UNIVERSITI PUTRA MALAYSIA

DETERMINANTS OF DROUGHTS AND ITS IMPACT ON SECTORAL OUTPUT GROWTH AND INCOME INEQUALITY IN AFRICAN COUNTRIES

BASHIR AHMAD BUGAJE

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By

BASHIR AHMAD BUGAJE

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

June 2020

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DEDICATION

With deep sense of appreciation and gratitude, I dedicate this work to my parents and family. My father Bashir M. Bugaje and my mother Prof. Mairo A. Bugaje who have supported me all my life.

To my wife, Habiba and my daughter, Fatima for their love and patience shown throughout this journey.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

DETERMINANTS OF DROUGHTS AND ITS IMPACT ON SECTORAL OUTPUT GROWTH AND INCOME INEQUALITY IN AFRICAN COUNTRIES

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June 2020

Chairman : Professor Muzafar Shah Habibulah, PhD
Faculty : School of Business and Economics

Droughts are natural hazards that result from reduction in rainfall water and its storage capacity which adversely affects agricultural sector and have a potential spillover effect on other economic activities. Africa has the highest occurrences of this phenomena and the second highest number of people affected within the 20th century. The region has the least natural and artificial surface storage capacity relative to other regions in the world and the countries in the region heavily depend on agricultural sector for employment opportunities and uses rainfall water as input of production in farming activities. The economic and social implications of these events in the region will increase due to climate change and vulnerability of agricultural sector.

Global warming will increase climatological natural hazards like droughts around the world. Although, the continent lags behind all other regions of the world in terms of total CO2 emission from fossil fuel and per capita CO2 emissions, the continent has experienced an upsurge in the number of climatic extreme events. This calls for concern and research into the area to understand the economic implications of these events on the key sectors of the region. Drought as an example of climatic extreme event is likely to increase the disparity of income between different countries because of the likelihood of affecting the income of households in some particular sectors relative to others. In this study, drought has been measured as a percentage of normal precipitation, meaning when the calculated value of percentage of normal precipitation is lower than the threshold of 100%, there is an existence of drought and when the percentage of normal precipitation is equal or higher than the threshold of 100%, there is no existence of drought.

The general objective of the study is to examine the determinant of droughts and its impact on sectoral output growth and income inequality in African countries. Objective one specifically investigates the impact of droughts on sectoral output growth for the period 1980 to 2014, for 44 African countries. The impact of droughts on income inequality and the determinants of drought fatalities in the region were investigated in objectives two and three respectively using ~~a~~ dataset from 2006 to 2014 for 42 and 35 African countries respectively. The preferred technique used was Generalized Method of Moments (GMM) to estimate the models of all the three objectives of the study. However, two-step system GMM estimator was used for making inferences in the study. Diagnostics and robustness checks were conducted for all the models to ensure reliability and efficiency of the estimates.

The estimated results of the model in objective one revealed that droughts significantly reduce agricultural, manufacturing, mining and utility sectors' output growth. However, drought does not affect the construction sectoral output growth. This means the former sectors are impacted by drought, while the latter sector is immune to this phenomenon. Results in objective two showed that droughts significantly increase income inequality, thus, confirms the assertion that drought increases the disparity of income between different groups and countries in Africa and dependency on agriculture sector positively related to income inequality. Lastly, results for objective three ~~result~~ showed that government size reduces drought fatality while dependency on agriculture activities and the low level of financial development increases drought fatalities.

The general findings of the study suggest that droughts disproportionately affect different economic sectors. The results also suggest that over dependency on agricultural activities had hindered the structural transformation of the sector and policymakers needs to design programmes to fast track agricultural transformation. The general policy recommendation of the study is that African governments should focus on agricultural transformation policies to mitigate the dependency on agricultural sector and further diversify its economic structure from agricultural activities. In the short run, adaptive capacity measures should be in place to mitigate the impact of these phenomena. Policy makers should build more reservoirs and irrigation systems to increase water storage capacity for agricultural activities and disseminate information on the expected timing of rainfall to farmers by mobile phones to optimize the planting and yield of crops.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENENTU KEMARAU DAN IMPAK NYA TERHADAP PERTUMBUHAN OUTPUT SEKTORAL DAN KETAKSAMAAN PENDAPATAN DI NEGARA AFRIKA

Oleh

BASHIR AHMAD BUGAJE

Jun 2020

Pengerusi : Profesor Muzafar Shah Habibulah, PhD
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Kemarau merupakan bencana alam yang di sebabkan oleh kekurangan air hujan dan kapasiti untuk menyimpan air yang akan memberi kesan buruk terhadap sektor pertanian dan membawa kepada kesan limpahan terhadap aktiviti ekonomi yang lain. Afrika merupakan negara yang tertinggi menghadapi kejadian ini dan kedua tertinggi dari segi jumlah orang yang terkesan dalam abad kedua puluh ini. Wilayah ini mempunyai kapasiti simpanan permukaan tiruan dan semulajadi yang terrendah di bandingkan dengan wilayah lain di dunia, dan negara dalam wilayah ini tersangat bergantungan kepada sektor pertanian untuk peluang pekerjaan dan penggunaan air hujan sebagai input dalam aktiviti pengeluaran pertanian. Implikasi sosial dan ekonomi oleh bencana ini akan meningkat di sebabkan perubahan iklim dan kerentanan sektor pertanian.

Pemanasan global akan meningkatkan bencana alam klimatologi seperti kemarau di serata dunia. Walau pun benua ini tertinggal kebelakang di bandingkan dengan wilayah lain di dunia dalam hal pelepasan CO2 daripada bahan api fosil dan pelepasan CO2 per kapita, benua ini telah mengalami lonjakan dalam jumlah kejadian iklim yang melampau. Justeru itu, perhatian dan penyelidikan untuk memahami implikasi kejadian ekonomi ini terhadap sektor penting dalam wilayah ini adalah amat di perlukan. Kejadian iklim yang melampau seperti kemarau berkemungkinan akan meningkatkan jurang pendapatan di antara negara kerana ia menjejaskan pendapatan isirumah dalam sesuatu sektor di bandingkan dengan sektor yang lain. Dalam kajian ini, kemarau di ukur sebagai peratusan pemendakan yang normal yang bermaksud apabila nilai peratusan pemendakan normal adalah lebih rendah daripada satu tahap ambang 100%, maka akan berlaku keadaan kemarau; dan apabila peratusan pemendakan normal menyamai atau lebih tinggi daripada tahap ambang 100%, maka tiada berlaku kemarau.

