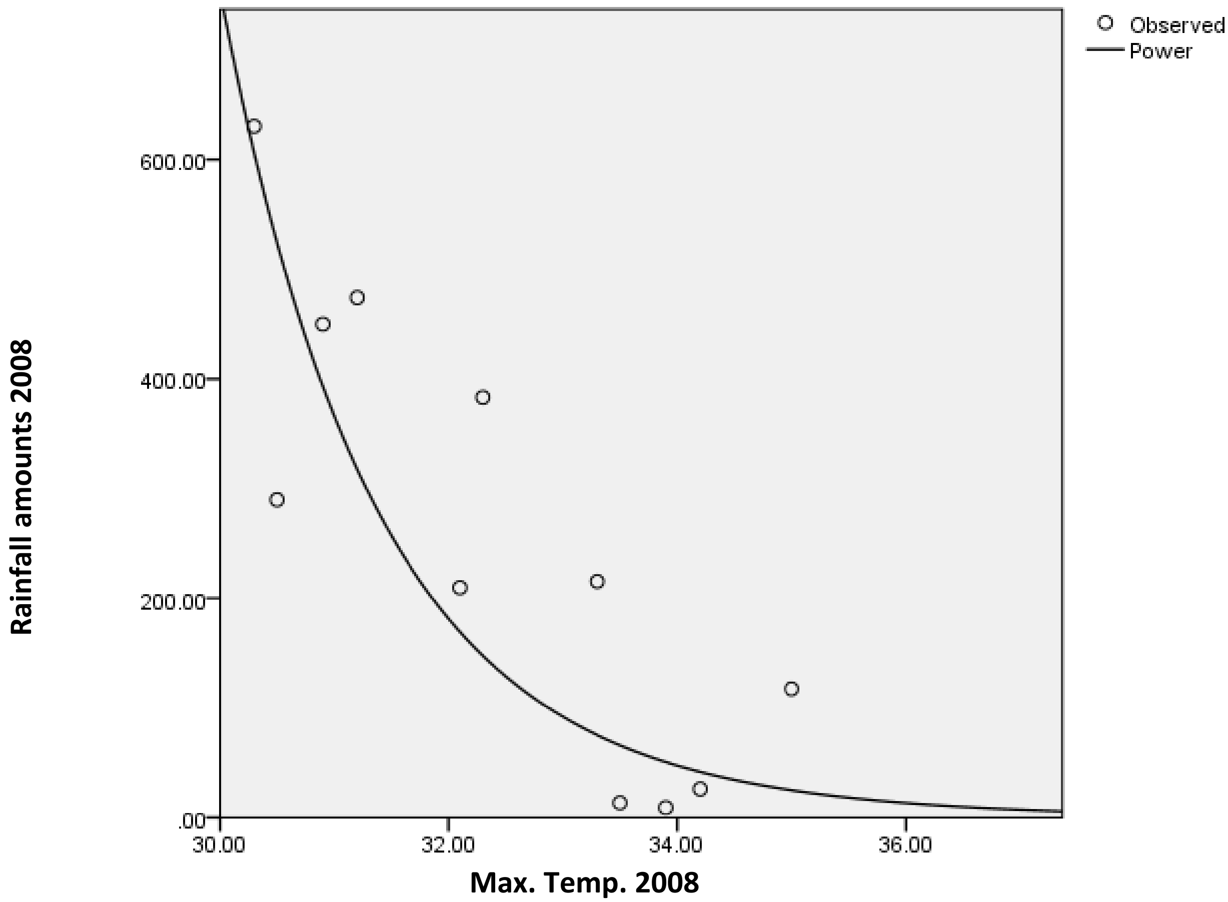

Appendix 1: Rainfall amounts 2008 versus Maximum air temperature 2008

