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The Determinant Of Monthly Effects On Fire Outbreaks In Ghana

Emmanuel Kojo Amoah

Department of Mathematics Education, University of Education, Winneba

Daniel Opoku

School of Business, Department of Human Resource, University of Education, Winneba

Abstract: ***The occurrences of Fire Outbreaks and cost of damages are of an increasing trend globally for the past decade. There is no day without incidence of fire in some part of Ghana which affect individual citizens and the government economically. The study was based on monthly time series data on Fire Outbreaks and obtained from Ghana's Ashanti Regional Fire Service database. Multiple Regression was employed to determine the monthly fire effects by considering differential effects in terms of change in percentage. However, the study revealed that there is no serial correlation of the in the model residuals with Durbin-Watson statistic of 2.011460 and also F-statistic of 9.651750 and p-value of 0.0000 indicated that, the regression model was significant. The findings have revealed that, the month of January showed the highest increment of 72% and this can be attributed to the dry weather conditions corresponding to the harmattan season. Relatively, the month of April revealed the highest percentage decrement of 30% on Outbreak of and this could be due to continuous rain fall during that time. However, the study recommends that, fire stakeholders such as Ghana National Fire Service, Ghana police Service, insurance companies and other financial stakeholders should come together educate, implement regularizations and policies measures during the harmattan and cultivation seasons to reduce the number of fire outbreaks in the country. Furthermore, with developing effective means of managing fire, it is recommended that they make data on daily, weekly and monthly number of Fire occurrences readily available to researchers. This would enable researchers to investigate within the month effects on the number of fire outbreaks. This would enable researchers to investigate within the month effects on the number of fire outbreaks.***

Keywords: Multiple regression Model, Fire Outbreak, Ashanti Region and Monthly Effects.

I. INTRODUCTION

In spite of advances in technology, occurrence of fire outbreak is growing at an increasing rate all over the world but particularly in developing countries like Ghana. Moreover, it is most at times very difficult for actuarial and insurance practitioners to effectively help manage the risk of Fire Outbreaks. Researchers and fire stakeholders are also challenge by this difficulty because not much studies appear to have been done in accessing the statistical model for predicting Fire Outbreaks. In Ghana, researchers and policy makers have focused their attention on causes of fire without paying attention to its effect on the economic growth. Fire outbreak is a sudden occurrence of fire greater than would otherwise be expected at a particular time and place. The current changes in ecosystem functioning and climate systems are having major impact on Fire outbreak conditions globally. Fire is a good servant but a bad master as well. Fire is a rare event and is often classified as an 'Extremal event' and is characterized by relative rareness, huge impact, and statistical unexpectedness.

The huge impact of catastrophic events on our society is deep and long. Not only do we need to investigate the cause of such fire events and develop plans to protect against them. For a country to not grow economically, the existence of fire outbreaks may also be a major contributing factor. This is because it causes both the individual and government to lose financially leading to a retired economic growth. This is made evident by some researchers. Accuweather (2018) conducted a research on the economic effect of fire and revealed that California suffered $400 billion on fire damages which affected their economy. Also in 2017, the U.S. Forest Service spent almost $2.9 billion to put out fires nationwide as compared to the year 2015 which was more than the $2.1

billion spent in 2015. It was revealed that firefighting consumed 52% of its budget. Amdeo (2019) also conducted a research on wildfire damage and impact on the economy; it was revealed that western U.S wildfire increased by 400% since 1970 and California, Colorado, Arizona, and New Mexico experience the worst damage. All these research conducted justify that fire outbreak adversely affect the economic progress of a country. Another Research conducted by Fire Safe Europe shows that, in 2008, the total cost of fire in the US was estimated at $ 362 billion, or roughly 2.5% of US GDP. Economic loss (property damage) reported or unreported, direct or indirect represents only $ 20.1 billion of this total. Net costs of insurance coverage ($ 15.2 billion), fire department costs ($ 39.7 billion), costs of fire protection in new buildings ($ 62.7 billion), other economic costs ($ 44.0 billion), monetary value of time donated by volunteer firefighters ($ 138 billion), and the estimated monetary equivalent of civilian and fire fighter deaths and injuries due to fire ($ 42.4 billion) are all larger components than property loss and these cases provide examples of extreme events. If important risk management organizations such as Ghana Fire Services cannot predict and capture the risks appropriately, their losses could be huge and therefore extremely increase behaviour of fire damages and the substantial impacts of these increments motivate us to carry out a research on modelling fire occurrence and provide insurance premium for the Fire Outbreaks. In Ghana, the researchers and policy makers have focused their attention on causes of Fire without paying attention to this important indicator of economic growth. Moreover, in Ghana, fire outbreaks did sustain a constant rise reflecting market conditions such as unexpected inflations on goods and services and statistics indicate that there has been about 1500 Fire Outbreaks recorded in Ghana for 2013 alone, and this worrying figure is expected to rise if we fail to tackle this with urgency as a national crisis. (Johnson, 2013). Also, according to the late president Mills, Ghana lost GH¢360,027,775.75 to Fire Outbreaks in the year 2011 (Source: Ghana News Agency, 2011).

