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Full Length Research Paper

Temporal relationship between cases of veterinary vector-borne diseases and rainfall amount in a Kenyan Rangeland

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The expected global temperature increase, more intense rainfall and more frequent droughts will have devastating effects on pastoral livelihoods. The economy of the affected areas also dwindle in the event of these calamities considering that droughts and diseases resulting from floods affect the health of livestock which is the major source of livelihood for the pastoralists. The aim of this study was to investigate the relationship between veterinary vector-borne diseases (VBDs) and rainfall amount. This study utilized review of reports, published literature and other sources of secondary data as methods of data collection. The correlation results of this study indicated that apart from Heartwater (p=-0.403, sig=0.012 and N=38), other veterinary diseases had no relationship with the rainfall amount {*Trypanosomiasis* (p=-0.224, sig=0.189 and N=36), *Babesiosis* (p=-0.124, sig=0.457 and N=38), *Anaplasmosis* (p=-0.156, sig=0.351 and N=38) and East Coast Fever (p=-0.224, sig=0.176 and N=38)}. However, graphical plots depicted the existence of relationships. Despite correlation analysis showing no significant relationship existing between rainfall and cases of Trypanosomiasis, Babesiosis, Anaplasmosis and ECF, graphical plots indicated some degree of relationship between these variables. The plots showed either an increase or decrease in VBDs cases with increasing or decreasing rainfall amounts. Also, correlation analysis indicated very strong relationship between cases of various VBDs. For instance, Anaplasmosis and ECF showed a very strong significant relationship. These results indicate the existence of a common factor in the transmission of these diseases.

Key words: Climate variability, veterinary vector-borne diseases, El Nino, temporal relationship, correlation, rangeland.

INTRODUCTION

The estimated global temperature increase by 1.0 °C to 3.5 °C by the year 2100 is expected to change the trend of vector-borne diseases to an upward one because of the change in both temperature and precipitation scenarios resulting from climate change affecting the biology and ecology of vectors and their hosts (Githeko *et al.,* 2000). Pastoralists have been experiencing various environmental hazards and natural disasters related to climate variability and change. The tropical climate in Africa is seemingly favorable to most of the vector-borne diseases including Rift Valley Fever (RVF), Trypanosomiasis and Tick-borne haemorrhagic fever (Githeko *et al.,* 2000). RVF outbreaks over the last six decades have been closely intertwined with El Nino/Southern Oscillations (ENSO) phenomenon (Anyamba *et al*., 2010). In Marigat area, notable climatic changes have been experienced by the pastoral communities over the last four decades (Wasonga *et al.,* 2011). According to a research conducted based on indigenous knowledge, heavy rainfall accompanied by floods were reported to be more common recently than 40 years ago (Wasonga *et al.,* 2011). While the exact magni tude of the changes in temperature, precipitation, and

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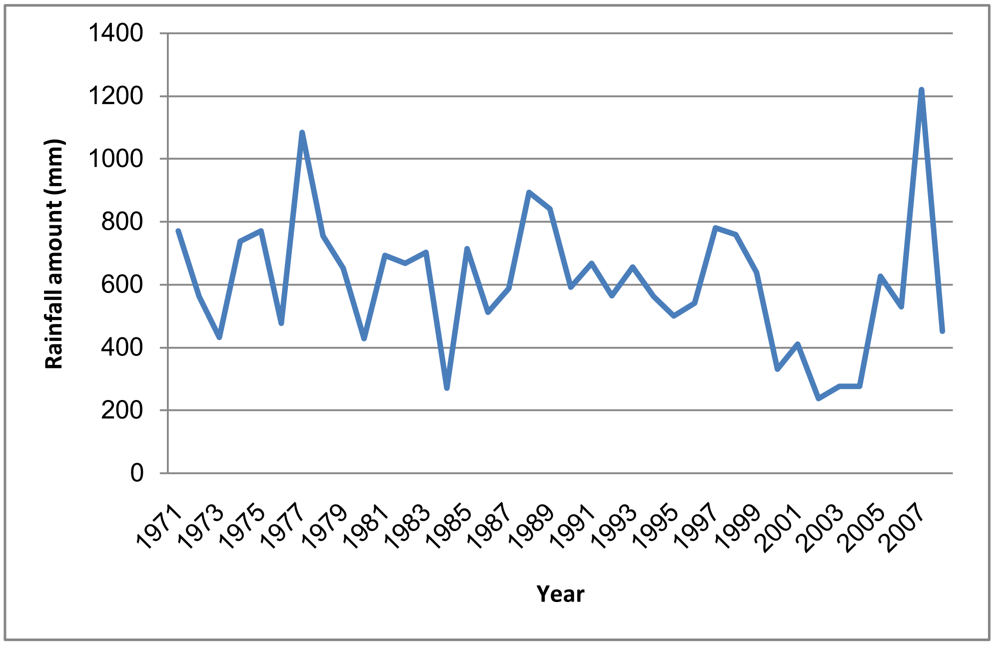