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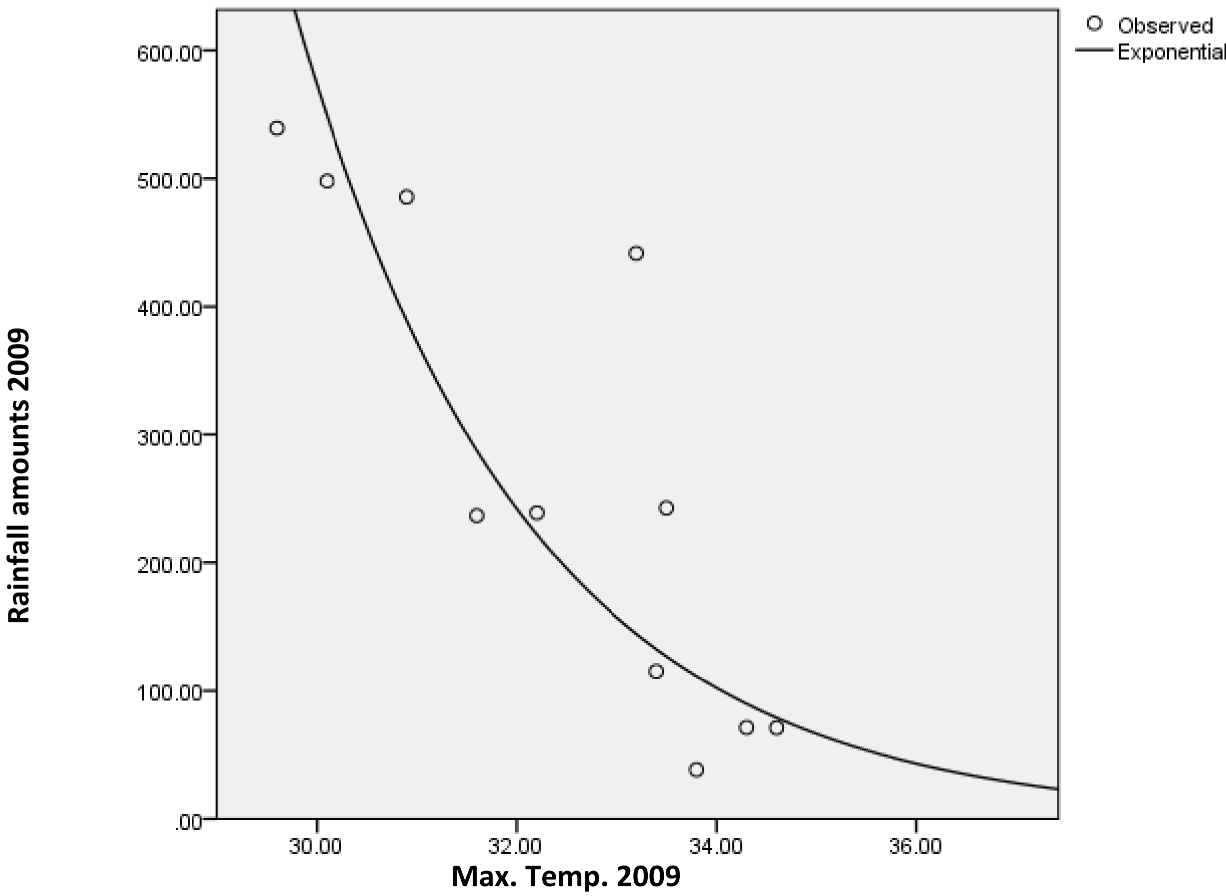