PROBLEM STATEMENT

Twum (2014) made a research on assessing the awareness of fire insurance in the informal sector by considering a sample of 95 traders and found out that majority (50.52%) of the traders did not understand the concept of insurance by wrong perception about it but they were aware of the causes of fire outbreaks and ranked electricity power fluctuations as the major cause. The researcher recommendations have been made for these traders and policy makers to strategize in order to have better protection on the markets. Also, Ghana National Fire Service (GNFS) claimed that in the year 2018 5,531 fire outbreaks were recorded across the country compared with the 2017 total of 4,544 cases of which 44 lives were lost. Also the cost of damage to property as of November 2018, was over GH¢28.87 million and that of 2017, was GH¢36.28million through fire outbreaks (Ghana business news, 2016) this can affect the economic indicators. Furthermore, Addai et al. (2018) researched on the trend of fire outbreaks in Ghana and ways to prevent these incidents and was revealed that Ashanti region recorded the highest percentage of 19.4% fire outbreaks as compare with other regions. Another study conducted by the Research, Monitoring and Evaluation Unit of the National Fire Service revealed that the government spend GH₵40,321,963 properties (www.graphic line.com) on fire cases. Fire Outbreaks and disasters are caused by many factors, some of which can be blamed on humans and others beyond our control. The chief purveyors of fire outbreaks in Ghana are classified into seven main categories namely: Electrical, Domestic, Bush, Institutional, Commercial, Industrial and Vehicular Fire Outbreaks. The Fire Service of Ghana has been targeting a reduction in the number of Fire Outbreaks systematically on yearly basis and hope to achieve single digit in fire fatality rate by the year 2015 (Ghana News Agency, 2009).

In order to efficiently achieve this objective of achieving this single digit in fire fatality rate as established in the literature, the Fire Service of Ghana needs to know an accurate effects of monthly fire outbreaks and in modelling the rare phenomena that lie outside the range of availably observations is a problem. Therefore, it is very essential to rely on well-founded methodology to investigate the monthly effects on the fire and these issues motivate us to undertake a research to determine the monthly effect on fire outbreaks to help policy maker and analyst to develop an efficient means of reducing the number of fire outbreaks in the country. This is essential because as the number of fire outbreaks continues to increase, it would lead to persistent adverse impact on the economy.

II. MATERIALS AND METHODS

In order to achieve the objectives of this study, secondary data on monthly fire outbreaks were obtained from the Ashanti Regional Fire Station database. The data consists of monthly fire outbreaks from January, 1997 to August, 2014. The Computational Software employed to analyze the data were R, Minitab and Gretl.

III. REGRESSION ANALYSIS

The concept of regression analysis is to explain the variation in an outcome or response variable using one or more predictor variables. The end result of a regression analysis is often to generate a model that can be used to predict future values of the response variable given specified values of the predictor variables. When the model involves a single predictor variable, the model is referred to as simple linear regression model. The simple linear regression model is given by

$$Y = \beta_0 + \beta_1 X + \varepsilon \qquad (2.1)$$

Where Y is the response, X is the predictor variable, β_0 and β_1 are unknown parameters and ε is an error term. The model parameters, β_0 and β_1 have physical interpretation as the intercept and slope of straight line respectively. When the simple linear regression model is extended to include additional predictor variables say k predictors, then we have the multiple linear regression model. The multiple linear regression model is given by

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots \beta_k X_k + \varepsilon \quad (2.2)$$

The parameters $\beta_0, \beta_1, \beta_2, \ldots, \beta_k$ in this model are called the partial regression coefficients because they convey information about the effect on Y of the predictor that they multiply given that all other predictors in the model do not change. In the theoretical model, many assumptions are made about the predictor variables and the error term.