Figure 1. Trend of rainfall in Marigat District over the study period.

extreme events has not been worked out, on the basis of several General Circulation Model (GCM) scenarios, the future long-range climatic outlook for Kenya signifies an increase in mean annual temperature of 2.5°–5°C magnitude, with up to 25% increase in precipitation (Mendelsonh *et al.*, 2000). These increases in mean temperatures could result in significant changes in precipitation, evaporation, hydrological cycle, sea-level rise, as well as frequency of extreme weather events (floods, droughts and storms). Climate variability and change has heavy impact on livestock production which is the main source of livelihood to most pastoralists. The impacts have affected various aspects of livestock production including feed quantity and quality, animal and rangeland biodiversity, distribution of diseases, management practices and production systems changes among others (Herrero et al., 2009).

Marigat area is prone to floods, having been affected by high amounts of rainfall in the past. For instance, the 1997/98 El-Niño rains resulted in an outbreak of yellow fever disease while the 2001 floods swept away and resulted to deaths of both people and livestock and finally 2006/2007 unusual heavy rains and floods resulted in an outbreak of RVF (Nguku *et al.,* 2010). The torrential rains of 1997-1998 and 2006-2007 which were way above the seasonal average provided ideal conditions for the breeding of insect vectors of animal and human diseases and caused the eruption of various diseases in Kenya including Rift Valley Fever, blue tongue, lumpy skin disease and malaria (Department of Veterinary Services annual report, 2007). A disease outbreak often forces the closure of livestock markets drastically affecting the economy of the affected regions.

MATERIALS AND METHODS

The study was carried out in the Semi-arid rangeland in Marigat District of Baringo County, Kenya. This area is located between latitude 00^{o}26'- 00^{o}32'N and longitude 36^{o} 00'- 36^{o}09'E and an average altitude of 900m above the sea level.

The study adopted both descriptive and explanatory research designs. As the former allows for description of a given phenomenon, the latter allows test of relationships.

A forty-year rainfall data from 1971 to 2010 was obtained from the Kenya Meteorological department. The data included monthly precipitation (in millimeters). The period 1971–2010 constituted the climate baseline. Disease cases data was obtained from the Ministry of Agriculture, Livestock and Fisheries development, Department of Veterinary Services and other published literature. Such data included the number of RVF cases in both humans and livestock and number of mortality cases during the previous outbreaks of this disease. Also the number of cases for other vector-borne diseases was obtained. Weather and climate data and epidemiological data was entered and analyzed in Ms-Excel spreadsheets. Graphs and charts were used to compare different variables. Disease cases and rainfall data were entered and analyzed in Statistical Package for Social Sciences (SPSS). Pearson Product-Moment

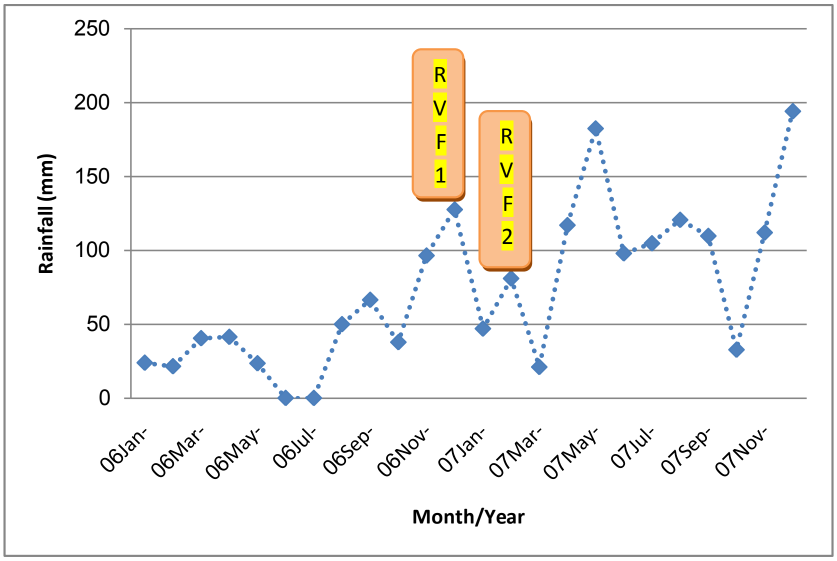

Figure 2. Relationship between monthly rainfall and the 2006/2007 RVF outbreak.