Objektif kajian adalah untuk meneliti penentu kemarau dan impak nya terhadap pertumbuhan output di peringkat sektoral dan ketaksamaan pendapatan di negara Afrika. Objektif satu khusus nya menyelidik kesan kemarau terhadap pertumbuhan output benua ini di peringkat sektoral menggunakan data daripada tahun 1980 hingga 2014 untuk 44 negara Afrika. Objektif kedua dan ketiga masing-masing menyelidik kesan kemarau terhadap ketaksamaan pendapatan dalam wilayah ini menggunakan data daripada tahun 2006 hingga 2014 untuk 42 negara, dan penentu kepada kematian akibat kemarau untuk 35 negara. Teknik kaedah momen umum (GMM) di pilih untuk menganggarkan model untuk ketiga-tiga objektif kajian. Walau bagaimana pun, penganggar GMM sistem dua-peringkat di gunakan untuk membuat kesimpulan hasil kajian. Ujian diagnostik dan kemantapan di lakukan ke atas semua model untuk memastikan kebolehpercayaan dan kecekapan anggaran.

Hasil penganggaran model untuk objektif satu mendedahkan bahawa kemarau dengan ketara mengurangkan pertumbuhan output sektor pertanian, perkilangan, perlombongan dan utiliti tetapi kemarau tidak member kesan terhadap pertumbuhan sektor pembinaan. Ini bermakna sektor di atas adalah terkesan terhadap kejadian kemarau, manakala sektor pembinaan tidak terkesan oleh fenomena ini. Hasil dapatan objektif kedua menunjukkan bahawa kemarau meningkatkan ketaksamaan pendapatan dengan ketara dan kebergantungan terhadap sektor pertanian meningkatkan ketaksamaan pendapatan. Ini membuktikan bahawa kemarau meningkatkan jurang pendapatan di antara negara di Afrika. Akhir sekali, hasil dapatan objektif ketiga menunjukkan bahawa saiz kerajaan mengurangkan kematian akibat kemarau manakala kebergantungan terhadap aktiviti pertanian dan tahap pembanguan kewangan yang rendah meningkatkan kematian akibat kemarau.

Penemuan umum kajian mencadangkan bahawa kemarau secara tidak seimbang mempengaruhi pelbagai sektor ekonomi. Hasil kajian juga mencadangkan bahawa terlalu bergantung terhadap aktiviti pertanian telah menghalang transformasi struktur sektor ekonomi dan pembuat dasar perlu mereka-bentuk program untuk mempercepatkan transformasi pertanian. Implikasi dasar umum kajian ini adalah kerajaan negara Afrika patut menumpu kepada dasar-dasar transformasi pertanian untuk mengurangkan kebergantungan terhadap sektor pertanian dan seterusnya mempelbagaikan struktur ekonomi selain daripada aktiviti pertanian. Dalam jangka pendek, tindakan kapasiti adpatasi semestinya di sediakan untuk mengurangkan kesan impak fenomena ini. Pembuat dasar perlu membina lebih banyak takungan air dan sistem pengairan untuk meningkatkan kapasiti penyimpanan air untuk keperluan aktiviti pertanian dan penyebaran maklumat terhadap ketetapan hujan yang dijangkakan kepada petani melalui telefon bimbit untuk mengoptimakan penanaman dan kehasilan tanaman.

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This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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ARC	African Risk Capacity
CRED	Centre for Research on the Epidemiology of Disasters
EM-DAT	Emergency Event Database
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
GFDFRR	Global Facility for Disaster Reduction and Recovery
GMM	Generalized Method of Moments
IMF	International Monetary Fund
LDC	Least Developing Countries
MMU	Mining Manufacturing and Utility sectors
SDG	Sustainable Development Goals
SWIID	Standardized World Income Inequality Database
UN	United Nations
UN-EHS	University Institute of Environmental Human Security
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organisation
UNSD	United Nations Statistical Division
WDI	World Development Indicator
WMO	World Metrological Organisation
WRRH	Wholesale, Retail, Restaurant and Hotel sector

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Climate[1] change is already upon us, as and it will likely get worse. The planet will continue to warm even without any further emission, and further emissions are certainly on the way because of expansion of economic activities. Many countries have already begun to experience the consequences of climate change in the form of an increase in temperature and reduction of rainfall. In December 2018, a panel of scientists under the auspice of United Nations (UN) warned that there is only a dozen years left for global warming to be kept to the maximum temperature of 1.5°C, and unless something critical is done by policy makers around the world, it will have a major implication on environmental, economic and social activities. This is also because carbon from fossil fuel is widely accepted as one of the major contributor of global warming; and the emissions will significantly increase the risk of drought, flood, extreme heat, and poverty for over hundred million people around the globe (Jonathan, 2018).

In the present decade, the average global temperature of the first half of the year 2016 was recorded to be the hottest since 1880 around the world and the record is broken every year. Man-made activities have an adverse effect on environment, which mostly become disastrous considering its negative implications that may lead to total destruction of the natural environment. This could explain why countries are experiencing higher temperatures and extreme weather conditions in the form of disasters[2] such as droughts, heat waves, floods, storm surges, desertification encroachment and even threatening agricultural supply chains (Hallegatte et al., 2016).

Global warming is mainly caused because of combustion of fossil fuels (coal, oil, and natural gas), which ultimately increases emission of carbon dioxide (CO_2), as well as, other form of greenhouse gases that pollute the atmosphere (IPCC, 2007). In order to reduce the global emissions of CO_2, the Paris Agreement on climate change that was reached in December 2015 to maintain global temperature for this century below 2°C

[1] Climate is the statistical description in terms of the mean and variability of relevant quantities over a period ranging from months to thousands or millions of years. The classic period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often-surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system. Climate change refers to a change in the state of the climate that can be identified (i.e., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer

[2] Disaster refers to severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery.

above pre-industrial levels and to further aimed at limiting temperature increase to 1.5°C, was based on the envisaged climate change projection (UNFCCC, 2015). Although considerable uncertainty surrounds temperature projections, the scientific consensus predicts that without further action to tackle climate change, average temperatures could rise by 4°C or more by the end of the 21st century (IMF, 2017). In order to understand the implication on Africa's temperature, Figure 1.1 shows the average temperature change for Africa from 1960-2018. The figure suggests that average temperature change has been increasing within the continent, since 1976 and there has been a rise of temperature of about 1°C in 2018 relative to 1960 base year.