Appendix 2: Rainfall amounts 2009 versus Maximum air temperature 2009

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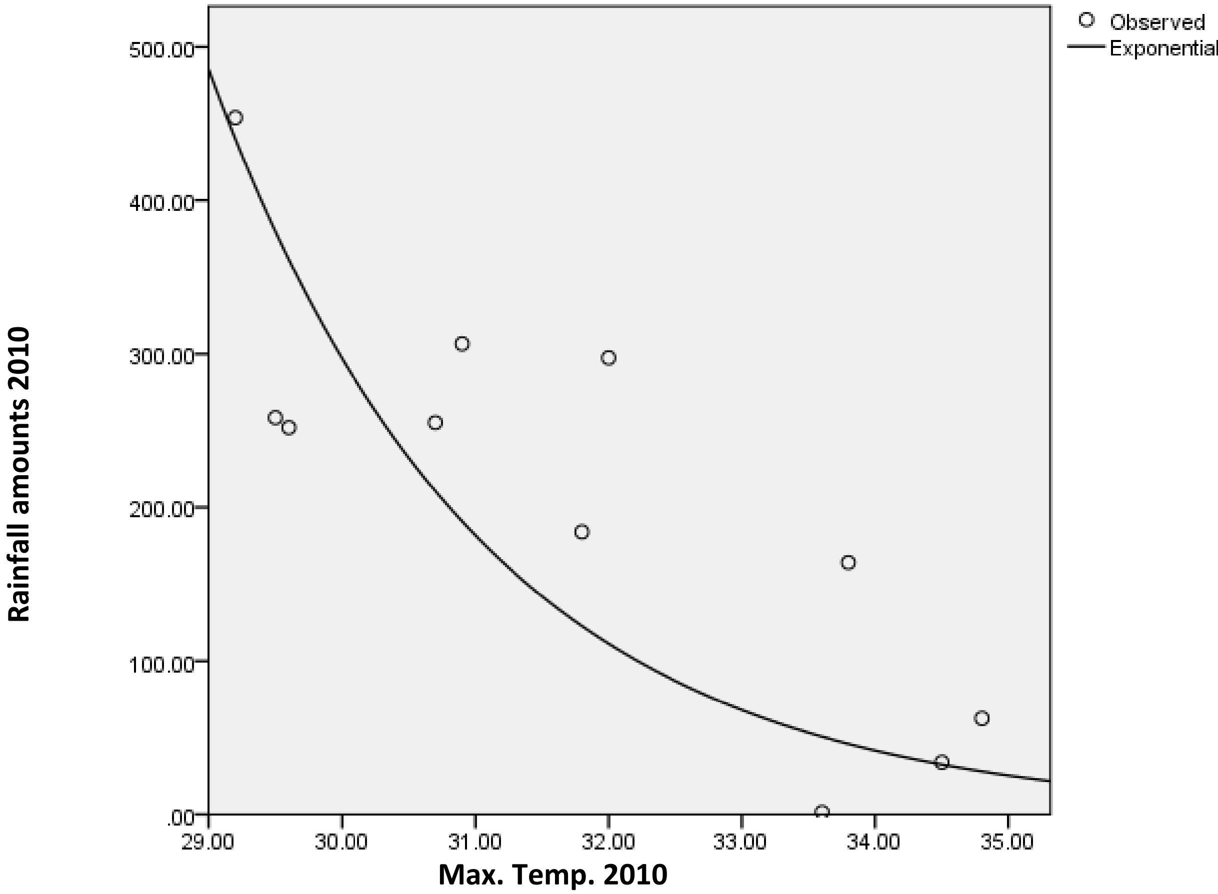