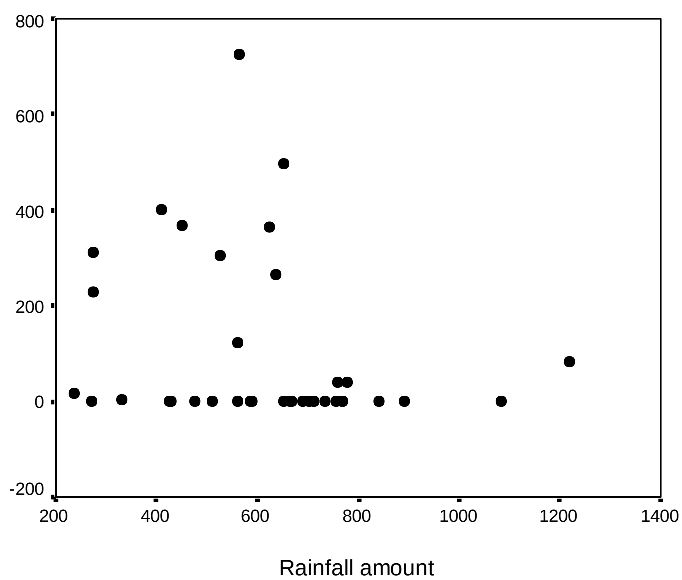

Figure 3. A scatter plot on the cases of trypanosomiasis against rainfall amount

correlation was used to test the relationship between rainfall amounts with number of cases of vector-borne diseases.

RESULTS

Rainfall Trend

Rainfall data shows an oscillating trend of rainfall with major peaks being observed in 1977 and 2007 (Figure 1). Other observable peaks are those of 1988-89 and 1997-98. These are the four major peaks with the highest amounts of rainfall over the last four decades.

RVF-Rainfall Relationship

Data on the last outbreak of Rift Valley Fever was obtained from the District Veterinary Office and other published literature. Rainfall figures for Marigat bring out a clear relationship between rainfall amount and RVF (Figure 2). There were two outbreaks of RVF in this area;

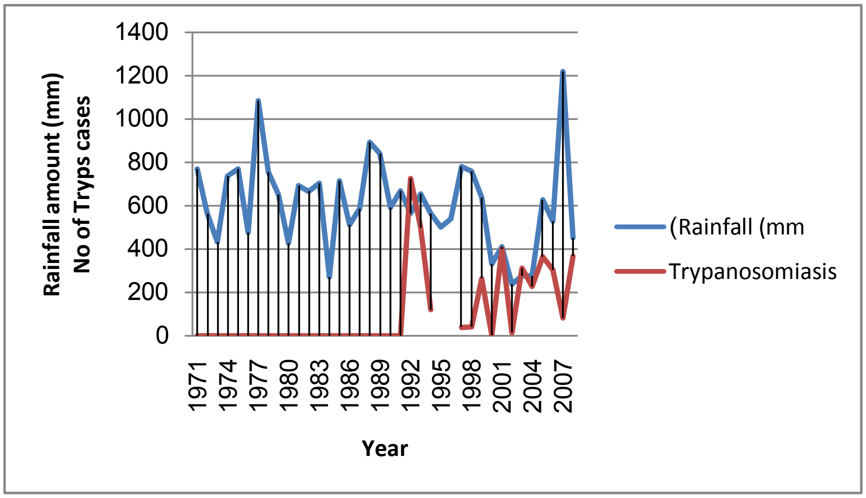

Figure 4. A graphical representation of the number of cases of trypanosomiasis against rainfall amount.

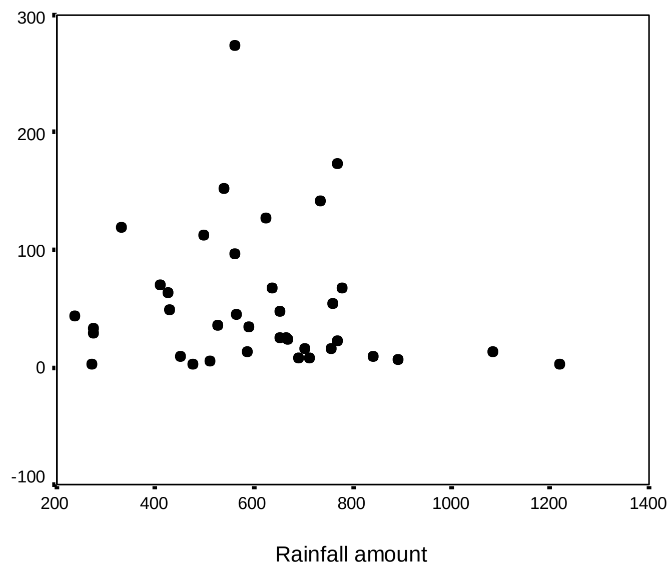

Figure 5. A scatter plot between rainfall amount and cases of Babesiosis

the first was in December 2006 while the second happened in February 2007.