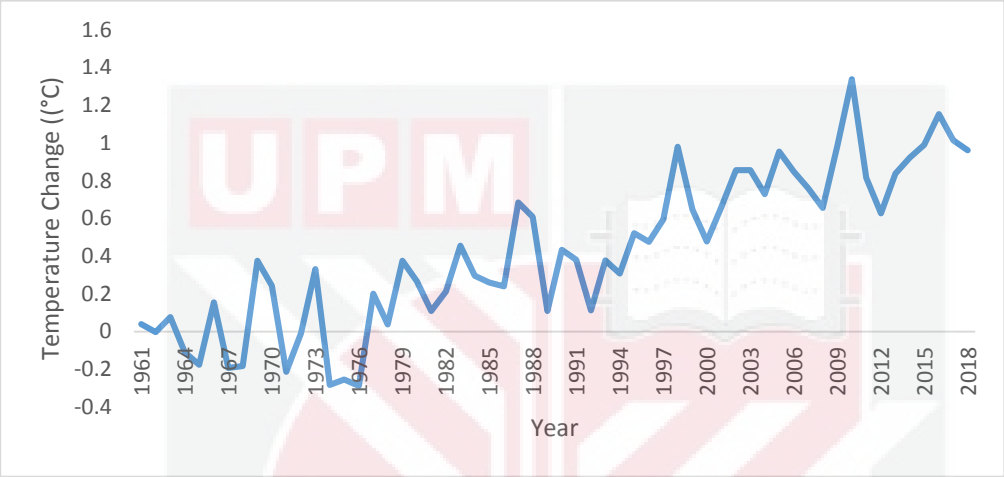

Figure 1.1 : African countries average temperature change for a metrological year
(Source: Climate Change Knowledge Portal and University of East Anglia, Climate Research Unit)

The most noteworthy point in the previous illustration is the marked spike in temperature in 1998, 2010 and 2016, relatively to other years. Although, the rise started in earnest in the 1970s, following a large increase in CO_2 emissions, most scientists agree that global temperatures are set to rise further, at a scale and pace very much independent on our ability to restrain greenhouse gas emissions, which is the central cause of global warming (IPCC, 2013). In addition, emissions in low-income developing countries are still a fraction of those in advanced and emerging market economies, in both aggregate and per capita terms respectively (See Figure 1.2 and Figure 1.3). Although advanced economies have managed to stabilize their overall emissions of CO_2 over the past decade, in per capita terms, they still contribute vastly in emission of CO_2 relative to the rest of the world, while the impact, in terms of increase in natural disasters, will be experience by developing countries, mostly situated in African continent.

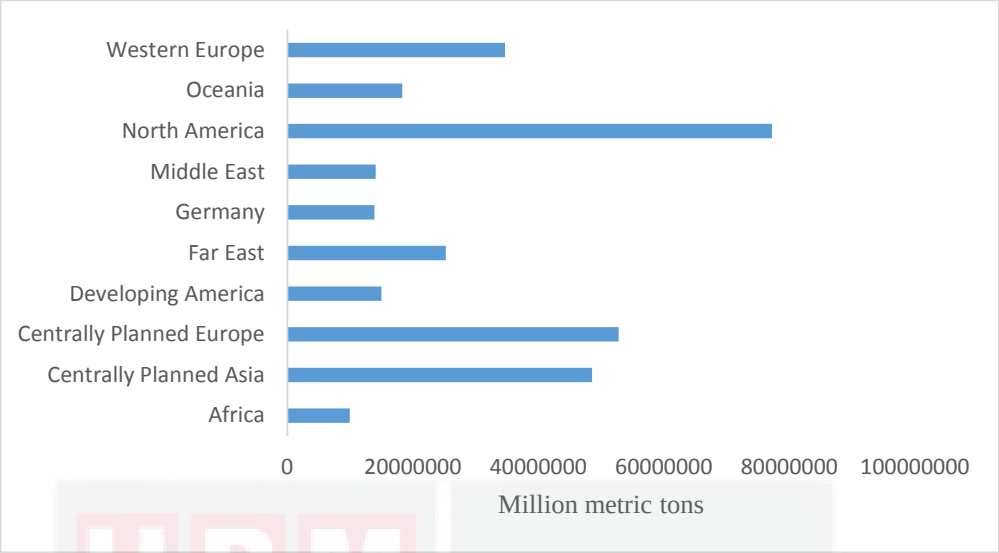

Figure 1.2 : Total CO_2 emissions from fossil-fuel and cement production 1960-2014
(Source: Carbon Dioxide Information Analysis Centre Database)

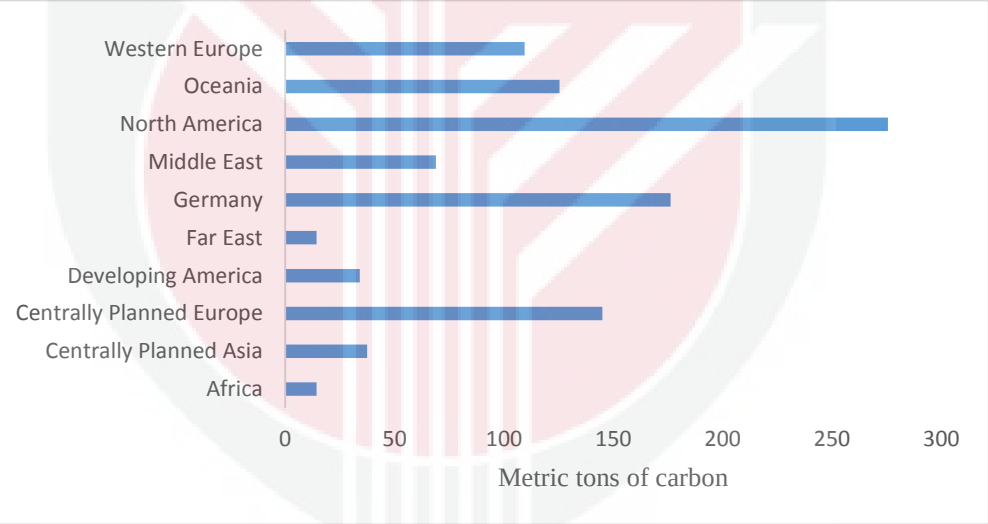

Figure 1.3 : Per capita CO_2 emissions by regions
(Source: Carbon Dioxide Information Analysis Centre Database)

In technical terms, Climate change[3] is said to be mainly caused by Greenhouse Gases (GHGs) such as Carbon dioxide (CO_2) emissions, Methane (CH_4) emissions, Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF6). However, out of these gases, CO_2 emissions account for more than

[3] Climate change is a change in the state of the climate that can be identified (for example, using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or because of human activity.

80% of global GHG emissions and as at 2010 fossil, fuel energy consumption contributed about 40% of the GHG emissions (Fay et al., 2015). Thus, CO_2 emissions, particularly, from primary energy sources is focused as the major contributor to climate changes that may eventually become a threat to human existence[4].

Environmental disasters witnessed in recent times across the globe that include: earthquake, flood, drought, desertification, wildfire etc. are a result of climate changes, because of an increase in temperature and reduction in rainfall. World Food Program highlights that recent natural disasters[5] such as the drought of 2016/2017 in Southern Africa increased the number of people affected to 40 million. From an economic point of view, Hallegate and Dumar (2014) alleged that a natural disaster should be referred to as an event that causes a fluctuation to the functioning of an economic system, with negative impact on assets, factors of production and output. Thus, the economic perspective on natural disaster captures the nuance that disaster might not be a natural event alone, but the impact is affected by the socio-economical, institutional, and demographic characteristics of the locality where they occur. Freire-Gonzåles et al. (2017) conceptualise these risk mitigation factors as indirect cost (such as the cost of setting up a new infrastructure, operating, and managing an infrastructure) because of natural disaster and cost that are induced to other sectors of the economy.