Appendix 3: Rainfall amounts 2010 versus Maximum air temperature 2010

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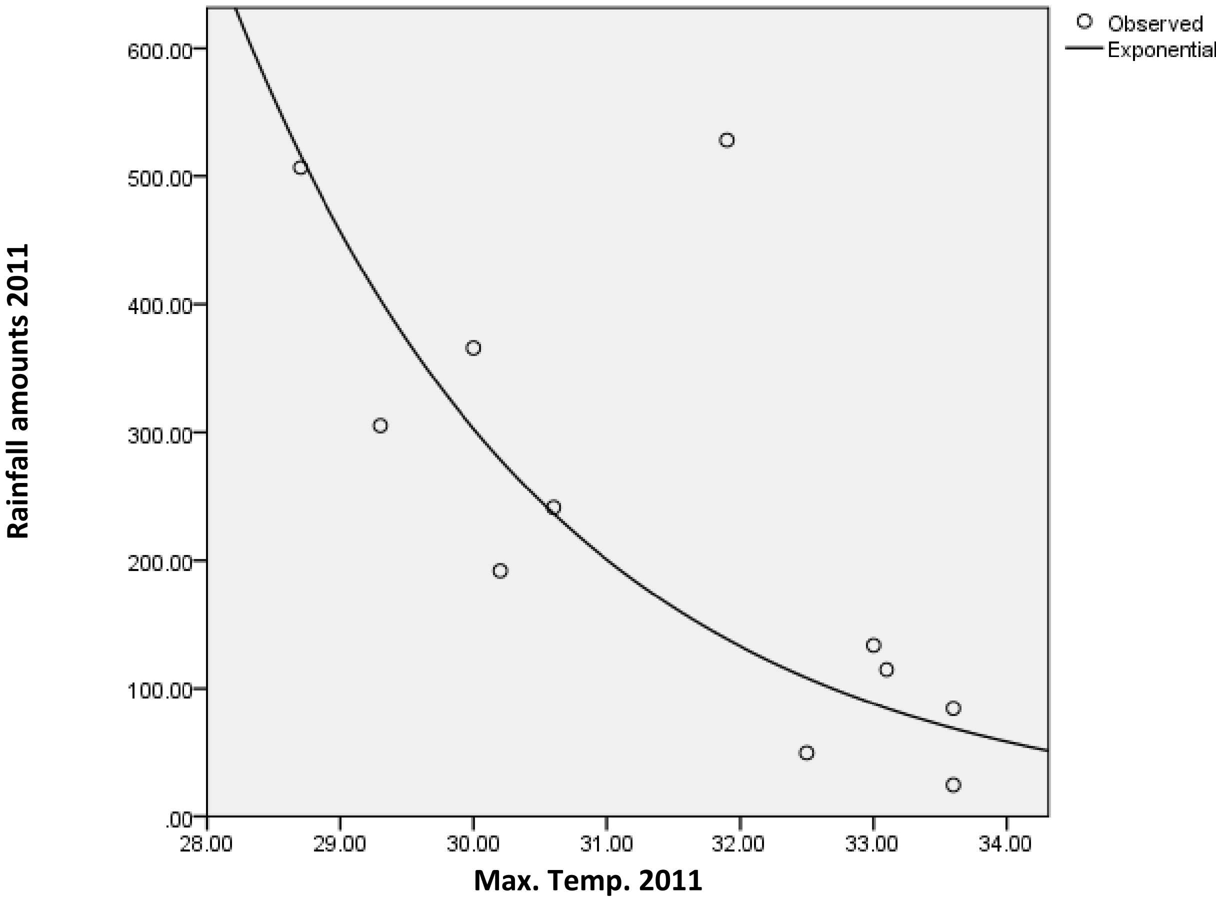