Relationships between rainfall and other vector-borne diseases

Pearson Product Moment Correlation analysis was carried out to determine whether there is any significant relationship between rainfall amount and various vector-borne diseases. The results of the correlation analysis are described below.

Rainfall amount versus Trypanosomiasis Relationship

A correlation between cases of trypanosomiasis and rainfall amount showed no significant relationship (p=0.189, N=37). A scatter plot also showed a more widely distributed dots indicating a very weak relationship (Figure 3).

However, a graphical plot showed some concordance between cases of trypanosomiasis and rainfall amount (Figure 4). The two variables had a generally similar distribution trend.

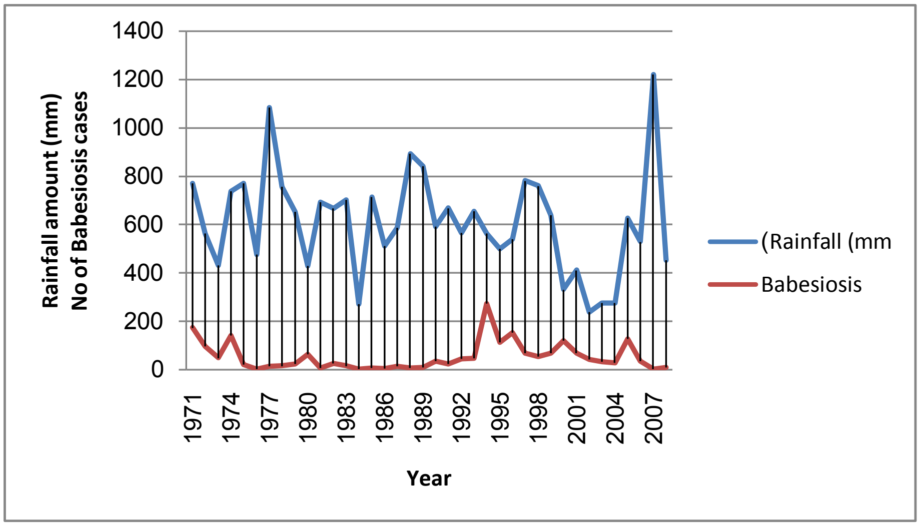

Figure 6. A graphical plot on the number of cases of Babesisosis against rainfall amount over the study period.

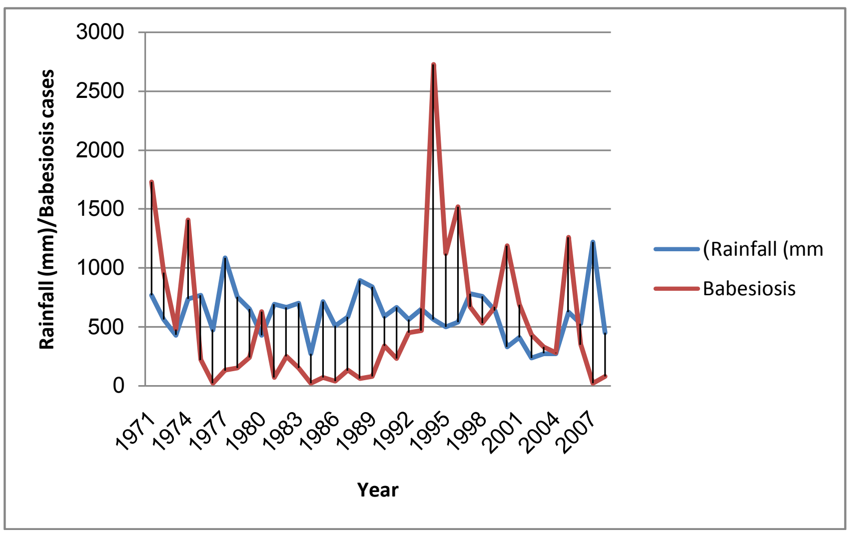

Figure 7. A graphical plot on the extrapolated number of cases of Babesisosis against rainfall amount over the study period.

Rainfall amount versus Babesiosis cases Relationship

A correlation analysis between the cases of Babesiosis and rainfall amount showed no significant relationship between these two variables (p=0.457, N=38).