Natural hazards such as hurricanes, floods – may not be disasters. Rather it is their consequences and the ability of the local/national community/government to respond to them that determines whether an event is characterized as a natural disaster. For instance, if a cyclone washes over an uninhabited island in the Pacific, it is not a disaster, if the local community respond to mitigate the number of causalities. The important issue is the ability of local authorities to easily deal with the effects of flooding, hence, it is not considered a disaster. For it to be a natural disaster, it must overwhelmed the national government capacity to respond. In another instance, if a reduction in rainfall occurs during a particular season, and if the availability of irrigation facilities that makes it easier for local/national community/government to deal with it, this will not be considered a natural disaster. These events that may result into disasters can be categorised into: hydrological, metrological, geophysical, climatological, or biological disasters (see Figure 1.4).

[4] CO_2 emissions contribute about 80% of Greenhouse Gases (GHGs), leading to climate changes and global warming (WDI, 2015).

[5] Natural disaster is defined as an event, which overwhelms an economy's local capacity and necessitates a request for external assistance (CRED, 2008).

Figure 1.4 : Classification of natural disasters according to EM-DAT

The economic cost associated to damages from natural disasters can be broadly classified into direct, indirect, and secondary effect on an economy (Cavallo and Noy, 2011). The direct effect includes the damage to assets, such as, buildings, crops, and infrastructures, reduction of labour productivity and shortage of production input. On the other hand, the indirect effect focuses on economic loss to customers or suppliers of those affected by natural disasters through the supply chain. The secondary effect is of a larger effect on the welfare situation of an economy, because of the structural nature of an economy.

Various specific drought[6] definitions are given due to the shortage of rainfall over an extended period to measure the economic impacts, such as, on reservoir levels or crop losses. FAO (2015a) defines the hazard as the percentage of years when crops fail from lack of moisture in soil composition. In the same way, Benson and Clay (1994) define agricultural drought as reduction in moisture availability below the optimum level needed for a crop to optimally grow, during different stages of its growth cycle, resulting in an impaired growth and reduction in yield. In general, climatic condition of shortage of rainfall or/and an increase in temperature, resulting to dryness of moisture in the soil is the source of this type of drought.

On the other hand, Wilhite (1993) sees hydrological drought as an extended period characterized by a reduction in a country or region's water storage capacity, because

[6] Drought is generally defined as an extended period, a season, a year, or several years of reduction in rainfall compared to the statistical multi-year average for a region, that results in water shortage for some activity, group, or economic sector (NDMC, 2008).

of a prolong decrease in rainfall below the average mean within a geographical area of land. This type of drought affects the inland water navigations that may affect transportation sector and hydropower plants that may have an impact on electricity generation in a country. Perhaps, the reduction in water storage capacity of a country, through its underground storage capacity, dams, and reservoirs will have an lesser impact on economic activities within a geographical area, when a country has the capacity to call upon other regions in times of water scarcity, or has the technology for desalination of ocean water, or even recycling capacity for used water. Then the country can be able to mitigate the impact of hydrological type of drought on economic activities and water intensive sectors.

In order to quantify cost of natural disaster, most studies on the economic and human cost of disasters use data from the Emergency Disasters Database (EM-DAT)[7], which is managed by the Centre for Research on the Epidemiology of Disasters (CRED) (see. Cavallo and Noy, 2010; Loayza et al., 2012; Klomp and Valckx, 2014). For the purpose of this study and in order to measure the event and not the human impact as the after mentioned studies above, drought is measured as the percentage of normal precipitation. Percentage of normal precipitation is calculated by dividing actual precipitation by normal precipitation for the time considered and multiplying by 100. When the value is below 100 for a particular period, it means drought exist. However, when the value is greater than 100, it means drought does not exist within the specified period. It is recommended to have data of at least 30 years' worth for the calculation of normal period, so as to have an accurate normal precipitation (WMO, 2016).

Since the beginning of 20th century, more than 11 million number of people have been killed as a result of hunger and starvation from drought, 2 billion number of people have been affected as a direct result of this disaster, and US$136 billion worth of goods and services have been lost across the world, especially in terms of crops (see Table 1.1). Asian region had the highest number of people affected, with 1.7 billion people experiencing tremendous human suffering.

Table 1.1 : Drought across different continent from 1900-2016

Continent	Number of events	Number of people killed	Number of people affected	Economic Damages
Africa	297	867131	376205125	3484593
America	144	77	104310181	57773139
Asia	159	9663389	1756562029	37958065
Europe	42	1200002	15488769	25481309
Oceania	22	66	8034012	11526000
Total	664	11730665	2260600116	136223106

Source: EM-DAT database

[7] The international Disaster Databaase (EM-DAT) defines a natural disaster as an event, which is registered into the database, at least one of the following conditions must happened: 100 or more people are reported affected; or 10 or more people are killed; or call for international assistance; or declaration of state of emergency

The exhibition on economic damages in Table 1.1 is in line with Noy (2009) that argued the welfare impact of most natural disasters is higher in developing countries than in developed countries. This is because developed countries are likely to have more investment in infrastructure, including buildings, dams, and reservoirs to mitigate the impact of natural disasters. Consequently, Advance economies can be able to cushion the impact of reduction in water supply through investment in mitigation measures and in some cases the use of novel infrastructures.

Although, Africa incurred the least amount of economic damages as direct result of drought, due to lower economic activities, which constitutes around 2.6% of the world economic cost of damage from the catastrophe, the region hosts the second highest number of people affected from the phenomena, due to the lack of adaptive capacity. Table 1.1 suggests that the occurrences of droughts in Africa are higher than all other regions in the world between the periods of 1900 to 2016. The region suffers the highiest occurrences of droughts relative to other continents in the world possibly due to lower income per capita, with 297 reported occurrences of these phenomena, followed by 159 events in Asia, 144 events in America and 42 events in Europe.

Moreover, Figure 1.5 indicates the trend of occurrences of droughts across Africa, Asia and America and Europe. The Figure highlights that the occurrences of droughts peaked in 1983 in the African continent, with 17 countries experiencing the events. The African region is also reported to have the highest number of people killed, with an estimated number of 9.66 million people perishing from hunger. The general increase in number of people affected as a direct result of drought worldwide has resulted to higher social, economic and environmental implications, which has become far greater at this present two decades than in the past decades. In fact, the overall number of people affected by disasters has been growing by 6% each year since 1960 (CRED, 2008).