Appendix 4: Rainfall amounts 2011 versus Maximum air temperature 2011

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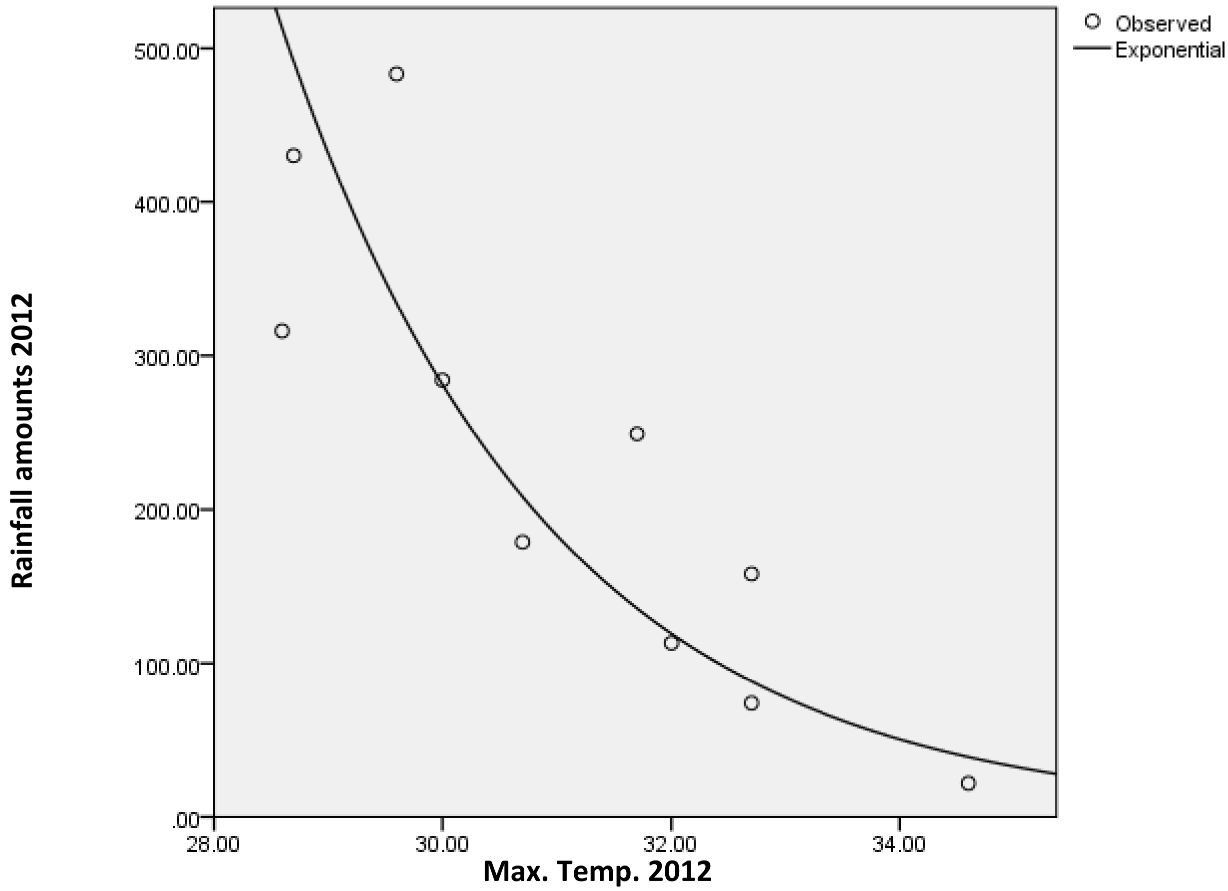

Appendix 5: Rainfall amounts 2012 versus Maximum air temperature 2012

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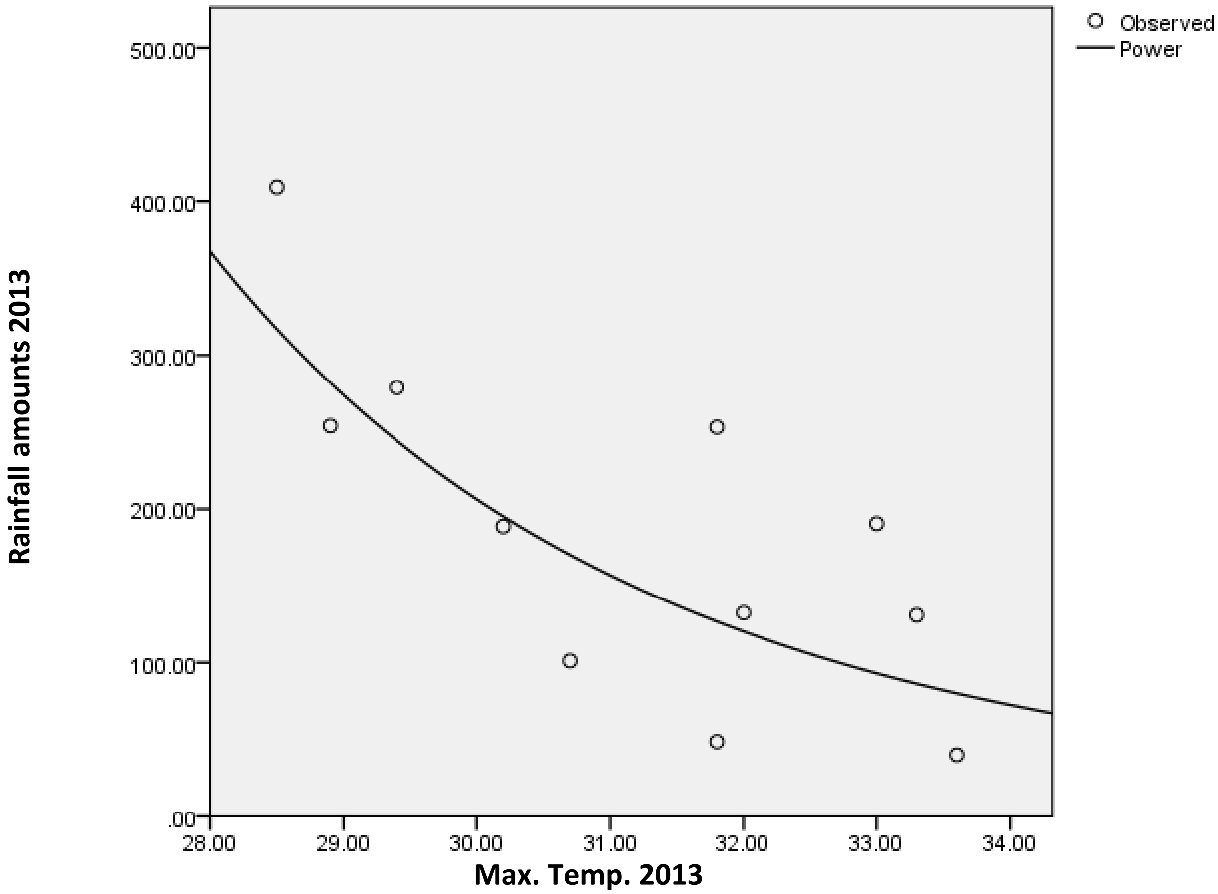

