Journal of development, education & technology ISSN 2959-0523 VOL. I No. 1 (FEB 2023)

UNDERSTANDING THE ASSOCIATION BETWEEN CATTLE TICK-BORNE DISEASES AND CLIMATE VARIABILITY IN MBARARA DISTRICT, WESTERN UGANDA

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ABSTRACT

A study to examine the association between tick - borne diseases and climate variability in cattle keeping communities in Mbarara district in South in Western Uganda was undertaken aiming at inputting into the tactical and strategic control of the diseases in the largely livestock dependant region in the country. In a multi-sectoral priority setting exercise, tick borne diseases was top on the list of constraints responsible for cattle mortality and reduced productivity. A clinical tick- borne disease data analyzed basing on standard microscopic procedures, including capillary agglutination test and giemsa stain, was obtained from Mbarara veterinary clinic.

The disease data was matched with rainfall data from 27 rain gauge stations obtained from National meteorological stations and recording centers scattered within the district covering a period of 56 years since 1950. The number of wet spells and disease cases showed that disease cases were positively correlated with rainfall at a 95% confidence level (R2= 0.56). Disease cases exhibited peak cyclical patterns related to rainfall during the transmission season during October, November and December with extreme peaks occurring every other year while Significant (r^2=0.536) variability was observed for the positive trend in March - April -May seasonal rainfall for one of the three zones. Additionally, the results in this study indicate that rainfall is a substantial determinant of seasonal activity of the transmitting vectors from season to season and from year to year.

Keywords: ***cattle tick-borne diseases, climate variability***

Introduction

The influence of climate variability/change on the spread of cattle-tick-borne diseases is an issue of global importance. What appears to be relatively minor variability can have dramatic effects on the incidence and epidemiology of diseases if this change removes the barrier for disease transmission. As a result, the effect of climate can be considered to be nonlinear and punctuated by sudden transition from absence to presence of the disease, depending on the factors influencing incidence, particularly in highly susceptible animal populations devoid of immunity.

In order to address the influence of current climate variability on occurrence of tick-borne diseases, this study examines the associations between tick-borne diseases and climate variability in a cattle keeping community of Mbarara district, western Uganda.

During a multi-stakeholder participatory research priority-setting exercise for this community, for whom keeping livestock is the leading economic enterprise and source of livelihood, cattle-tick-borne diseases were implicated as the first-priority constraint causing cattle mortality and loss in productivity.

In addition, participants attributed an increased occurrence of tick-borne diseases to current highly variable climate/weather patterns experienced throughout the district. Due to inadequate scientific articulation and lack of understanding of climate variability signals in the climate parameters, on one hand, and the signals' associations with cattle-tick-borne diseases incidence, on the other, climate information is not included in decision making relating to the control of cattle-tick diseases.

This information is an essential input into the tactical and strategic control of the disease. Articulation of climate change signals in the climate parameters would help in monitoring the frequency of occurrence and epidemiology of cattle-tick-borne diseases in the district. Existing disease-control policies do not pay sufficient attention to the complex interactions between climate, cattle disease, socioeconomic conditions and livelihoods. Yet, nearly all poor and vulnerable people in Mbarara district derive livelihoods from cattle keeping and ecosystem goods and services based on rainfall, and the people are highly vulnerable to any variability/changes in climate.

The main knowledge gap is articulating the link between cattle diseases and climate variability and change. Limited research results on the association between climate change and tick-borne diseases has hindered integrating climate information into policy formulation.

This paper examines variability trends in rainfall over the past 56 years. The authors apply statistical methods to analyze the dynamics of wet spells and how they favor disease transmission. Retrospective microscopically proven cases of tick-borne diseases, differentiated by breed for the period 1991-2006, were used to generate detailed information on cattle--tick-borne diseases. The two data sets were analyzed for associations as a starting point for developing climate-adaptive disease-control strategies.

Materials and Methods

Study Area

The study was conducted in Mbarara district, western Uganda (Figure 1), which covers an area of approximately 10,500 km^2. Mbarara district has the greatest number of cattle in the country, over 1,200,000 head of cattle, with over 30% of these being exotic animals and cross breeds with low immunity. (District Veterinary Reports).