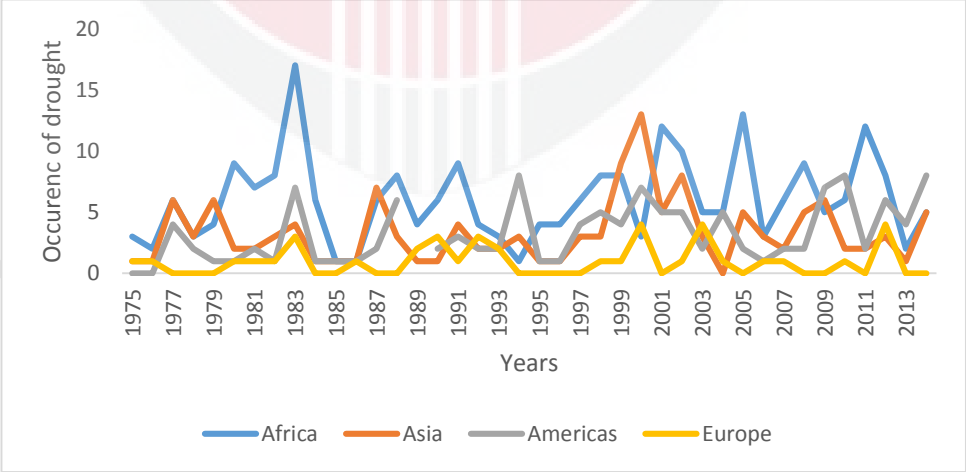

Figure 1.5 : Occurrences of droughts across continents between the periods of 1975 to 2014
(Source: Data from EM-DAT Database)

It is worth mentioning again that during the year 1983/1984 alone, 17 African countries that experienced drought including Morocco, Sudan, Cameroon, Congo, Sao Tome, Congo, Zaire Congo, Djibouti, Ethiopia, Kenya, Somalia, Lesotho, Zambia, Rwanda, and Tanzania. Rwanda and Kenya experienced consecutive drought years in 1983 and 1984. In a nutshell, droughts have both economic and social costs to many African countries, with the region having the highest occurrences of these phenomena in the world in the last century. In addition, Africa has the second highest number of people affected as a direct result of droughts. This accounted for 17% of the global share of people affected by drought. Moreover, in terms of number of people killed because of drought, 8% of people that perished are in the continent of Africa (see Table 1.1).

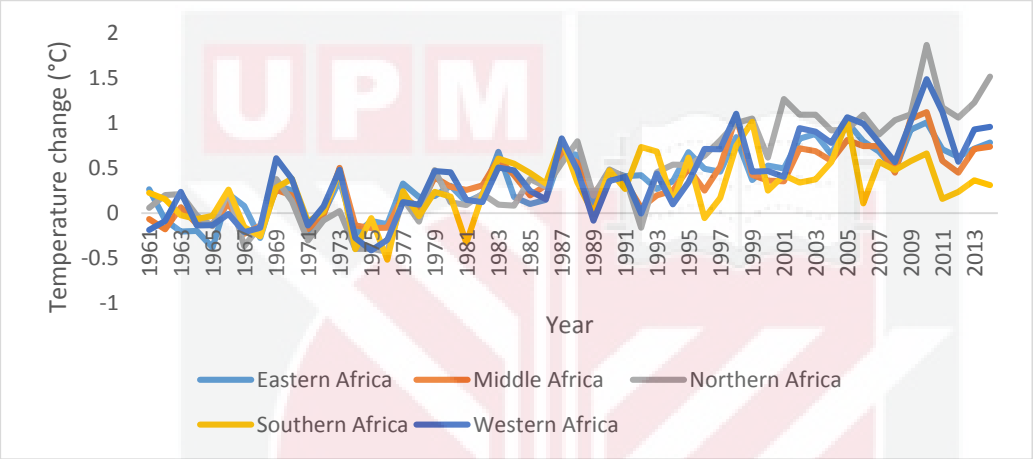

Figure 1.6 : Temperature change for a metrological years across regions in Africa from 1960-2014
(Source: Climate Change Knowledge Portal and University of East Anglia, Climate Research Unit)

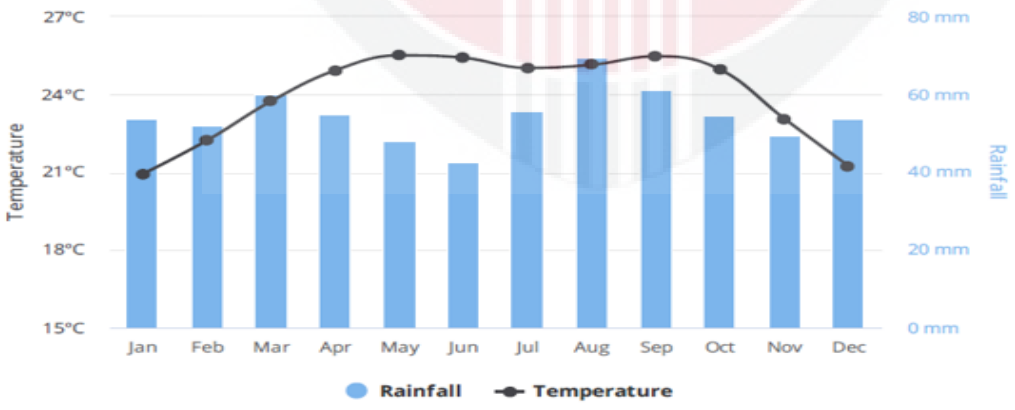

Figure 1.7 : Average monthly temperature and rainfall by months of Africa for 1901-2016
(Source: Climate Change Knowledge Portal and University of East Anglia, Climate Research Unit)

The impact of droughts is more pronounce in African continent than other regions in the world in terms of the magnitude of the number of people affected and killed,

because African countries are vulnerable to this disaster, due to high reliance on agricultural sector for subsistence farming, lower per capita income and limited number of infrastructures to mitigate the impact, that makes the economies vulnerable to achieve climatic resilient development (Benson and Clay, 1998). This principal type of disaster in Africa results from lower rainfall in the extensive arid and non-arid regions of the region and influences the ability of the soil to keep its moisture.

From an economic theory perspective, drought is not only an exogenous event, but also have an internal adverse supply effect[8], which consequently leads to a direct decline in agricultural production, employment and a reduction of export earnings, with a widespread losses of assets and fall in rural income of farmers (Benson and Clay, 1994). Although meteorological drought may result into a direct impact on agricultural production, it influence is felt mostly by the reduction of water supply, hydroelectric power generation, and the inefficiency of irrigation system of an economy that affects water intensive sectors of the economy. Consequently, droughts may have a higher impact on non-agricultural water intensive sector when there exist a level of linkage and interdependency between the agricultural sector and other water intensive sectors of an economy.

Stylized facts on distribution of droughts in Africa countries

African continent has five sub-regions; North Africa, Central Africa, West Africa, East Africa, and Southern Africa. In terms of the number of events, the Eastern Africa region has the highest number of occurrences of drought since 1900. In addition, the region has the highest number of people affected reported to be around 223 million people (see Table 1.2). Moreover, the number of people killed as a direct result of a drought in the eastern region is estimated to be 523,561 people. As a result, eastern Africa has the highest number of fatalities in Africa. On the other hand, Southern Africa region incurred the highest economic damages valued at US$1.6 billion (see Table 1.2).