Appendix 6: Rainfall amounts 2013 versus Maximum air temperature 2013

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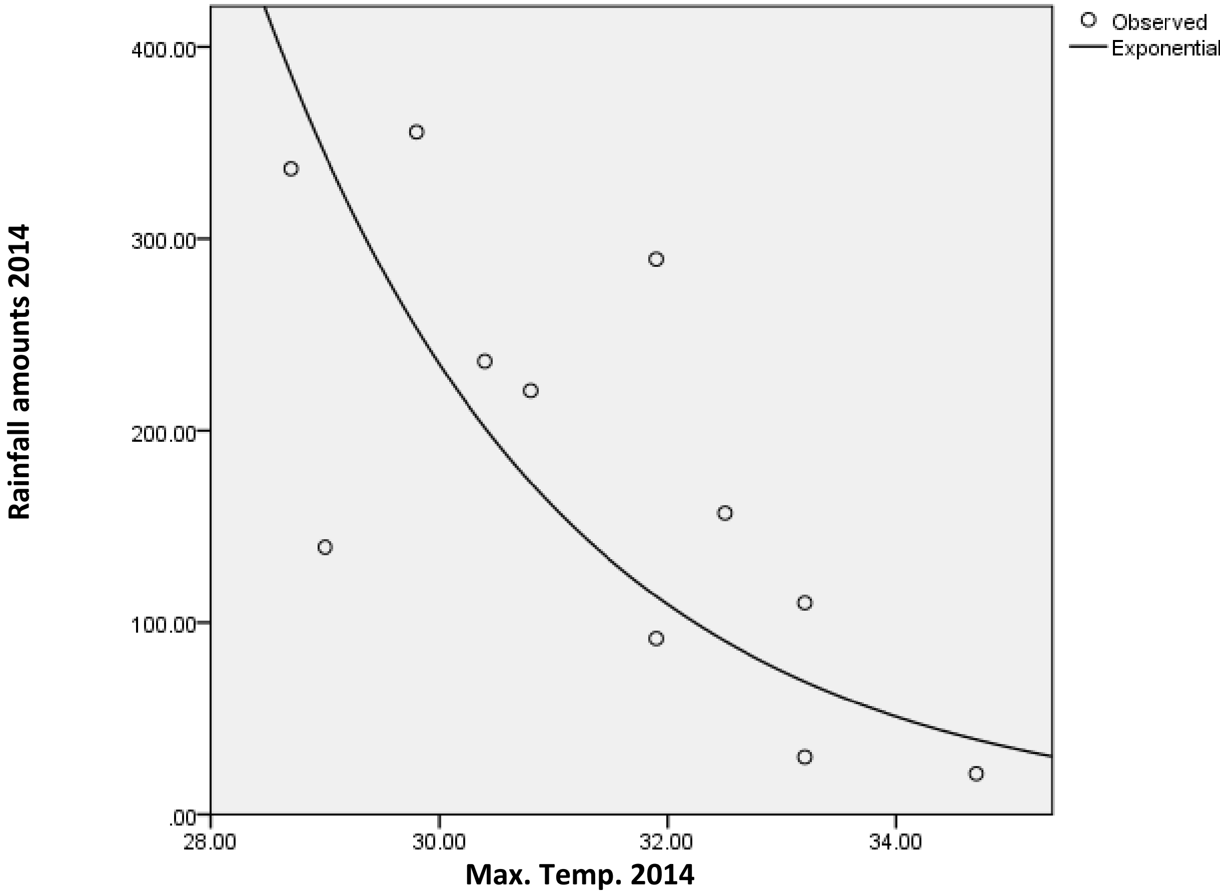

