

Documentary Driven Chronologies Of Rainfall Variability for Kenya, 1845-1976

Telesia M. Mutua*, Sebastian N. Runguma

¹Department of Geography and Environmental Studies, The Catholic University of Eastern Africa, Kenya

ABSTRACT

The study presents the first extensive reconstruction of rainfall variability for Kenya using documentary evidence. The study used over 10,345 documentary sources to review the rainfall changes witnessed in Kenya from 1845-1976. Different published and unpublished sources including the missionary records, settlers' diaries, explorers' journals, governmental reports were consulted. Based on the meteorological observations for the country, the rainy years were assigned the following indices: very wet, relatively wet, normal, dry and very dry. The results shows chronologies of significant dry phases identified in the years 1849/50/51, 1868, 1875/76, 1879, 1883, 1888, 1897, and 1899, 1918/19, 1928, 1934/35, 1944, 1972 and 1975, while wet episodes occurred in 1878, 1899, 1905, 1912, 1916, 1922, and 1929 and 1961. The evidences for the major dry and wet spells and the findings are evaluated within wider historical context.

Keywords: Documentary data; Rainfall; Droughts; Wet spells; Indices; Climate change; Rainfall variability; Long-term

INTRODUCTION

Studies of historical climate provide valuable knowledge for natural rainfall and climate variability, which is very useful for better understanding of the current climate changes and prediction of the future scenarios. This knowledge whether gathered from proxies or weather recordings can both improve our understanding of natural climate variability and help address the question of whether modern climate change is unprecedented over the long-term context in order to resolve environmental issues associated with climate variability [1].

In order to acquire adequate information and determine the past climate changes within different regions, researchers use various paleoclimatic proxies with well dated quantitative data for both seasonal and interannual resolutions. Global climate reconstruction during the past centuries rely on the ability of relatively sparse sets of palaeoclimate proxy indicators such as tree rings, ice cores, swamps and lake sediments, borehole temperature measurements, ancient manuscripts containing phenological and historical data of blossoming dates, harvest dates, grain prices, ship logs, newspapers and weather diaries to provide precisely dated annual information of broad scale temperature trends and rainfall reconstructions [2-5]. Instrumental records are generally considered not to be long

enough to give a complete insight to long-term global climate change and variability [6].

Climate change at seasonal to annual resolutions for recent centuries has been highlighted in a number of studies, which have included climate-modelling experiments with estimated natural and anthropogenic radioactive-forcing changes and empirical hemispheric or global reconstructions. Although, a notable lack of high quality, widespread, long-term instrumental records in many parts of the world before the mid-19th century remains a great challenge to scientists investigating various facets of climate change [7]. Such reconstructions are based either on natural archives only, such as ice cores, tree rings, speleothems, varied sediments, and sub-surface temperature profiles obtained from borehole measurements, or on multiproxy networks that amalgamate natural proxy indicators with climate information obtained from early instrumental and documentary evidence [8,9].

In most cases documentary sources are considered more preferable, they provide climatic anomalies and extreme events such as droughts and floods, which can be related to climate changes [10]. Studies show that the combination of instrumental and proxy data began in the 1960s with the investigation of the influence of climate on proxy data, such as tree rings and ice cores through

Correspondence to: Telesia M. Mutua, Department of Geography and Environmental Studies, The Catholic University of Eastern Africa, Kenya, Tel: +254 720966379; E-mail: trisanjagi@gmail.com

Received: June 02, 2020; **Accepted:** June 15, 2020; **Published:** June 25, 2020

Citation: Mutua TM, Runguma SN (2020) Documentary Driven Chronologies Of Rainfall Variability for Kenya, 1845-1976. J Climatol Weather Forecast 8:255. doi: 10.35248/2332-2594.2020.8.255

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cross validation processes [11,12]. With the development of multi-proxy climate reconstructions, climate data were extended not only from local to global, but also from instrumental data to patterns of climate variability [8].

In the northern hemisphere (NH), paleoclimatic reconstruction began as early as the mid-17th century as indicated by studies on Iceland and the Baltic sea using documentary accounts of ice area and volume [13-16]. It has been noted that documentary based vine-related biophysical indicators and vine harvest dates based on 400 to 500 year-long temperature reconstructions have been used in France [17], Switzerland [18,19], Germany and Italy [20,21], the Mediterranean basin [22], and a 392 year-long preliminary temperature reconstruction for western Hungary [23].

Documentary evidence such as accounts of canal, river freezing frequencies and the duration of snow cover have also been used in several studies to determine winter severity in various parts of Europe [24,25]. Moreover, a combination of documentary and long term instrumental records has also been used to reconstruct the past half millennium January-April air temperature for Stockholm (Sweden), the seasonal winter/spring temperature for Central European regions, monthly time series of the North Atlantic Oscillation (NAO) and the Eurasian (EU) circulation indices back to 1675 [26].

There is evidence that records from the southern hemisphere are under-represented in paleoclimate studies, in particular records from continental Africa [27]. It is a great struggle for researchers trying to establish the chronology of weather variability in most of the African countries. Due to scarcity of the weather observation stations in most African countries in comparison to the developed regions, such as those in the northern hemisphere, there is less confidence in the robustness of the climate trends in these areas.