Table 1.2 : Summary of drought event recorded in Africa from 1900 to 2016

Region	Number of events	Number of people killed	Number of people affected	Economic Damages (000)
North Africa	18	150012	31153400	900100
Central Africa	25	3058	11379800	84500
West Africa	96	170000	84429257	507354
East Africa	125	523561	223047853	371900
South Africa	33	500	26194315	1620739
Total	297	867131	376205125	3484593

Source: EM-DAT database

[8] The negative effects that a policy or measure aimed at one objective might have on other objectives, irrespective of the net effect on overall social welfare. Adverse side effects are often subject to uncertainty and depend on local circumstances and implementation practices, among other factors

Northern African Region

The region consists of Algeria, Tunisia, Libya, Morocco, Sudan, and Egypt. Sudan, Algeria and Tunisia have experienced drought at least once since 1900. The number of people killed and the number of people affected as a direct result of droughts in the region were 150,012 and 31.1 million respectively. In addition, Sudan had the highest frequency of droughts within the region and number of people affected from this phenomenon. When accounting for economic damages, the region has incurred economic losses estimated at around US$900 million. In terms of the frequency of drought, Northern African region is the least region with occurrences of these events.

Central Africa Region

Droughts significantly threaten record GDP growth in some Central African countries. The number of people killed and number of people affected as a direct result of droughts involving natural events in the region was estimated to be around 3,058 and 11.3 million respectively. Although, the number of people deceased from droughts in the sub- region is relatively low compared to other regions, a 1-in-10-year drought event could have had an estimated adverse impact of 4% on the annual GDP of Malawi, with even larger economic and social impacts for 1-in-15 and 1-in-25 year events (ARC, 2012). Such decreased productivity detracts from economic growth, causes major budget dislocation, erodes development gains and resilience, and requires additional emergency aid from the international community.

Eastern African Region

Out of 297 droughts events suffered in African continent in between the periods of 1990 to 2016, 125 events occurred in East African countries. The sub-region has the highest occurrences of droughts within Africa. The number of people deceased and affected, as a direct result of droughts involving natural event was 523,561 and 223 million respectively. The sub-region contains countries such as Uganda, Eretria, Kenya, Seychelles, Comoros, Tanzania, Ethiopia, Mauritius, Rwanda, Somalia, Burundi, Djibouti, and Madagascar. The countries with highest number of droughts are Ethiopia, followed by Kenya, Somalia, and Mozambique.

Ethiopia has the highest number of people killed and affected as a direct result of drought, while, Mauritius incurred the highest economic damage within the region (UNDP, 2017). Drought affected around 70% of land mass in Kenya and 75% of household population depend on agriculture sector for livelihood, which in turn depends on rainfall as key input of production for subsistence farming (UNDP, 2015). Available crop data for 2009 alone indicated that Kenya's agriculture was the most severely affected as result of drought that year, with wheat yields production dropping by 45% compared to 2010's good crop season than all other countries (FAO, 2015b).

The eastern region, as a whole, had experienced more severe drought than other regions in Africa. This is because the region experiences inconsistent and poor rainfall within most of its dry and semi-arid topography. In the year 2016 alone, drought affected around 1.1 million people at the end of the raining season, with 284,000 people affected in arid counties, while 855,000 were affected in the semi-arid region. Compared to 2000-2013 mean rainfall, nearly 50% more people were affected in semi-Arid regions during 2016 season (UNDP, 2017).

To portray the point again, Kenya hosts the hottest spot on earth in terms of average cumulative temperature. This can be seen further in dry conditions throughout most of East African countries. Some countries in Eastern Africa region including Ethiopia, Somalia, and Tanzania had received no rainfall, and some provinces have experienced less than 30% below the mean rainfall (UNDP, 2015). The Eastern Africa sub-region experienced the highest temperature relative to other sub-regions in the continent.

During the year 2015 alone, 10.2 million people (including nearly 60% children) living in more than 400 rural districts were affected by drought in Ethiopia (UNDP, 2017). The human impact of drought includes severe and moderately acute malnutrition standing at 0.4 million and 1.7 million respectively because of lower crop production. Moreover, over 400,000 livestock died and 2 million number of people had no safe drinking water during the disaster period. Furthermore, in 2015/2016 agricultural season, drought in Burundi has affected 40% of the total population of the country, and the amount of economic losses incurred as a direct result of drought amount to more than US$40 million (UNDP, 2017). As a direct result of the drought, 2,108 people died, over 1000 families were displaced, and 30 hectares of arable land have suffered economic damage.

Western African Region

The countries in this sub-region includes Guinea, Niger, Benin, Guinea-Bissau, Burkina Faso, Liberia, Cameroon, Togo, Mali, Cape Verde, Mauritania, Chad, Cote d'Ivoire, Nigeria, Gambia, Senegal, Ghana, and Sierra Leone. Niger has the highest frequency of drought, followed by Burkina Faso, then Mauritania and Cape Verde. In terms of people killed, Niger and Cape Verde have the highest frequency of people who perished from drought. In addition, Niger has the highest number of people affected. The total economic damage between the periods of 1900 to 2016 is estimated at $507 million and Senegal borne the highest economic damage estimated at US$375 million dollar.

During the year 2012 alone, UN agencies estimated that over 16 million numbers of people in Mali, Sudan, Niger, Burkina Faso, Senegal, Gambia, and Chad were affected by drought (UNIDR, 2014). Moreover, the report indicated that the drought reduced the cereal crop production in the region by 26% relative to the previous year. Chad and Gambia experienced a decrease of 50% in crop production and other countries suffered serious localized deficits in agricultural production.

During the year 2014, Senegal experienced a severe drought, due to poor and erratic rainfall through four of its five regions in agricultural seasons. 784,000 total numbers of people were affected because of this phenomenon and relative to the 2000-2013 years cumulative average rainfall, the 2014 rainfall was far below the cumulative average (ARC, 2014). The report inferred that around 13.68 million number of people were living within the agricultural areas, 154,000 number of people were at risk of mild drought, 402,000 number of people are at risk of medium drought, and around 1.05 million people were at risk of severe drought in 2015 agricultural season. Moreover, ARC (2016) estimated that up to 730,000 people were affected by drought conditions in central and north-western Senegal at the end of the 2016 agricultural season, as a result of the poor performance in crops during the season.

Southern African Region

In South Africa, drought resulted in a loss of 49,000 agricultural jobs and 20,000 formal jobs in non-agricultural sectors in the year 2016 (FAO, 2017b). The southern African sub-region consists of Lesotho, Angola, South Africa, Zimbabwe, Namibia, Zambia, Mozambique, Swaziland, Botswana, and Malawi. During the year 2016, Swaziland's maize production has decreased by about 64%, and 28% of the population were in urgent need of humanitarian support, 75,662 cattle are estimated to have died and 200,000 people are unable to access to safe water (UNISDR, 2016).In 2017 alone, 30% of the population in Zimbabwe required urgent assistance, mainly in the southern province. Food insecurity peaked to approximately 4.1 million numbers of people during the dry season. In Buhera state, food scarcity rose to 70% between January-March 2017. The planted area decreased by 40% from 2015, 89% below the five-year average. It was estimated that up to 1.9 million people will lack adequate access to water until the beginning of the rainy season (UNDP, 2017).