When these assumptions are satisfied, the estimators are unbiased and have the minimum variance property. The assumption of the regression model are;

- ✓ ε_i is a random real variable.
- ✓ The mean value of ε_i in any particular period is zero.
- ✓ The variance of ε_i is constant in each period.
- ✓ The variable ε_i has a normal distribution.
- ✓ The random term of different observations $(\varepsilon_i, \varepsilon_j)$ are independent.
- ✓ The predictor variables are not perfectly linearly correlated

IV. ANALYSIS AND DISCUSSION OF RESULTS

The data on fire outbreaks in the Ashanti Region of Ghana had maximum (Max) and minimum (Min) values of fire outbreaks 218 and 18 respectively for the entire period as shown in Table 1. Also, the fire outbreaks for the entire period was positively skewed and leptokurtic in nature with the average and coefficient of variation (CV) being 54.17 outbreaks and 52.95% respectively.

Variable	Mean	Min	Max	CV (%)	Skewness	Kurtosis
Outbreaks of Fire	54.17	18	218	52.95	2.03	6.37

Table 1: Descriptive statistics for Fire Outbreaks

An exploration of the fire outbreaks for the various months indicates that, the highest average outbreak of fire occurred in the month of January and the least average occurred in the month of September as shown in Table 2. In terms of the maximum and minimum fire occurrences, January and June had the highest and lowest values respectively. The month of January has the largest variability followed by April as shown by their coefficient of variations (CV) in Table 2.

Again, it was observed that the occurrence of fire for each month were positively and negatively skewed and leptokurtic and platykurtic in nature.

Month	Mean	Min	Max	CV (%)	Skewness	Kurtosis
January	97.6	39.00	218.00	47.89	1.15	1.13
February	92.44	53.00	150.00	30.02	0.52	-0.43
March	68.11	38.00	99.00	25.57	0.00	-0.90
April	49.28	22.00	79.00	37.25	0.35	-1.08
May	42.78	21.00	61.00	30.00	-0.01	-1.45
June	38.56	18.00	73.00	36.68	0.87	0.68
July	38.44	21.00	62.00	30.51	0.66	0.10
August	39.17	19.00	63.00	33.46	0.41	-0.74
September	37.24	19.00	57.00	30.63	1.28	-0.67
October	43.41	29.00	75.00	35.80	1.27	0.04
November	44.71	28.00	69.00	29.87	0.59	-0.75
December	56.41	25.00	85.00	29.45	0.11	-0.56

Table 2: Monthly descriptive statistics for Fire Outbreaks

For the purpose of analysing the monthly implication of changes of fire outbreaks the transformed fire outbreaks was first differenced and regressed on the full set of periodic dummies. The intercept was not included in the model to avoid dummy variable trap. The result (Table 3.3) revealed that January, March, April, October and December had a significant monthly effects on the fire outbreaks whiles February, May, June, July, August, September and November were insignificant. The F-statistic of 9.651750 and p-value of 0.0000 indicates that the regression model was significant and Durbin-Watson statistic of 2.011460 means that there is no serial correlation of the first order in the model residuals.

Variable	Coefficient	Standard error	T-statistic	*P*-value
January	0.541027	0.0737322	7.3377	0.00001*
February	0.00320213	0.0716548	0.0447	0.96440
March	-0.296074	0.0716548	-4.1320	0.00005*
April	-0.359251	0.0716548	-5.0136	0.00001*
May	-0.11886 9	0.0716548	-1.6589	0.09871
June	-0.119466	0.0716548	-1.6672	0.09704
July	0.015369	0.0716548	0.2145	0.83039
August	0.00765891	0.0716548	0.1069	0.91499
September	-0.0285957	0.0737322	-0.3878	0.69855
October	0.14928	0.0737322	2.0246	0.04424*
November	0.0401232	0.0737322	0.5442	0.58693
December	0.228835	0.0737322	3.1036	0.00219*

**: Means statistically significant at the 5% level of significance*

Table 3: Regression parameters of the transformed first differenced series

Considering Table 3, their significance does not really matter because some of the estimated coefficients of the dummy variables are of an incremental month effects of each year. Hence, an approach of interpreting differential coefficients in semi-logarithmic was proposed by Halvorsen and Palmquist (1980) and the equations of the transformations of differential coefficients are to show differential effects in terms of change in percentage. The monthly effect for each is calculated with the aid of an exponential transformation and further multiplied by 100% to show percentage change as indicated in Table 4. The month of March, April, May, June, and September decreases the Outbreak of Fire by 25.6268, 30.1801, 11.2076, 11.2606 and 2.8191 percent respectively.

Similarly, the month of January, February, July, August, October, November and December increases the outbreak of fire by 71.7770, 0.3207, 1.5488, 0.7688, 16.0998, 4.0939 and 25.7135 percent respectively.