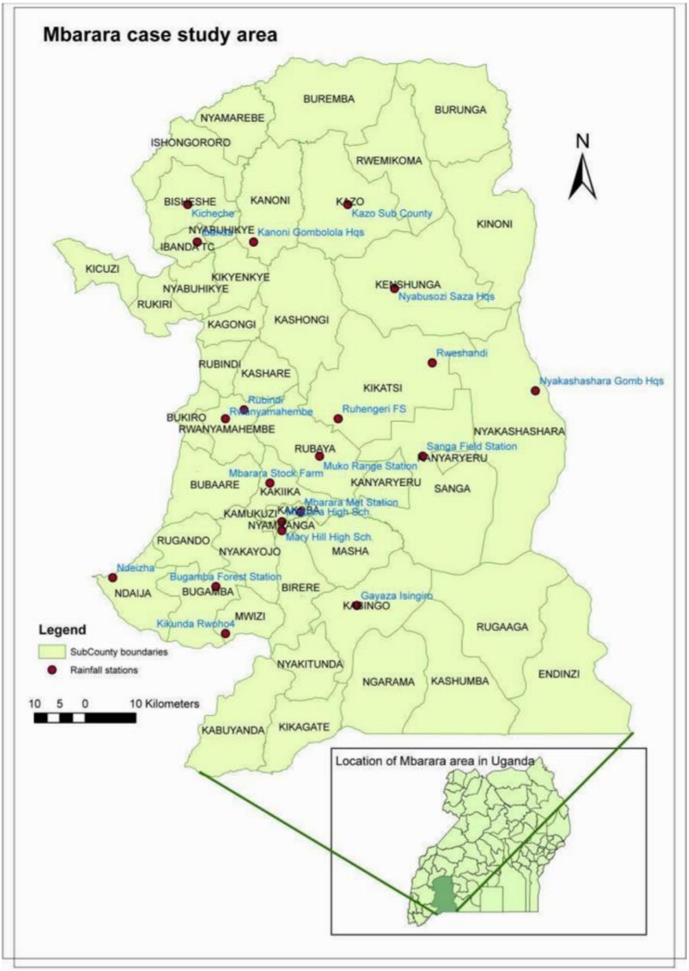


Figure 1: Location of Mbarara Case Study Area

Clinical tick-borne disease data were obtained from the Mbarara Veterinary Clinic that serves the whole South-Western region since 1991. The background of the data collection reveals that the data samples were taken from animals in advanced stages of the disease. Where a problem was widespread to the whole herd, specimens were taken from more than one diseased animal and attempts were made to avoid contamination of the samples.

The sample-identification routine included the name of the farmer and his address, animal description including age, sex and breed, duration of the condition or outbreak, mortality rate, number of animals affected, clinical signs observed, treatment history, clinical diagnosis, change in feeding regimes, possibility of contact with neighboring animals, and type of preservation used on the specimen prior to or en route to the laboratory. All samples were analyzed using standard microscopic procedures, including a capillary agglutination test and geisma stain.

Rainfall data for 27 rain gauge stations scattered within the district for the period 1950-2006, were obtained from the National Meteorological Service and from the recording sites within the district.

Statistical Methods

Homogenous zones were delineated from a network of 27 rainfall stations for the period 1950-2006 using a ward clustering method and Principle Component Analysis (PCA) statistical procedures. Both procedures are mathematical methods used to uncover relationships among many variables and to reduce the amount of data needed to define the relationships. The sums of squares of the coefficients of variation from the statistical solutions (communality) were used to determine representative rainfall stations within the homogenous zones. Analysis of the time series revealed trends within rainfall and these trends were used as a basis to define modes of climate variability.

Data relating to microscopically proven cases from homogenous zones, and corresponding rainfall variability data from the representative rainfall station in that zone, were used to test for associations using nominal logistic analysis odds ratio.

Results

Time Series Analysis

The results of statistical analysis of the rainfall time series showed three homogenous zones delineated in the district. Zone one comprising of northeastern parts, zone two the northwestern, western and central parts while zone three had parts of eastern and southeastern. Representative stations for the three respective zones were Nyakashashara, Rubindi and Mbarara Metrological
Station.

The Mbarara Met station time-series analysis for the October-November-December (OND) season revealed a tendency for slightly increased rainfall, while the MarchApril-May (MAM) season showed a slightly decreasing trend. On the other hand, June-July-August (JJA) seasonal rainfall shows a normal 10-year cyclical trend, with the period corresponding to the tick data manifesting in a lower than normal rainfall cycle. Significant (r^2=0.536) variability was observed for the positive trend in MAM seasonal rainfall for the Nyakashashara zone. In addition, the OND time series trend shows a slight tendency of decreasing rainfall at this location.