Although, climate variability in this region strongly forces the global climate system, only a few continuous, high-temporal-resolution climate histories are available in the tropics [28]. Consequently, environmental reconstructions in these low latitude regions have been primarily focused on swamp and lake sediments records [29]. For instance, paleoclimatic data in African have been gathered from large lakes such as Lakes Victoria, Turkana, Naivasha, Malawi and Tanganyika [30-34]. Using these proxies, warming during the 20th century has been observed in most of the East African Rift valley lakes [2,6]. Although these environmental issues associated with climate variability proxies only provide limited spatial resolution over this vast continent, such studies have been fundamental for climate projections, especially temperature and rainfall modeling within East African region [35,36].

Moreover, documentary based paleoclimatic reconstructions have been carried out, especially in the southern Africa region. These includes an extensive 19th century climate record for Lesotho, derived from documentary evidence by Grab and Nash (2010) and several other historical records representing the 19th century rainfall and climate variability for other parts of southern Africa [28,33,34,37-44]. Studies on sea surface temperature variation include different observations [45]. While the other researchers have assessed 20th century temperature trends [46,47].

In the East African region, documentary based paleoclimatic reconstructions are less advanced. Kenya in particular suffers a

scarcity of such records and therefore, there is a clear need to explore longer lead times for predicting seasonal rainfall and continuously monitor prediction relationships. This can be achievable by using earlier records, which can give better spatial and temporal resolutions for the locally based rainfall variations [48,49]. Most of the environmental reconstructions in eastern Africa have focused on swamp and lake sediment records [12,29,50]. There has been less effort in utilizing documentary evidence to establish chronological climatic trends for this region [12]. Researchers investigated rainfall variability in Western Kenya using documentary evidence [51]. Analysis show recent climate variability in the eastern Africa region, mostly from 1960 to 1990 [35,52-55]. Other researchers have concentrated on the impacts of climate change, and associated mitigation, adaptation and coping strategies [56].

Although there are a few studies on droughts and famines in Kenya, they have covered the period between c1897-1982, and mainly focus on dry land areas, such as Kitui and Turkana Districts, which are more susceptible to drought conditions [57,58]. Study of drought in Embu, Isiolo, Meru, Machakos, Kitui, and Marsabit has incorporated the socio-economic impacts, adaptation and coping strategies for the year 1972 [57]. However, the covered areas are situated in the eastern parts of the country, the other parts of the country are not represented. There is no evidence of a chronological documentary based research covering the entire country. This knowledge gap can be filled through utilization of the available documentary records extending over a long period in order to establish the trend of climate change for the entire country.

Instrumental climatic records are very recent for Kenya. The first climatic data were recorded at Mombasa town in 1890, and then in 1891 and 1894 further stations were opened in Malindi and Machakos towns respectively. By 1904, there were additional stations at Makindu, Voi, Murang'a, Kapsabet and Kisumu towns. Meteorological recording developed further, incorporating other weather elements for Nairobi such as temperature, daily sunshine hours, cloud cover and wind speed. Since then, weather recording has been consistent in Kenya and substantial archival proxies are available for earlier periods, which can be used to establish the chronology of rainfall variability and long term societal adaptation and coping strategies in Kenya.

However, such documents are underutilized and thus the annual climate chronology for Kenya, for the period preceding reliable meteorological instrumentation, has not been forthcoming. Given this knowledge gap, this study has utilized the available 'proxy' documentary for the period 1845-1976, to investigate rainfall variability in Kenya during this period. This includes scrutinizing available documentary evidence (personal diaries, journals, reports, letters, notes, correspondences, and memoirs) among others. The nature and extent of extreme events such as flood episodes, droughts, famines, and reference to food production are of primary interest.

CLIMATE AND ENVIRONMENT OF KENYA

Kenya is located at latitude 4° N to 4° S and longitude 34° E to 41°E in eastern Africa. The country covers an area of 582,650 sq km including 13,400 sq km of inland water and 536 km coastline straddling the equator, which cuts across the country about 90 miles north of Nairobi. Kenya's boundaries are defined in the east

by the Indian Ocean and Somalia, in the west by Lake Victoria and Uganda, in the south by Tanzania and to the north by Ethiopia and Sudan [59]. According to the 2009 population and Housing Census, Kenya has a population of 38,610,097 [60]. Being an equatorial country, there is only a small variation in mean monthly temperature. Most of the country experiences a semi-arid to sub-humid climate, with the highlands and lake areas being wetter compared to other parts of the country. The temperature ranges between 21°C and 25°C in most parts of the country. However, in the highland regions, the mean monthly temperature is usually 17°C between the month of January and April [2]. The diurnal temperature ranges in nearly the whole of country is in the range 9°C to 13°C except above 2200 m in the highlands where it is about 14°C to 17°C and at the coast on the Islands where it is between 5°C and 9°C [61]. Kenya has diverse geographical features; the Coastal region, Nyika plateau, highlands regions, and the lake basin region.

DATA SOURCES AND METHODS

Documentary data

The study has utilized documentary sources to generate the rainfall variability for Kenya during the period 1845-1976. The primary data sources for the study were the archived, published and unpublished documentary evidence such as letters, journals, memoirs, diaries, travelogues, reports, monographs, and newspaper articles written by explorers, travellers, missionaries and colonial officials who lived in and travelled through Kenya and neighbouring countries such as Tanzania and Uganda during the 19th century. Early travellers in the East African region, such as Dr. David Livingstone, Rev. Charles Ludwig Krapf and Rebmann expedition records dating from c1845 were useful in providing earlier information before the settlement of the missionaries and colonial government in Kenya.