A scatter plot between cases of babesiosis and rainfall amount showed a wide clustering of dots around the centre indicating a very weak relationship (Figure 5).

Also, due to the small number of cases of babesiosis, it was difficult to establish the existence of a relationship between rainfall amount and incidences of babesiosis (Figure 6).

When the values for the cases of Babesiosis were extrapolated by a factor of 10, a graphical analysis indicated some degree of relationship existing between these two variables (Figure 7). Generally, the trend showed increasing cases of disease incidences with increase in the amount of rainfall to a certain level where any more increase in rainfall amount resulted to a corresponding decline in the number of Babesiosis disease incidences or cases.

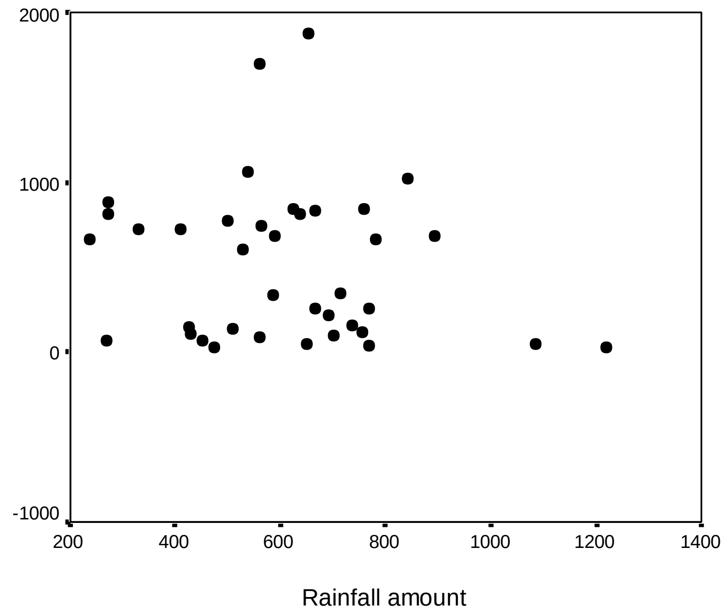

Figure 8. A scatter plot on the number of cases of Anaplasmosis against Rainfall amount over the study period.

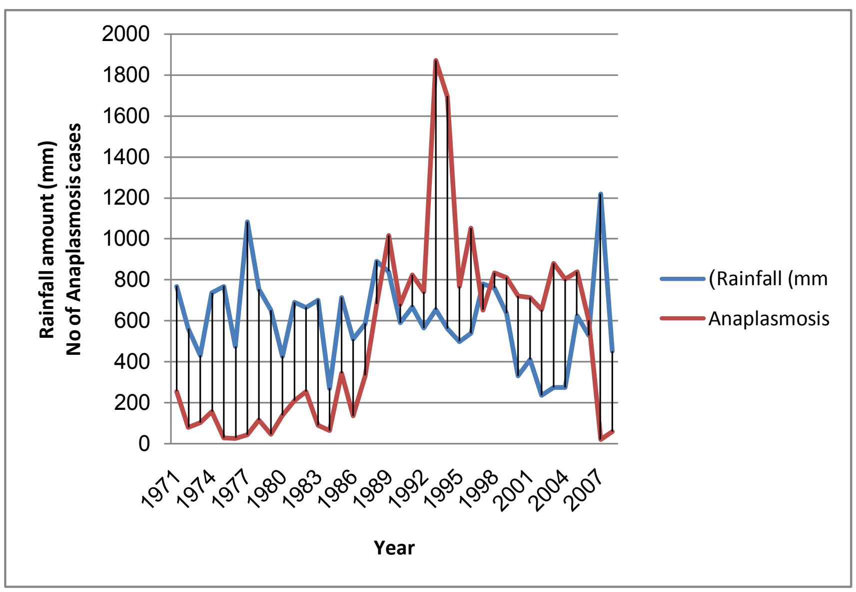

Figure 9. A graphical analysis of rainfall amount versus Anaplasmosis cases over the study period.

Rainfall amount versus Anaplasmosis cases Relationship

A correlation analysis between cases of analysis and rainfall amount showed no significant relationship (p=0.351, N=38). A scatter plot also showed widely distributed dots indicating the existence of a weak relationship (Figure 8). The distribution of dots on the scatter plot was also non-linear hence no significant relationship was observed between these two variables.