Appendix 7: Rainfall amounts 2014 versus Maximum air temperature 2014

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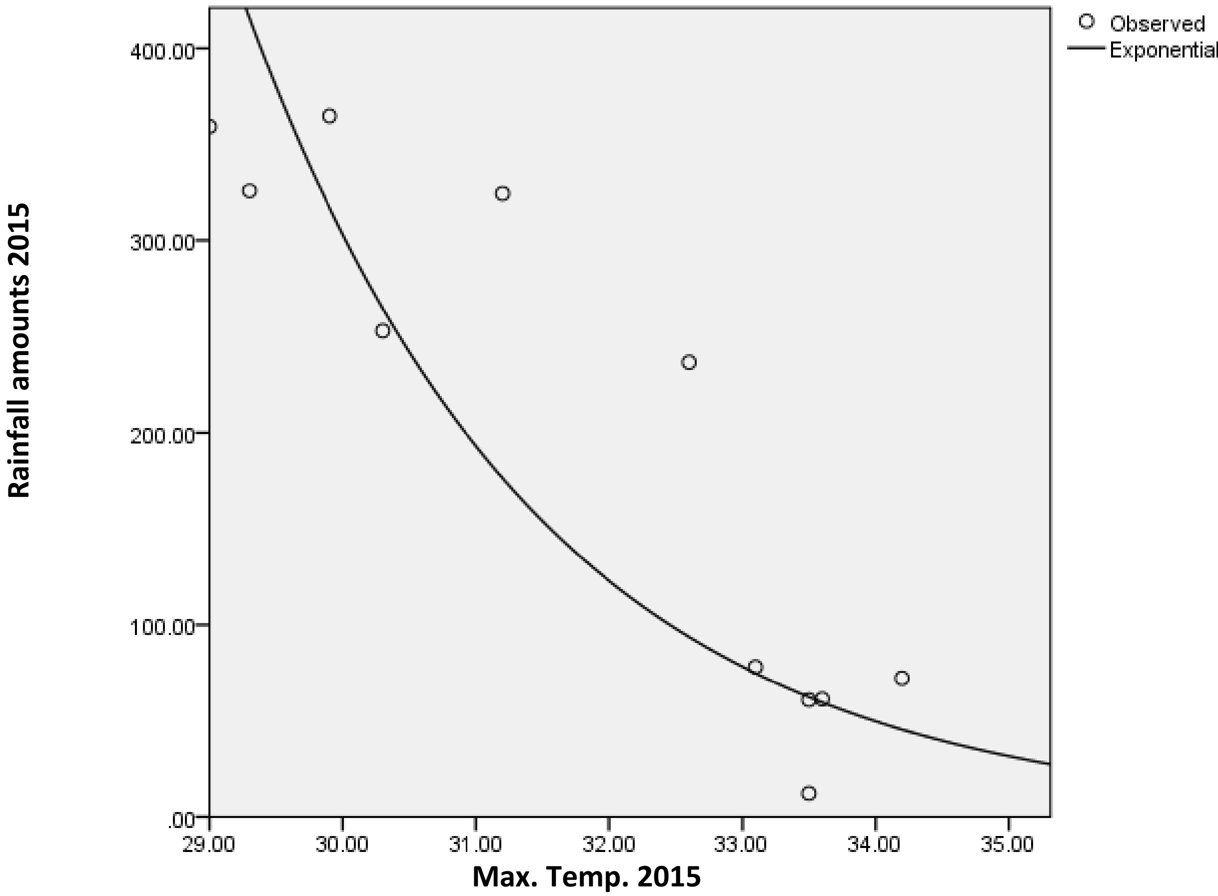