The most resourceful materials were the collection of the unpublished letters from the missionary stations, established by the Church Missionary Society (CMC) in Kenya. Most of these letters were very detailed because they were written by missionaries who had stayed in Kenya for many years, therefore can be considered reliable for climate interpretations. They were also place specific, thus showing long-term spatio-temporal variations for different parts of the country. In contrast, there was a need for more careful analysis of the quarterly colonial government reports or annual summaries in order to identify the specific timing of the climatic events and the impacts they had on the environment. The quarterly and annual reports and letters from the, ministry of Agriculture and the East African Protectorate Meteorological Department were also consulted. These contained annual, seasonal and in some cases quarterly accounts of rainfall, temperature and harvests reports of different parts of the country. Letters and reports sent to and colonial government offices during the colonial period, also contained valuable information of harvests, droughts, floods and other weather occurrences written by the District commissioners.

The documentary records were retrieved from University libraries in South Africa and Kenya, the Kenya National Archives (Nairobi and Mombasa), Kenya National Museum (Nairobi), McMillan library, and Kenya national library services in Mombasa and Nairobi (Table 1). The main objectives during data retrieval were identification of documentary series that may offer climatic

information with an acceptable density, optimum reliability, precise dating, homogeneity over time and possibility of being quantified [62].

Table 1: Details of the documentary data sources

Location	Details of sources	Dates
Kenya National Archives (Nairobi and Mombasa)	<ul style="list-style-type: none"> Published and unpublished colonial government records such as annual and monthly reports, government gazette, Blue books, monographs, journals, diaries and memoirs 	1840s- onwards
	<ul style="list-style-type: none"> Explorers, travellers and missionary records such as travelogues, diaries, incoming letters from various districts and outgoing letters from government offices and reports 	1840s- onwards
	<ul style="list-style-type: none"> East African Protectorate instrumental weather records 	1876-1976
McMillan library	<ul style="list-style-type: none"> Newspapers, such as East African Standard which is now referred as the Kenya Standard Newspaper 	1902-1976
	<ul style="list-style-type: none"> Annual reports, books, journals, diaries, Annual 	1840s -onwards
Kenya National Museum (Nairobi)	<ul style="list-style-type: none"> Books and historical records written by explorers and travellers, such as diaries and Journals 	Any available record starting from 1840s Onwards
Meteorological Department (Nairobi)	<ul style="list-style-type: none"> Republic of Kenya instrumental weather records 	1900-1976
University libraries in South Africa and Kenya	<ul style="list-style-type: none"> All available books showing climatic conditions in East African region, particularly the conditions for Kenya, diaries and Journals written by the colonial government, explorers, travellers and missionaries in Kenya or any other East African country 	1840-1976

Data analysis

The methodology used to identify the climatic conditions from documentary sources in this study was adapted from different researchers [42-44,62-68]. Whenever possible, all references were read and noted in a chronological order, with all information related to seasonal weather phenomenon, environmental conditions, and human societal responses recorded verbatim. Observations from each year were subsequently compiled in a chronological order along with details of the author, dates and location captured [62-64,67].

In the case of most letters, journals and quarterly reports were relatively straightforward process although some annual records only permit the identification of seasonal patterns [44]. Considering the fact that some authors are both time and place specific in their

observations, all comments about the environment (observations about weather, harvest quality and hydrological conditions) or description of unusual events such as droughts, famines, floods or pest infestations and the human societal responses since c1850 were used in determining the timing of the rainfall seasons (onset and cessation dates). In cases where time lags between the occurrence and documentation of an event or phenomena is suspected, relevant contextual material was noted to allow the timing to be more tightly constrained [66,67]. All materials were scrutinized to minimize bias from external factors such as war, slave trade, pestilences and land use changes, which are not products of climate variability [63,68].

To determine variations in the relative amounts of seasonal and annual precipitation, the ordered documentary records were analyzed according to 'rain-year' between March-May (long rainfall season) and October-December (short rainfall season) with the seasonal and annual rainfall amounts being qualitatively categorised into one of the five classes: 'very wet/floods', 'relatively wet', 'normal', 'relatively dry' and 'very dry'. This method is identical to that used by many researchers [42-44,63,64,67]. During the classification process, preference was given to climate related phenomenon that provide the strongest indication of relative and actual rainfall occurrences, such as reports of rainfall intensity, wind and storms/lightning, hail, fog, river levels, floods, description of crops and vegetation cover, information of droughts, famines and societal coping strategies [8,26,67,68]. The content analysis and discourse analysis was used to assess the information and rank the observations in terms of severity.

Each of the classes was assigned an ordinal index relative to the documentary descriptive rainfall intensity within a given season or a 'rain-year' (Table 2). Indexation ranged between -2 to +2 based on the impact of the events and the community responses [22,62,63,66,69].

Therefore, positive or negative indices indicated unmistakably extreme conditions [62]. Because the documentary information does not have regional sub-divisions, these indices were used to develop an annual time series representative of the whole country over the documentary period c1845-1976. These series were useful for verification of seasonal and annual rainfall anomalies identified in the instrumental time series, especially when there were gaps in the instrumental records. Descriptive information on seasonal and annual anomalies was quoted wherever possible so as to emphasize the extremities of events over the study period.

Data and methodology limitations

The study is subjected to various limitations. Firstly, there are spatial and temporal constraints imposed by the limited availability of documentary and instrumental records for the earlier part of the chronology. The earliest instrumental recording in Kenya was done in Frere town in 1876-1880, then after a decade, a weather station was established in Mombasa in 1891. Recording concentrated in the coastal region for about two decades before the establishment of a station at Machakos in 1896. Due to this, the study only relies on the scarce documentary evidence for the years preceding these records. This may affect the continuity of the data and result in poor presentation of the rainfall conditions in the early 19th century.