A graphical analysis of rainfall amount versus Anaplasmosis cases over the study period showed the existence of a relationship (Figure 9). There is a similarity in the trend of rainfall and anaplasmosis cases between

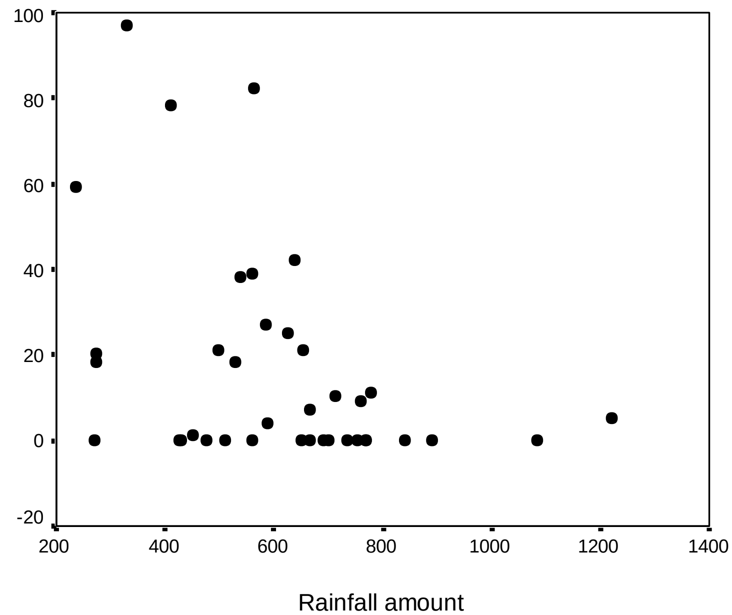

Figure 10. A scatter plot between the numbers of cases of heartwater against rainfall amount.

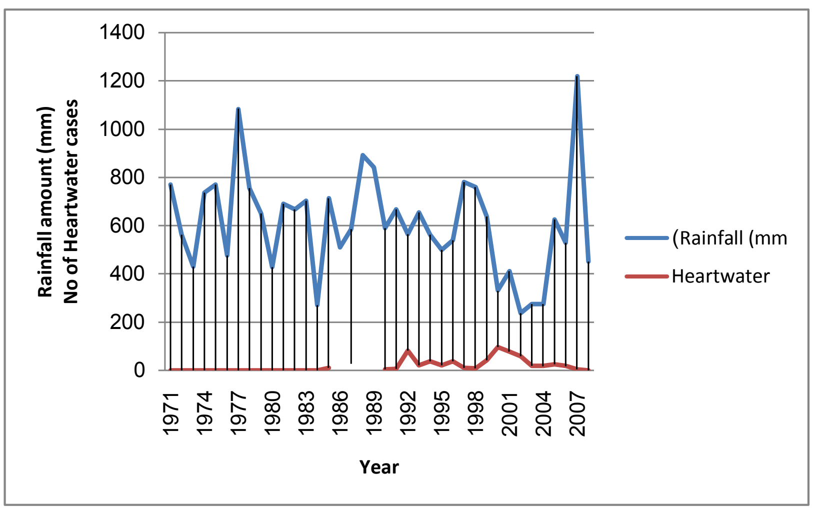

Figure 11. A graphical plot showing the trend of Heartwater against rainfall amount over the study period.

1971 and 2008. Just like the case with Babesiosis, the trend showed increasing cases of disease incidences with increase in the amount of rainfall to a certain level where any more increase in rainfall amount resulted to a corresponding decline in the number of Anaplasmosis disease incidences or cases.

Rainfall Amount versus Heartwater cases Relationship

A correlation analysis between rainfall amount and cases of heartwater showed a negative significant relationship at the 0.05 level (p=0.012, N=38). A scatter plot also showed a concentration of dots in a descending order indicating a clear negative relationship (Figure 10).

When the rainfall figures are plotted against cases of Heartwater in a graph, the relationship is not very clear due to very low number of cases of this disease (Figure 11). However, when numbers of cases are extrapolated by a factor of 10 to make the results visible, a clear relationship is seen in the trend of the cases of Hearwater in relation to rainfall amount (Figure 12). There was no data for the number of cases of Heartwater for the years 1985 to 1990 but generally the graphical plot showed an