1.1.1 Drought and economic activities

Drought can occur in any climate of the world. In general, it is known as a climate-related condition relative to what is perceived as normal condition. Because normal precipitation and water use expectations vary and the specific definition of drought is more a matter of, where the water comes from and how it is being used. Climate variability[9] is already a major constraint on food security, health, environment, and poverty reduction, due to the high dependence on the primary agricultural sector in African countries, which contributes to 86% of the GDP in some regions (GFDRR, 2011a). Droughts are the major climate-related hazards in Burkina Faso, which hamper the country's development and contribute to problems such as desertification,

[9] Climate variability is variations in the mean state and other statistics (i.e., standard deviations, occurrence of extremes, etc.) of the climate across all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability).

land degradation, food insecurity[10], increased poverty incidents, migration[11] away from the central area of the country, and overall under development.

Burkina Faso is a landlocked country located in the middle of the West African Sahel region and occupying over 274,000 square kilometers (sq km). With limited natural resources and a highly variable climate, Burkina Faso struggles to provide its dense population with food security and economic opportunity. One of the smallest economies in the world, Burkina Faso is deeply dependent on agriculture, with roughly 80% of employment linked to subsistence farming (GDFRR, 2011a). The country's soils tend to be poor in nutrients, have low water-holding capacity, and are largely degraded. When rainfall declines or temperature spikes, food supplies/yields are immediately affected. As a result of this fragility, Burkina Faso remains at the bottom of the UN's Human Development Index, ranking 162 out of 169 countries, with 46% of the population below the poverty line. Unlike other natural hazards such as floods, hurricanes, tornadoes, and earthquakes, which occur over finite periods of time and result in visually obvious damage, drought develops slowly and quietly, lacking highly visible and structural impacts. Developing drought conditions often go unnoticed until precipitation shortages become severe and impacts begin to occur. The slow pace and long duration of drought typically makes it difficult to quantify the overall economic impacts.

In another instance, Djibouti is a small country located in the Horn of Africa and the vast majority of Djibouti's rural population is highly susceptible to climatic uncertainty – they live in deserts or marginal and infertile areas, often with highly erodible soils, poor ground cover and limited water supplies, where food security is a serious concern (GDFRR, 2011b). In the same way, Ethiopia occupies 1.2 million square kilometers in the Horn of Africa and is considered to be one of the poorest countries in the world, with an average GDP of US$ 350 per capita and high rates of poverty(GDFRR, 2011c). Although, Ethiopia has a long history of coping with extreme weather events[12], rainfall is highly erratic and typically falls in the form of intensive storms spawned by the country's varied topography and over the past three decades, Ethiopia has experienced countless localized drought events and seven major droughts, five of which resulted in famines.

[10] Food security is a state that prevails when people have secure access to sufficient amounts of safe and nutritious food for normal growth, development and an active and healthy life.

[11] Climate change-induced migration is migration that can be attributed largely to the slow-onset impacts of climate change on livelihoods owing to shifts in water availability and crop productivity, or to factors such as sea level rise or storm surge.

[12] Extreme weather events is an event that is rare at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of a probability density function estimated from observations. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (i.e., drought or heavy rainfall over a season).

Increased climate variability is already affecting the household of Ghana. The impacts are observable and increase the stress on the country's vulnerable sectors: agriculture, marine ecosystems, water resources, and energy production. Increased climate variability reflected in changing climate regimes is evident[13]. Climatic extremes, leading to periods of severe drought, decline in crop production and livestock herds, and the severe food shortages experienced in the country, especially in the early 1980's, point to potential future threats [14](GDFRR, 2011d). The adverse impacts of climate change on the natural resources base and the sustainable livelihoods of rural communities can translate in increased poverty and limited economic development in other sectors, because of lower labour productivity.

Broadly, between 1980 and 2010 alone, Madagascar was struck by 35 cyclones and floods, five periods of severe droughts, five earthquakes, and six epidemics[15]. The events of drought are becoming increasingly frequent and intense, affecting food security, drinking water supply and irrigation, public health systems, environmental management, and lifestyle. Likewise, Climatic changes are already a significant threat to the country's development and the nutrition and health of its inhabitants,[16] due in part to erratic rainfall, increased crop pests, rainfall shortages, and breaks during critical growing periods, as well as desertification over the last 50 years.

Mozambique also experiences high levels of climate variability and extreme weather events (i.e. droughts, floods, and tropical cyclones). Droughts are the most frequent disaster, occurring every three to four years, and pose a major constraint to development since most of the country's population, especially the poor, reside in rural areas and rely on rain-fed agriculture (GDFRR, 2011f). Malawi's National Adaptation Programme of Action assesses impacts of climate change on the agriculture, water, human health, energy, fisheries, wildlife, and forestry sectors, as well as the implications on gender. The sector that will be most severely impacted by climate change is agriculture and over 50% of the population lives below the poverty line and one in five people is chronically food insecure (GDFRR, 2011g). Rain fed subsistence agriculture is the main livelihood for 85 percent of the population, leaving them highly vulnerable to weather shocks such as erratic rainfall that can cause flooding in the south of Malawi, and periodic droughts that affect the entire country.

The impacts from natural hazards, including drought, can be both direct and indirect. Direct and indirect effects are sometimes referred to as primary and secondary (or higher-order) effects in the literature. Identifying an adequate definition for direct and indirect impacts is important for economic impact assessments because the bounds set by such definitions dictate the scope of impacts that may or may not be included.

[13] Climate Change Adaptation in the three Northern Regions of Ghana. ALM
[14] Ghana's First National Communication to the United Nations Framework Convention on Climate Change
[15] National Disaster Management Institute Study of the Impacts of Climate Change, 2009 and BioCLIM Long Term Historical Surfaces
[16] 4 IPCC 4th Assessment Report and UNDP Climate Profiles

However, one challenge is that a clear and consistent classification of these two types of effects is lacking.

In addition, Okuyama (2009) argued that the cost of a disaster could be double, or even a triple, when considering the rippled effect base on the inter-sectoral linkages within an economy, with manufacturing sector incurring higher order effect than agricultural sector. The latter sectors are more predominant in lower income countries and damages to agricultural sector can lead to reduction in growth in industrial sector. For instance, a decline in rainfall will initially only have impacts on agriculture through making the land arid. However, due to inter-sectoral linkages and lower labour productivity, this may further reduce manufacturing and industrial sectors output that use livestock and dairy as input of production. Agriculture sector supplies vital resources to industry and stimulates the growth of some manufacturing subsectors. Therefore, the agricultural production losses can reduce manufacturing and industrial outputs that depend on agriculture sector for raw materials (Benson and Clay, 1994).