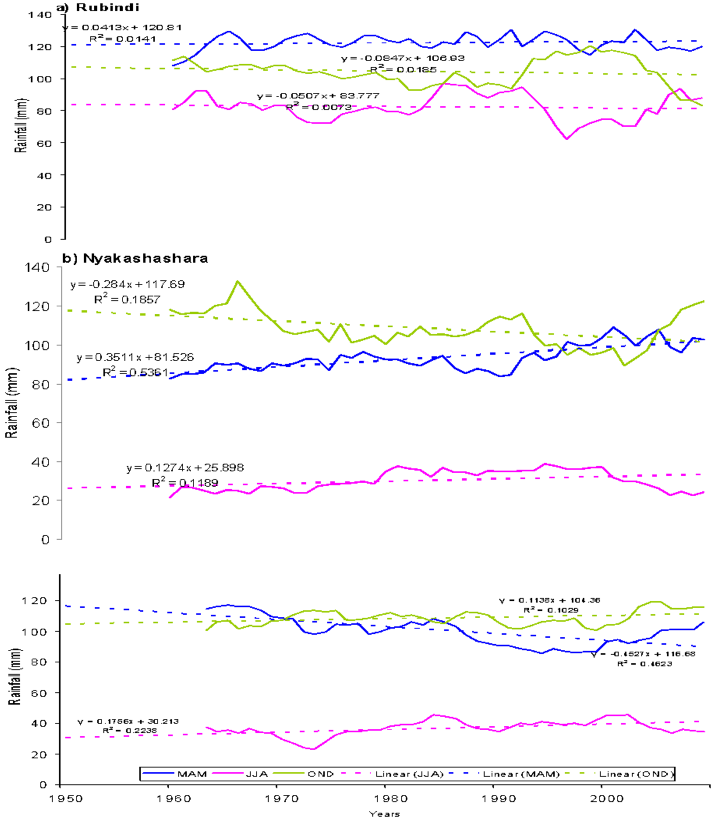


Fig 2: Seasonal Trends for the 10-Year Moving Average for Homogenous Zones in the Mbarara District

The period corresponding to the tick data however shows lower rainfall. The zone represented by Rubindi station exhibits a tendency for decadal variability in the JJA and OND seasons, with the period corresponding to the tick record wetter for JJA and drier for OND season. The MAM season at this location is much more unstable (see Figure 2).

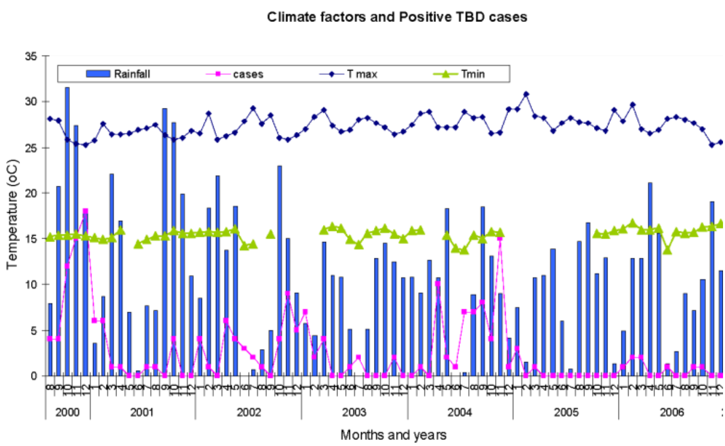
Journal of development, education & technology ISSN 2959-0523 VOL. I No. 1 (FEB 2023)

Association Patterns between Disease Cases and Rainfall

Results from multiple regression analysis of a combination of rainfall at lag-month three and lag-month two, the number of wet spells and disease cases showed that disease cases were positively correlated with rainfall at a 95% confidence level (R2= 0.56). The time-series display of disease cases and rainfall are shown in Figure 3 below.

Disease cases appeared to exhibit peak cyclical oscillations related to rainfall during the transmission season, OND, with extreme peaks occurring every other year. The absence of a peak in disease incidence in the last two years could be a result of the persistently dry conditions during the December to January period of 2004-2005 and the accompanying very high maximum temperatures. These conditions may have not favored survival of the vector life stages occurring at that time, hence a lag in population buildup.

Figure 3: Climate Factors and Positive TBD Cases



Journal of development, education & technology ISSN 2959-0523 VOL. I No. 1 (FEB 2023)

Discussion

Tick-borne-disease cases showed a positive correlation with rainfall. In addition, the odds of having a disease case on a rainy day was significant P=0.05. Field studies show a distinct seasonal activity pattern for *R. appendiculatus* adults, with the number of ticks on host animals increasing markedly with the onset of the rain, remaining high throughout the wet season, and decreasing to very low levels during the dry season (Kaiser *et at.*, 1991; McCulloch *et al.*, 1968; Minshull and Norval, 1982; Mulilo, 1985; Pegram *et al.*, 1986;). Since this tick is the vector of the tick-borne disease theileriosis, caused by T.parva, the pattern of disease incidence from the results is agreeable with results from previous studies.

Fluctuations in population density are not wholly explained by differences in rainfall; however, other factors such as temperature, photo-period, vegetation cover, host availability, host susceptibility or resistance to ticks, types of husbandry, crops, and density of human population have also been suggested (Short and Norval, 1981a; Yeoman, 1966).

Rechav (1981) proposes that environmental humidity regulated population density by controlling survival, while long-day photo-period determined seasonal activity. Recent experimental studies have established that the activity of *R. appendiculatus* adults in the field is regulated by the combined influence of temperature and humidity (Punyua *et al.*, 1984, 1985a), with quiescent adults being activated by rainfall (Short and Norval, 1981b). Short and Norval (1981) introduced a model in which the joint influence of humidity, temperature and photo-period determined the climatic conditions necessary for adult *R. appendiculatus* activity; their model successfully predicted observed activity periods in eight African localities.

The results in this study indicate that rainfall, while not the only factor influencing disease incidence patterns, particularly during the transmission season, is a substantial determinant of seasonal activity of the transmitting vectors from season to season and from year to year. This information is useful in designing control strategies.

ACKNOWLEDGEMENT

The author thanks the director and coordinator of the Nile Basin Research Program for supporting this study, the staff of the Mbarara Veterinary Department for availing the data on disease cases, and the director Mbarara ZARDI and the director General NARO, Uganda, for permission to conduct the study.

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