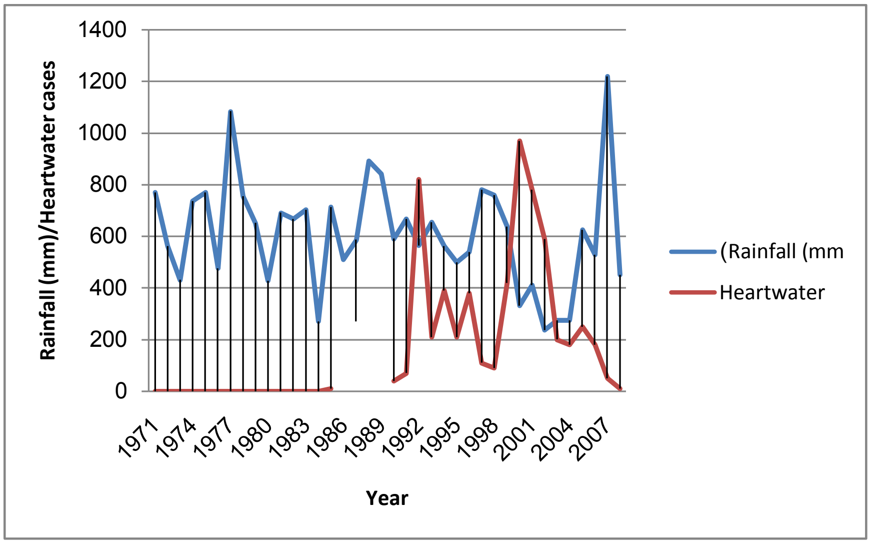

Figure 12. A graphical plot showing the extrapolated trend of Heartwater against rainfall amount over the study period

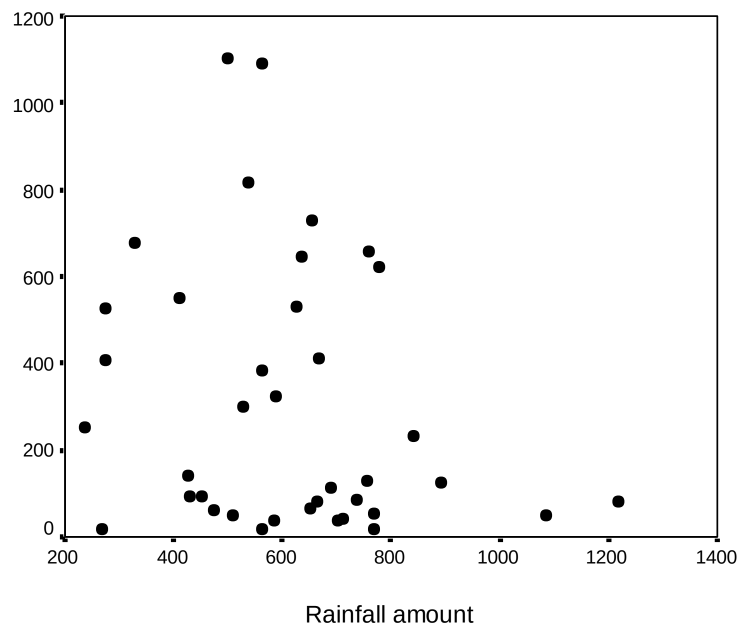

Figure 13. A scatter plot between cases of ECF and rainfall amount.

increasing trend of disease incidences with increase in rainfall to a level where any more increase in rainfall amount resulted to a decline in the number of cases.

Rainfall Amount versus ECF Cases Relationship

A correlation analysis between cases of ECF and Rainfall amount indicates that there is no significant relationship that exists between these two variables (p=0.176, N=38).

On the other hand, a scatter plot showed a descending trend of widely scattered dots indicating a very weak negative relationship between rainfall amount and number of cases of ECF (Figure 13). The trend was similar to those exhibited by Babesiosis and Anaplasmosis cases.

A graphical plot of the two variables provides evidence of a certain degree of relationship that exists between rain-

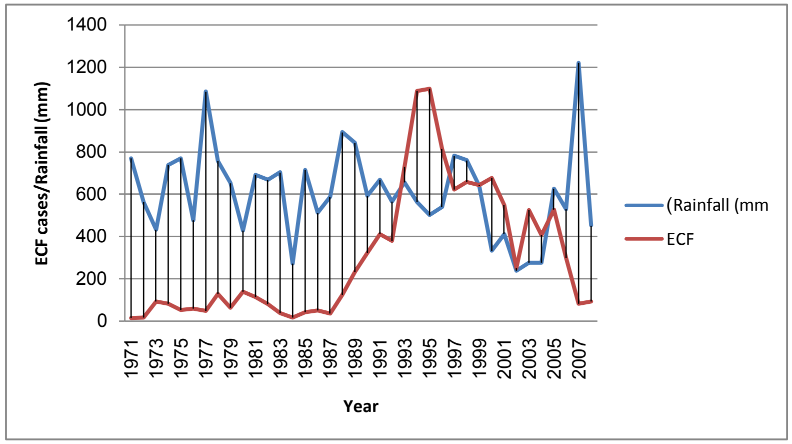

Figure 14. A graphical plot between ECF cases and Rainfall amount.