Secondly, there are issues of data reliability [42]. Whilst the descriptions of environmental conditions contained within documents are mostly eyewitness testimonies, all observations necessarily reflect the positionality of the observers as well as their intended audience [67]. For example, individual observers may describe environmental conditions for a specific time and place very differently. This may in part be influenced by their nationality background, and experience of conditions in the study area. Observers from different climate backgrounds may describe the climate at their destination differently compared to their home country, and this may be subjective [68]. On basis of such subjectivities of individual correspondents, the classification process also becomes highly subjective. Potential errors therefore, can be overcome wherever possible, by cross-referencing between multiple observers and basing classifications upon accounts from correspondents who had been resident at a location for some time.

Additionally, the influence of various factors, such as the altitude and physical features on rainfall quantity and distribution across the country, also may affect the results of this study. Rainfall in lowlands is usually low compared to that of the highlands. Therefore, interpretation of weather events may vary depending on the location of the observers. Moreover, the instrumental records for the highlands may not represent the rainfall intensity in the lowlands in cases of data shortages. Due to that, only years with extreme events reported by a number of respondents may be classified as very wet or very dry, with other years categorized according to the weight of documentary evidence. Normal years may only be identified where there is little or no reference made to 'abnormal' rainfall, where correspondents comment that rainfall had been unremarkable, or where wetter conditions during one part of the year were offset by an earlier or later dry period [42,43,67]. Therefore, all accounts of individual climatic events were read with an awareness of these potential subjectivities.

Table 2: Rainfall events indexation in relation to documentary interpretations

Event	Index	Description
Very dry	-2	Drought accompanied by reports of dry rivers and springs, if being impossible to sow or very bad harvests, rise of prices, great famine associated with death of people, lack of pastures and livestock deaths.
dry	-1	Records of meteorological drought, involving lack of rainfall without the explicit mention of deficits in the runoff of rivers and springs
Normal	0	Events in which the author did not comment on weather conditions and where other non-meteorological events are found.
wet	+1	A strong and continuous rainy period which affects agricultural and other socio-economic activities
Floods	+2	Rains accompanied by floods

RESULTS

The current study utilizes the documentary evidence to describe consolidated documentary based chronologies of droughts and wet spells in Kenya over 134 years from the year 1845-1976 in order to extend our understanding of historical rainfall anomalies in the country beyond the instrumental recording era.

The drought spells

Drought is a normal feature of any climate, a temporary recurring natural disaster observed in all climatic zones due to rainfall deficiency in a given region over an extended period of time [70-72]. This phenomenon is rated as the costliest natural disaster of the world and affects more people than any other natural disaster [73]. The fact that the region's economy is largely agro-based and the agricultural production is predominantly rain-fed renders acute the vulnerability to drought [71].

The earliest recorded droughts in Kenya come from sporadic accounts of the travel writers aiming to the interior of the country from the coast. These records are not continuous, hence it was only possible to establish individual dry years from them and not possible to identify period of droughts. Nevertheless, the years identified as drier were 1849/50/51, 1868, 1875/76, 1879, 1883, 1888, 1897, and 1899 in the 19th century [74]. Dr. Krapf, noted the first dry spell on his journey to Tana River in 1850, along the Kamba land where people had moved to their neighbouring land in search for food and he describes the situation as follows:

26th [July, 1850]. "... arrived at the plain on the top we proceeded to the nearest village, and inquired after the kamba, Muiluwa Kiwui, with whom I was first to reside. We were told that he had quitted the village, in consequence of a famine from which the country was suffering through want of rain..." [74].

This drought was an extension of a relatively dry conditions experienced in 1849 due to delayed onset of the short rains. As Krapf passed by Kikumbuliu towards the end of the year 1849 he noted dry conditions with Kamba people devastated and associating a white man's visit with rainfall blessings as he says;

17th [November, 1849]. ...when we reached Kikumbuliu the Wakamba surrounded me...they often asked me if rain would fall and whether I could not make it come, as if I was a " *mundu wa mansi manene*" a man of great water (the sea coast), and had with me " *niumba ya mbua*" , an umbrella.

20th [November, 1849]. Today the first rain fell in Kikumbuliu, which places me in great favor with the Wakamba, although I tried to counteract the superstitious notions and ascribe all to God... [74].

Most of the early documentaries have concentrated on coastal and Kamba land (the current Machakos and Kibwezi). Hence, it was impossible to know whether these conditions were wide spread in the entire country. From 1851-1868 the traveler's records are not available, and information is quite limited, the records become more detailed from 1871 onwards. Nevertheless, a famine report shows chronology of droughts in Kitui, noting the oral traditions suggested that severe droughts were experienced in Kitui in 1836, 1868, 1887/88, and 1888 [58]. Although other droughts were bad, severest of all droughts was noted in Kitui to have occurred 1897.

It was a year of great scarcity, there was nothing available to eat resulting in an extensive famine, which lasted in Kitui for five years. Description of the state of this famine is shown below:

During this famine, people hunted alligator for food because the wild game had disappeared from the forests and caves because of severe drought [58].

Consequently, the famine was locally referred to as " *lwaya*" (alligator).