Month	Coefficients	Percent effect
January	0.541027	71.7770
February	0.00320213	0.3207
March	-0.296074	-25.6268
April	-0.359251	-30.1801
May	-0.118869	-11.2076
June	-0.119466	-11.2606
July	0.015369	1.5488
August	0.00765891	0.7688
September	-0.0285957	-2.8191

October	0.14928	16.0998
November	0.0401232	4.0939
December	0.228835	25.7135

NB: Effect of January $= (e^{0.541027} - 1) \times 100\%$

Table 4: Monthly effects on Fire Outbreaks

V. DISCUSSION OF RESULTS

The results for the study clearly indicate that the fire outbreak distribution was asymmetric and more peaked in nature. This lack of symmetry can be attributed to the large swings in data set and increase in the number of occurrences of Fire in the Ashanti Region of Ghana. The leptokurtic nature of the data set tells us about how volatile the Fire Occurrence is. Furthermore, the nature of the distribution of the data set has shown that the fire outbreaks are distributed closely around their mean value. Since there was evidence of seasonality in the residuals, the logarithmic transformed fire outbreaks were regressed on the periodic dummies. To provide better interpretation for the coefficient of the periodic dummies, Halvorsen and Palmquist's (1980) approach of interpreting differential coefficients in semi-logarithmic equations was adopted and ignoring the significance of the differential coefficients, the month of January, February, July, August, October, November and December increases the Outbreak of Fire by 71.7770, 0.3207, 1.5488, 0.7688 ,16.0998, 4.0939 and 25.7135 percent respectively. The increase in the fire outbreaks in these months can be attributed to the dry weather conditions corresponding to the harmattan season. In addition, the month of January and December showed higher increment (71.7770%) and (25.7135%) respectively than other months and can be attributed to the fact that many farmers start preparing their land for the next season cultivation during that period. Again, this increment is as a result poor visibility (fog) resulting to fuel truck accident leading fire explosion. The reduction of electricity dam level also leads to electricity power fluctuation and so forth. Relatively, the month of March, April, May, June, and September decreases the Outbreak of Fire by 25.6268, 30.1801, 11.2076, 11.2606 and 2.8191 percent respectively and this could be due to continuous rain fall during these periods.

VI. CONCLUSION AND RECOMMENDATIONS

In this research, the monthly fire outbreaks in Ghana from January, 1997 to August, 2014 was studied and before fitting model to the fire outbreaks, the monthly characteristics of the series were explored. The research has shown that fire outbreaks are growing at alternating increasing and decreasing rates. The fire outbreaks revealed perfect evidence of various monthly effects. The wet season was seen as the months of decrease in fire outbreaks whiles the harmattan period was indicated as the period of increase in fire outbreaks. The month of January had the highest percentage increment. Following the outcome of this research work, the following recommendations were made;

- ✓ The fire stakeholders such as Ghana National Fire Service, Ghana police Service, insurance companies and other financial stakeholders should come together and assist in developing efficient means of reducing the number of fire outbreaks in the country. This is essential because as the number of fire outbreaks continuous to increase, it would lead to persistent adverse impact on the economy.
- ✓ Since the fire stakeholders such as Ghana National Fire Service, insurance and actuarial practitioners were concerned with developing effective means of managing fire, it is recommended that they make data on daily, weekly and monthly number of Fire occurrences readily available to researchers. This would enable researchers to investigate within the month effects on the number of fire outbreaks.

REFERENCES

[1] Dare, A. A., Oke ,S.A., and Olanrewaju, K. L(2009). Incidents of fire outbreaks during fuel truck acidents in oyo state. Disaster Prevention and Management: An International Journal, 18:443-450.
[2] Ghana National Fire Service. (Accessed: March 2009). Economic effect on Fire Outbreak. www.ghanafireandrescue.org.
[3] Ghana National Fire Service. (Accessed: March 2010). Cost of damage by fire outbreak. wwwghananewssagency.org.
[4] Ghana National Fire Service (Accessed: March 2013). National Fire Outbreaks for 2011 based on region by data.gov.gh/dataset/national-fire-outbreak-2011-based-regions
[5] Halvorsen, R., and Palmquist, R., (1980). The Interpretation of Dummy Variables in Semi-Logarithmetic of Equations. American Economic Review, 70(3): 474-475.
[6] Hansen (1999). Risk-Based Fire Research Decision Methodology. Worcester Polytechnic Institute published MSc thesis.
[7] Twim-Barima, L.M. (2014). An assessment of the awareness of fire insurance in the informal sector: A case study of Kumasi central market in Ghana. International Journal of Humanities Social Science and Education,1:41-47.