Appendix 8: Rainfall amounts 2015 versus Maximum air temperature 2015

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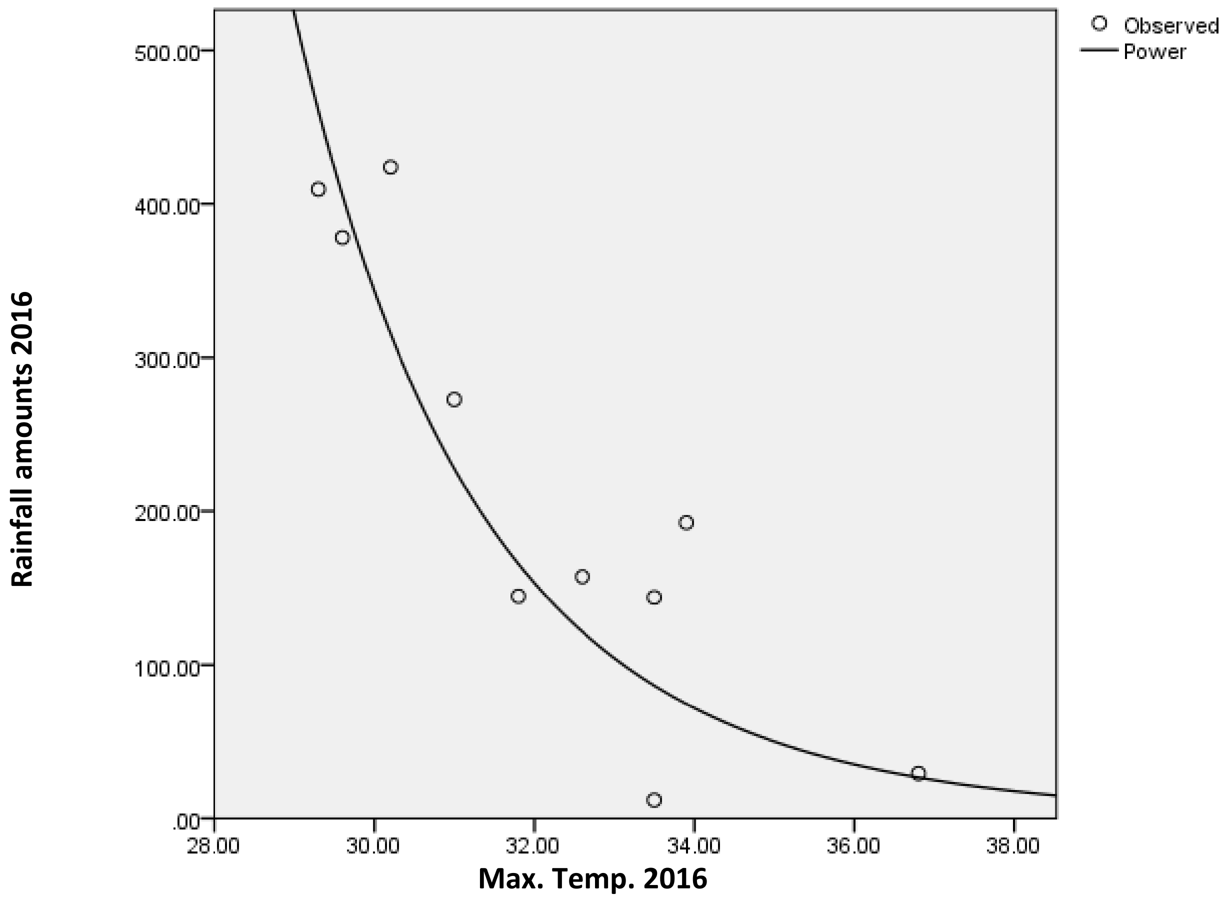

Appendix 9: Rainfall amounts 2016 versus Maximum air temperature 2016

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