In the following year, the famine spread to all parts of Kitui driving people to resort to diverse and desperate methods of adjustment, as a result famine came to be referred to severally depending on how the people in the local areas perceived it. In Kitui central for example, it came to be known as *Nzaa nene* or *Nzaa kubwa* (big famine). Alternatively, it was known referred to as *ngomanisie* (all over or worldwide).

The year 1898 was the same year that the colonial post was opened in Kitui town and the drought experienced in this year was unique in the history of the Kamba in several ways. The colonial administration immediately initiated moves to provide food stuffs in selected markets areas to be purchased as famine relief. Rice was made available in Mumoni in Northern Kitui where the Kamba from Northern and central division exchanged bulls for rice. In Southern Kitui especially Kanziko location, people trekked to Kimbwezi in Machakos. In the southern Kitui therefore, the famine came to be known as (*Nzaa ya mvunga*) the famine of rice [58].

The writer quotes words used by Amber to present a vivid impression of how people in Kitui responded to this famine:

Animals became a main source of food; goats were held in store to be exchanged for grain. Men turned avidly to hunting, large groups from both sides of the Tana even met at the River to organize the killing of hippos. All kinds of fruits and berries became dietary staples, and small children spent their day as foraging for these and the roots called (*ngatu*) that were prepared and eaten. However, such actions were only stopgap measures, they could not possibly support people through famine lasting several years. Indeed, the traditions recall that people were soon reduced to eating the skins that they slept on, their quivers, and even the urine soaked slings used to carry babies [58].

Nevertheless, evidence from other records show while Kitui was severely dry there were other areas, which had food such as the Kikuyu land. For instance, in such areas food could be work for as shown below:

... because of hopelessness of the situation, the Kitui A.D.C, Mr. C.R.W Bane accompanied the caravan of about 5,000 Kitui Kambas in search of food across river Tana to Kikuyu land. This traditional mode of coping with scarcity was successful as usual. However, the strugglers were attacked by people identified as Kikuyu, robbing them of food they had so painfully acquired and carried. Angered by this Mr. Bane petitioned for a punitive military expedition against the Kikuyu [58].

This gives an impression that these droughts were not being experienced uniformly in the whole country. This famine continued until 1902, documentary observations provide interesting observations and perceptions of what transpired during the recurrent droughts. One of the missionaries located at Machakos

saw all rampage caused by this famine which coincided with the building of the railway, consequently the building activities being interfered with by the great hunger. By 1901, the famine had greatly affected people causing massive deaths as described by a missionary below:

The scenes around our mission station were appalling. Skeleton were tottering hither, thither with every bone, and joint in their body exposed to view. No matter where one went, corpses strewed the tracks. Little skeleton babies were found crying by the dead bodies of their mothers.

By 1902, the situation was completely devastating in the whole country. Deaths were wide spread, people searched for help though helplessly died on their way as shown below:

At this time the railway, which the government was building from the Coast to Lake Victoria Nyanza...was now used in saving the lives of ten thousands of native savages. Over the stretch of rails which already had been laid the Government brought up large quantities of Indian rice and opening free food depots at various forts in the country, distributed food to those wrecks of human beings. Some reached the area of distribution too late, and soon passed away, while hundreds ravenously bolted the uncooked grains and immediately died, but withal many thousands of lives were saved. The train which the savages had called 'The great serpent', to whose advent they had attributed the famine, became, in the goodness of God, the means of salvation.

The dry conditions ended 1903 with good rains, the anguish which lasted all these years diminished. The other notable droughts in the documentaries spanned in 1918/19, 1928, 1934-35, 1944, 1972, and 1975. The 1918/19 drought was widespread with severe consequences particularly to the natives because the colonial government had now settled, putting much emphasis on development projects. Additionally, the drought had been accompanied by small pox, meningitis and other killer diseases, which increased the anguish among the native. In his survey research noted the following:

... Even in 1918-19 when there were widespread famine and several outbreaks of smallpox and other killing diseases throughout Kenya, the government was less concerned with improving food production in the rural areas than with recruiting laborers for the European farms. According to Ainworth, at least 155,000 people died from famine in 1918. Many others died from smallpox and others diseases [75].

... in 1918, the famine which was experienced resulted from the failure of 1917 November rains and 1918 April rains...The famine was nicknamed Mukunakyongo (That which beats the head), because during the famine, many people were struck by severe headache probably meningitis, which caused death. The famine was also referred to Vita-kuu (the big First World War)... the head disease is said to have started from among men who had just returned from the war [58].

This drought seems to have extensively affected most of the East African region as described in a Tanganyika hand book.

It was difficult for those of today to visualize the state of the territory after the 1914-1918 war. The territory's economy, its

communications and its inhabitants had been disrupted by the East African campaign and Tanganyika did not escape the influenza epidemics of 1917-1919. Which were estimated at time to have caused 50,000 and 80,000 African deaths.

...in addition failure of rain in 1919, caused disastrous famine in what is now central province, so that even in 1924 there were nearly as many skulls scattered over the countryside between Kondoa-Irangi and Dodoma, the remains of some of these who had tried to walk to the central line to fetch food there provided by the government as there were skulls of horses which had been so freely used by South African forces and which died of trypanosomiasis and other diseases.