Table 1. Correlations analysis between Trypanosomiasis, Babesiosis, ECF, Heartwater and Anaplasmosis.

		Cases of tryps	Cases of babesiosis	Cases of Anaplasmosis	Cases of heartwater	Cases of ECF
Cases of tryps	Pearson Correlation	1	.165	.146	.414(*)	.176
	Sig. (2-tailed)	.	.328	.388	.011	.297
	N	37	37	37	37	37
Cases of babesiosis	Pearson Correlation	.165	1	.431(**)	.359(*)	.575(**)
	Sig. (2-tailed)	.328	.	.006	.025	.000
	N	37	39	39	39	39
Cases of Anaplasmosis	Pearson Correlation	.146	.431(**)	1	.437(**)	.823(**)
	Sig. (2-tailed)	.388	.006	.	.005	.000
	N	37	39	39	39	39
Cases of heartwater	Pearson Correlation	.414(*)	.359(*)	.437(**)	1	.518(**)
	Sig. (2-tailed)	.011	.025	.005	.	.001
	N	37	39	39	39	39
Cases of ECF	Pearson Correlation	.176	.575(**)	.823(**)	.518(**)	1
	Sig. (2-tailed)	.297	.000	.000	.001	.
	N	37	39	39	39	39

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

fall amount and number of cases of ECF (Figure 14).

Correlations between various VBDs

A correlation analysis conducted for various vector-borne diseases showed that a relationship exists between the occurrences of various vector-borne diseases (Table 1). In the analysis of the relationships between various VBDs, ECF and Anaplasmosis showed a very strong significant relationship at 0.01 levels with all other tick-borne diseases (Babesiosis and Heartwater). Trypanosomiasis only had a significant relationship with Heartwater at 0.05 level.

DISCUSSION

It is worth noting that the area have been receiving extremely heavy rainfall every 10 years over the study period. This observation tends to concur with UNDP's climate change profile for Kenya which notes that rainfall observations since 1960 has not shown any statistically significant difference (McSweeney *et al.,* 2011). The report further expounds on the above observations by noting that heavy rainfall events have been increasing with no statistically significant trend.

Even though the 2006/2007 RVF outbreaks were the first to be experienced in this area over the study period, it seems to follow rainfall trend considering that the first outbreak was witnessed in December 2006 (Munyua *et al.,* 2010). This was the period when there was heavy flooding in the area following continuous rainfall received from August 2006. The first outbreak was contained through veterinary intervention (vaccination) and a drop in the amount of rainfall and flooding. However, the second outbreak was reported in February 2007 and this could possibly have resulted from increase in rainfall and flooding as indicated by rainfall figures from this area. The study shows that the outbreak affected Sintaan, Logumgum, Longewan and Kiserian areas. All the four areas share Molo River and flooding from this river often results to widespread flooding hence creation of breeding habitats for RVF vectors (mosquitoes).

The risk of disease transmission is increased by the changes in biology and ecology of vectors (Githeko *et al.,* 2000) and this could be the major contributing factor in the increasing trend of VBDs over the study period. The aspect of weather also comes into play when dealing with disease outbreaks because weather condition is known to affect both the timing and the intensity of the outbreaks. Temperature affects both the distribution and the effectiveness of the pathogen transmission through the vector (Hunter, 2003). Gubler *et al.* (2001) gave a list of possible mechanisms whereby changes in temperature and rainfall impact on the risk of transmission of vector-borne disease. The test of hypothesis in this study proves this by indicating that although there are no significant relationships between rainfall and number of cases of VBDs, a graphical plot indicates otherwise. The oscillating trends of both the rainfall and the cases of VBDs show a corresponding pattern.

Although there is no significant relationship observed between rainfall and cases of vector-borne diseases, graphical plots showed a relationship in their trends. Most of the VBDs cases increased with the increase in rainfall amount until a certain level where any additional increase in rainfall amount resulted to a decrease in the number of cases. However, some disease cases were few and needed extrapolation of the data in order for the relationship to be viewed clearly in a graphical plot. Therefore, hypothetically, no significant relationship exists between rainfall amount and cases of Anaplasmosis, Trypanosomiasis, Babesiosis, ECF and Malaria. However, a negative significant relationship at 0.05 level exists between rainfall amount and cases of Heartwater disease. On the other hand, a significant relationship exists between the number of cases of tick-borne diseases including Heartwater, Anaplasmosis, ECF and Babesiosis. This is possibly because the existing climate conditions favor the transmission of these VBDs by various tick species.

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