In 1928/29, there was also a notable drought, which caused massive migration of people from Kitui to other areas, which were more food, secure. The drought was brought about by a combination of locust swarms and less rainfall. In January that year, the A.D.C. Mr. Devonport acknowledged extensive destruction of vegetation by locust swarms, which marked the beginning of the existence (Mang'alata), parches of bare ground, completely denuded of vegetation, which the colonial administration attributed to overstocking. The vegetation took a long time to rejuvenate causing the drying up of springs and streams on the hillsides. The land remained with only tree trunks without vegetation causing population to be panic-stricken (Colony and protectorate of Kenya Annual Report of the Department of Agriculture for the year ended 31st December 1928) [58]. The situation is much more described below:

The local administrative officials estimated that 30,000 people from northern Kitui especially Tharaka and Mumoni crossed river Tana into the neighboring Kikuyu districts. An additional 5,000 people left Southern Kitui for coast settlement such as Mariakani and Mombasa' (Colony and protectorate of Kenya Annual Report of the Department of Agriculture for the year ended 31st December, 1928).

Such migration was observed again with recurrence of another great drought in 1934/35 triggered by failure of rains in 1934, which had far-reaching effects on the lives of people and on public policy in the district. Unlike previous famines, which caught the local administration in Kitui unaware, a lot of food had been imported from the other districts and stock piled awaiting eventualities. However due to severity of the drought, the famine was so wide spread that the stockpiled food was not sufficient and in 1935 a significant number of able bodied men left the district to provide migrants labor elsewhere, especially in Mombasa [58]. By virtual of food being imported from other districts it is an indication that sometimes the famines were not being experienced in the whole country especially in the highlands. Kitui district is one of the vulnerable semi-arid areas in Kenya, which has had frequent drought cases. Due to this, there is more literature on famines compared to the less vulnerable zones in the country. The 1934/35 drought lasted for more than two years, due to devastation people came up with different coping strategies as indicated below:

During the year, many cattle died due to tsetse fly and of lack of pasture and water... It had been nature's contribution to the destocking process which prolonged persuasion or seizure of livestock had not achieved... people realized that by collecting livestock bones, they could sell them to Asian traders at various

markets centers. The Asians would then in turn sell them maize flour. The famine therefore referred to as Nzaaya Mavindi (famine of bones)... £50,000 worth of food was made available in Asian shops to purchase with money received from the sale of livestock and livestock bones. In that year, 20, 698 head of cattle and 63, 718 head of small livestock were exported on hoof through officially arranged auctions. In addition to the measures famine relief was provided at schools, dispensaries and other public centers...Tax exception was considered for the first time. A family with a large number of huts (wives and children) and short of food or cattle was eligible for partial remission with a hope that would facilitate their ability to buy food [58].

There were several other droughts years in Kenya, but the famines were not only attributable to low rainfall amounts but also outbreak of locusts and Tsetse flies, which destroyed the crops rendering farmers helpless. For instance, some records such as Baringo District Annual report (1944), DC/BAR/1/4, KNA Nairobi, Akong'a (1982) and Colony and protectorate of Kenya, Agricultural Department Annual Report, 1944 give an indication that the hardships experienced in 1944-1946 were not only caused by decreased rainfall amount, but also locusts outbreak which lasted for more than three years. These records give the following details about these droughts.

The outbreak of the swarming phase of Desert Locust (*Schistocerca gregaria*) which began in December, 1942, continued throughout 1945 and by the end of the year there was still no indication in the East African area that the outbreak was diminishing (Baringo District Annual report 1944, DC/BAR/1/4, KNA Nairobi):

...In the first six months of 1944, particularly in the plain areas was a period of drought and hardships with half the average rainfall. This resulted to a great scarcity of grazing and much movement of stock in March, persistent trespass by *Kamasia* stock in the Solai area led to complaints by solai farmers Association' (Colony and protectorate of Kenya, Agricultural Department Annual Report, 1944).

... owing to persistent droughts and locust swarms, food shortages continued to be experienced in 1944. During that year, 48,000 bags of maize were imported and sold, especially in the July-December period. In the following year, 9000 bags of maize were also imported and sold at a price of Sh.10.50 per bag in the Northern Location. Moreover, the maize and maize flour provided was quite unusual. It was red in colour. The famine therefore came to be called (Katune) Red (Colony and protectorate of Kenya, Agricultural Department Annual Report, 1944).

The wet spells

Having traced certain dry years and drought periods attention will shift to the wetter periods noted in the documentaries. The wetter periods are often more difficult to identify using this methodology [44]. The dry periods have serious long-term consequences occurring over a number of years, compared to sudden isolated and short-lived wet spells. This again is probably a result of the fact that their effects are not as negative as those associated with droughts. Therefore, such occurrences are not recorded in as much detail although severe weather such as floods will be noted. Despite

these difficulties, the year 1924, 1926 and 1951 stood out as wet years, with severe storms being experienced in most of the country. The observations were well noted in the colonial record especially, the extremities experienced in 1951 when excellent harvests were registered in most parts of the country as described below:

...the year 1924 will be a memorable one in respect of the confidence which it has restored in agricultural industry, and the prosperity which it has brought to all sections of the community. The reward of development in the post-war period is now being reaped.

After one year, better rains recurred in the whole country in 1926 during the long rainfall season, although to some extent it affected the crop outputs in some areas. On the other hand, perennial crops such as coffee benefitted from the heavy rains and good harvests were expected in the following season as the records from the annual reports show below:

Rainfall was generally above normal and on the whole it was a favorable season, though in some districts crops suffered from an excess of rain. Of the main crops, coffee showed some improvement over the previous season, and the condition of the trees gives promise of heavy crop next season. The yields of maize were high in most districts, though disappointing in one or two because of weather conditions. Over the country as a whole fair crop of wheat were obtained. In native Reserves fears were entertained for a time in regard to food supplies but except in the Eastern part of North Kavirondo crops were sufficient to ensure the sustenance of the people, until the new season's plantings were well advanced. Market prices of some agricultural exports fell slightly towards the latter half of 1926, notably in case of maize, coffee, cotton, and sisal, making it more than ever necessary that the cost of production should be closely watched (Colony and protectorate of Kenya Annual Report of the Department of Agriculture for the year 1926).

The year 1951 was marked by exceptionally heavy rains in both long and short rain seasons. During the short rains there were strong hailstorms in some areas such as Fort-Portal as noted by one of the Rift Valley Province District Commissioner in an appeal letter for flood data in May 1951 and a letter by a meteorologist in charge to the Director East African Meteorological Department in September 1951 describing the wet conditions as follows:

25th-26th [April, 1951]. 'There was a heavy rain storm over Nairobi, accompanied by some thunder. Most of the rain fell between 2300 hrs and 0200 hrs. E.A.S.T. and as the storm was virtually stationary over the Centre of the city area, there was a rapid concentration of water into Nairobi River which caused considerable flooding and damage.

8th [May, 1951] '...the recent floods in Kenya have been quite exceptional. In a number of cases, all previous records have been broken. The Tana at Garissa rose foot higher than on any previous occasion since records were kept' (District commissioner, Rift valley province, a letter appealing for flood Data, PCNKKU/2/20/3).

Rainfall for the year was well above average in all main agricultural areas. Both the long and the short rains were good, the latter everywhere persisting far into December. During the short rains

hailstorms were also experienced in Nairobi as shown below:

[3rd September, 1951]. Unexpected thunderstorm associated with hard hail occurred at station at about 14.28 hours local...

some tree branches began to break off. After 1-hour period, rain was measured and was found as 3inches fall within 1 hour... We went down the valley near the station just to check whether the hailstones or ice, which fell, had been melted or not. But

Table 3: Rainfall event conditions in different years

Rain-year	Average rainfall conditions	Ordinal Index	Specific weather event
1845-46	Normal	0	No unusual event
1847-48	Normal	0	No unusual event
1848-49	Normal	0	No unusual event
1849-50	Relatively dry	-1	Late onsets of both long and short rain seasons (6 th April and 20 th Nov. 1849) respectively
1850-51	Very dry	-2	People in Kamba land had quitted villages because of famine and river volumes decreased
1860-61	Normal	0	No unusual event
1868-69	Very dry	-2	Severe drought in the entire country; in both seasons rainfall failed
1869-70	Normal	0	No unusual event
1875-76	Relatively dry	-1	Marked decrease of rainfall in most reporting stations
1879-80	Very dry	-2	A severe wide spread famine
1880-81	Normal	0	No unusual event
1883-84	Very dry	-2	Severe famine
1887-88	Normal	0	No unusual event
1888-89	Relatively dry	-1	Water scarcity and lack of food because of famine in Kamba land (Kimbwezi)
1890-91	Normal	0	No unusual events
1891-92	Wet	1	Wet, high rains at the coast
1897-98	Very dry	-2	Great famine, notably in Kitui which lasted for five years
1898-99	Dry	-1	Dry, but severe drought and famine in Kitui
1899-1900	Wet	1	But, great famine noted in Kitui
1900-01	Very dry	-2	Drought but unexpected rainfall occur at the end of December
1901-02	Very dry	-2	Drought in Kitui
1902-03	Very dry	-2	No rains at all
1904-05	Relatively wet	1	High record in Kitui relative to 1936 records
1906-07	Very Wet	2	Wet from SPI indices
1908-09	Normal	0	No unusual event
1912-13	Normal	0	Abundance of rainfall in the March-May (long) rain season
1915-16	Relatively dry	-1	Severe drought in the first quarter of the year until rainfall broke out in mid-April then the October-December(short) rain season fails
1916-17	Relatively dry	-1	Little and unevenly distributed long season rainfall, failure of the October-December rains.
1918-19	Very dry	-2	Severe widespread famine and drought due to failure of Oct-Dec rains in 1917 and April rainfall for this year.
1919-20	Very dry	-2	Widespread famine and several outbreaks of smallpox and other killing diseases throughout Kenya
1920-21	Relatively dry	-1	Low and poorly distributed rainfall in both seasons
1921-22	Relatively dry	-1	Rainfall was relatively below average
1922-23	Very wet	1	Heavy long rain season
1923-24	Normal	0	No unusual events
1924-25	Relatively Wet	1	Rains were satisfactory in most of the country with great harvests throughout the year
1928-29	Very dry	-2	Great drought and Swarms of Locusts destroy all vegetation leading to drying of springs and streams
1929-30	Relatively dry	-1	Low rains; Severe famine in Kitui
1931-32	Normal	0	No unusual events other than continued locusts destruction in most of the country
1932-33	Relatively dry	-1	Below average rainfall some parts such as Kitui suffer famine
1933-34	Very dry	-2	The rainfall for the five drainage areas in the colony was 25% below normal for the year 1933
1934-35	Very dry	-2	Failure of rains leading to wide spread famine
1935-36	Very dry	-2	Failure of 1934 and 1935 rains leading to a great famine
1936-37	Normal	0	Heavy rains with Kitui registering the highest rainfall figures (75 inches) since 1904 and no more events registered
1937-38	Normal	0	No unusual events
1938-39	Normal	0	No unusual events

1939-40	Relatively dry	-1	The rainy seasons were shorter than usual and there was scarcity of showers in the dry seasons
1940-41	Relatively dry	-1	Adequate rainfall in the first half of the year; later months somewhat deficient, short rains fails
1941-42	Normal	0	No unusual events
1942-43	Relatively dry	-1	Below average short rains
1943-44	Relatively dry	-1	Drought in the early half of the year, particularly in the plain areas with half the average rainfall
1944-45	Relatively dry	-1	Persistent drought and locust swarms increase famine intensity in 1944
1945-46	Relatively dry	-1	Rainfall was slightly below average over Kenya, the main rains started late and were below average, short rains were confined to September only the followed by dry weather until April (1946)
1946-47	Relatively Wet	1	Drought in the early quarter year; above average short rains extending to the beginning of the long rain season in 1947
1947-48	Relatively wet	1	Heavy long rains followed by below average short rains
1948-49	Relatively dry	-1	Conditions most variable, very poor in the drier areas as to above average in wetter areas. Total rainfall a little below average; long rains set on in March and were generally below average but short rains rather above average
1949-50	Relatively dry	-1	The year from a purely production viewpoint was a disappointing one. Drought conditions were widely prevalent
1950-51	Relatively wet	1	Above average rainfall in all main agricultural areas. Both the long and the short rains were good, the latter everywhere persisting far into December; excessively wet conditions in the highlands
1951-52	Relatively dry	-1	Prolonged 1951 short rains; late onset of long rain in most of the country, with some areas receiving below average annual rainfall
1952-53	Relatively dry	-1	Below average rain in most of the country with exception of Nyanza which received above average in most months
1953-54	Relatively dry	-1	Below average rainfall in most of the country with exception of the coastal areas; the long rains were poor and amounts were substantially below average
1954-55	Relatively dry	-1	Below average short rains; Some long rains
1955-56	Normal	0	No unusual events
1956-57	Normal	0	Climatic conditions were reasonably satisfactory throughout the year. No unusual events
1957-58	Relatively wet	1	Remarkable weather for exceptional rainfall in January; soil moisture was generally plentiful throughout the year
1958-59	Very wet	2	The total rainfall for the year was well up to average or above average except for areas along the coast
1959-60	Relatively dry	-1	Long rains set on (19 th March) but unevenly distributed; drought conditions widespread in the entire country during short rains, particularly in coast areas
1960-61	Relatively dry	-1	Heavy long rains commencing on 14 th March; Failure of the short rains extending to the first quarter of 1961; widespread drought
1961-62	Very wet	2	Heavy and very persistent short rains which started on 11 th Oct. continued without a break until Christmas
1962-63	Very wet	2	1962 was a wetter than average year in all areas except the Coast region
1963-64	Very wet	2	1963 was wetter than normal in all parts of Kenya; except in Muhoroni where less than average rainfall was registered
1964-65	Relatively dry	-1	Drought in most of the year; the long and short rains were below average in most parts of the country
1965-66	Relatively dry	-1	Rainfall was plentiful only during October and November while the March to May rains failed in most areas
1966-67	Relatively dry	-1	Good long rains records but short rains fails after good set on in October, the worst rainfall deficits from the December normal since 1952.
1967-68	Very wet	2	Significant flood in some parts of Kenya on (11 th /5/1967); Prolonged substantial long rain season
1968-69	Relatively wet	1	Plentiful annual rainfall throughout Kenya up till September; too much rain cause a famine especially in Kitui like that of 1960 and 1961
1969-70	Relatively dry	-1	Lowest April rain in Kenya since 1942; fairly early heavy onsets at end of February continuing to early march then long dry spells alternated by rain storms.
1970-71	Very wet	2	Above average or average rainfall was reported in most areas, wettest being Nyambene, Meru (806.5 mm, 101%) followed by Limuru (566.4 mm 189%), Butere (371.7, 133%)
1971-72	Relatively dry	-1	Rainfall inadequacy; a famine in Kitui and some other parts of the country
1972-73	Very dry	-2	The year was characterized by unevenly distributed rainfall which was much below average
1973-74	Relatively dry	-1	Exceptionally dry year; unusually wet January and February; then short unusually light long rains in April and May, followed by a very short Oct-Dec season
1974-75	Relatively dry	-1	Generally a good year in spite of the early drought and poor distribution of rainfall
1975-76	Very dry	-2	The rainfall was generally lower than that for 1975 which made 1976 the driest of the last three years

found some big stones lying there still which I anticipate will take three or four days more to be melted by sunshine' (A letter

from the Meteorologist in Charge to the Director East African Meteorological Department, Rs/19/21 KNA Nairobi) (Table 3).

CONCLUSION

Using documentary evidence the study establishes that during the 19th century dry years prevailed in 1849/50/51, 1868, 1875/76, 1879, 1883, 1888, 1897, and 1899. While, in the 20th century, droughts experienced between the period 1900-1976 occurred in 1918/19, 1928, 1934/35, 1944, 1972 and 1975. The study establishes that the 20th century had more experiences of severe and prolonged droughts than any other period of the study. Most of these droughts prevailed from mid 1940s, 1950s and 1970s, some lasting for more than four years. On the other hand, the wettest periods during the study were experienced in the 1870s and 1960s. More specifically, the wet years were, 1878, 1899, 1905, 1912, 1916, 1922, and 1929 and 1961. Notably, the extremely wet years during this study period were 1878 and 1961-63. The study was limited to the period with documentary evidence, however a calibration of the descriptive chronologies with relevant meteorological data to enhance the documentary driven weather chronology can also been employed to extend this analysis to the 21st century.

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