The adequacy of water supply is determined not only by the average amount of water available in a year, but also by the variability and predictability of rainfall. The African savanna, and even more the African Sahel, is characterized not only by low levels of rainfall relative to potential evotranspiration[17], but also by extreme variability of rainfall. Drought risk is very high; in many years the rain fails entirely, without enough precipitation to produce crop. Brown and Lall (2006) suggest that countries with high rainfall variability tend to have poorer of agricultural output, and their findings highlights the need for better storage of water during the rainy season and adequate irrigation during the dry season in countries with high rainfall variability. In humid and sub humid tropical regions with plentiful rainfall and low cost irrigation, the dominant staple crops tends to be rice, a highly coveted grain. In sub humid locations where irrigation is unavailable, rain-fed maize and up land (rain-fed) rice tend to replace irrigation based rice as the dominant staple food. In yet drier regions, farmers shift to more droughts-resistance crops such as cassava, to reduce impact (Sach, 2008).

African Sahel, the horns of Africa are home to pastoralist communities raising cattle's, camels, goats, sheep and cattle, and often moving between pasturelands to follow the brief seasonal rains that replenish the pastureland grasses. The seasonal movement of pastoral communities is known as transhumance and constitute one of the most difficult and precarious lifestyle on the planet today. The very poorest of the poor are found in regions, with low average water availability per person, high variability of rainfall, lack of irrigation, and low water storage capacity (for example, no dams, lack of irrigation facilities and reservoirs) (Sach, 2008). The description fits the African savanna and Sahel and the regions have no irrigation and lack year round river runoff. When the rains fail, which they do with increasing frequency, because of anthropogenic climate change, the crops, the livestock, and then the people perish. It

[17] Evapotranspiration: the process of transferring moisture from the earth into the atmosphere. Evaporation occurs when water vapor leaves the soil or a plant's surface. Transpiration involves the passage of water through a plant, from its roots through its vascular system. The sum of evaporation and transpiration is evapotranspiration.

is not surprising that all ten of the countries ranked as having the lowest human development index were stressed countries with extensive dry land population; this includes Niger, Sierra Leone, Mali, Burkina Faso, guinea Bissau, central African Republic, chad, Ethiopia , Burundi, and Mozambique (Brown and Lall, 2006). In the pastoralist horn of Africa, the water situation is so dire that violence is pervasive in Sudan, chad, northern Uganda, Ethiopia, Northern Nigeria.

It is widely noted that African countries have higher reliance on rainfed agricultural[18] economic activities (Mills and Thakoor, 2016). The report indicates that 95% of African countries depend on rainfall as input for agricultural production. Hence, the effect of drought on an economy may be very high when the sectors in the economy are interdependent. In other words, the economic impact of drought in African economies will be intensified to the extent through which agricultural sector in Africa draws on intermediate inputs from other sectors, as well as, to the extent that non-agricultural sector takes input as raw material from agricultural sector in African countries (Benson and Clay, 1998).

Agro-industries such as food processing are particularly vulnerable to the impact of drought, because the sector uses water as an input for production. The decline in value terms of drought-affected crops will be relatively higher than a decline in crops that uses relatively less water, resulting to lower supply and higher prices of drought affected crops and reducing agricultural drought-affected sector incomes (Benson and Clay, 2004). In addition, for non-food agro-industries, such as the textile industry, drought can negatively affect the industry in production losses because the sector depends on water as factor of production.

Furthermore, due to relatively strong inter-sectoral linkages between manufacturing and agricultural sector in some African countries, a reduction in rainfall will decrease domestic supply of output and increase imports of inputs. These would have an adverse impact on non-agricultural production as well as manufacturing value added. The inter-dependence between agriculture and industry is important to the economies of African countries where agro-industrial sectors account for two-thirds of the manufacturing output (Benson and Clay, 2004).

Agro-industrial sectors generally account for a substantial part of industrial output in developing countries compared to industrialized ones. This is particularly true in the case of African countries where the share of the agro-industrial sector can be as high as 70% (UNIDO, 2009). The share of agro-industrial sectors in total manufacturing value added is 70% in United Republic of Tanzania, 51% in Ethiopia, 35% in Kenya, 29% (UNIDO, 2009). One of the core challenges of the science of economic development is to understand the regional differences. Another is to understand how to unlock faster economic growth in the laggard regions. Why did Africa's income per person rise by a mere 3.5 times between 1812 and 1998 while the United State enjoyed a twenty-two-fold increase? (Sach, 2008) Can Africa now narrow the vast gap in per

[18] Rainfed agriculture are agricultural practice relying almost entirely on rainfall as its source of water

capita income with the high-income countries through faster economic development? What about other laggard regions.

Figure 1.8 indicates the correlation between occurrences of droughts and contribution of agricultural sector in African countries GDP. The figure suggests that the occurrences of droughts and agricultural sector contribution to African economies GDP (value added) correlate positively. In the same way, Figure 1.9 shows the correlation between the economic impact of droughts and manufacturing sector contribution to African economy. The figure suggests that occurrences of droughts and manufacturing sector contribution to African economies GDP (value added) correlate positively. In addition, objective one of the study also hypothesised that occurrences of droughts will reduce manufacturing sector contribution in Africa's GDP.

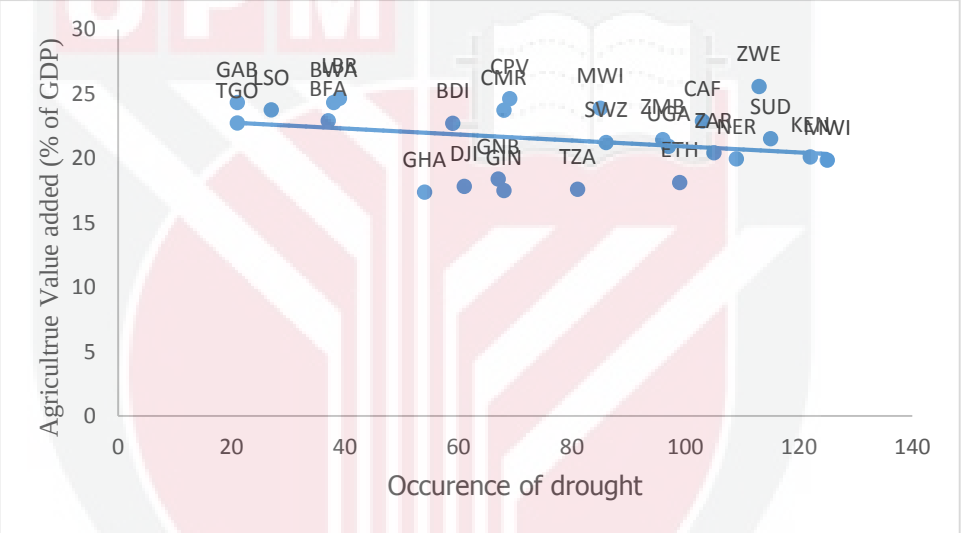

Figure 1.8 : Occurrences of droughts and agriculture value added in Africa from 1980-2014
(Source: Author's calculation from EM-DAT and WDI)

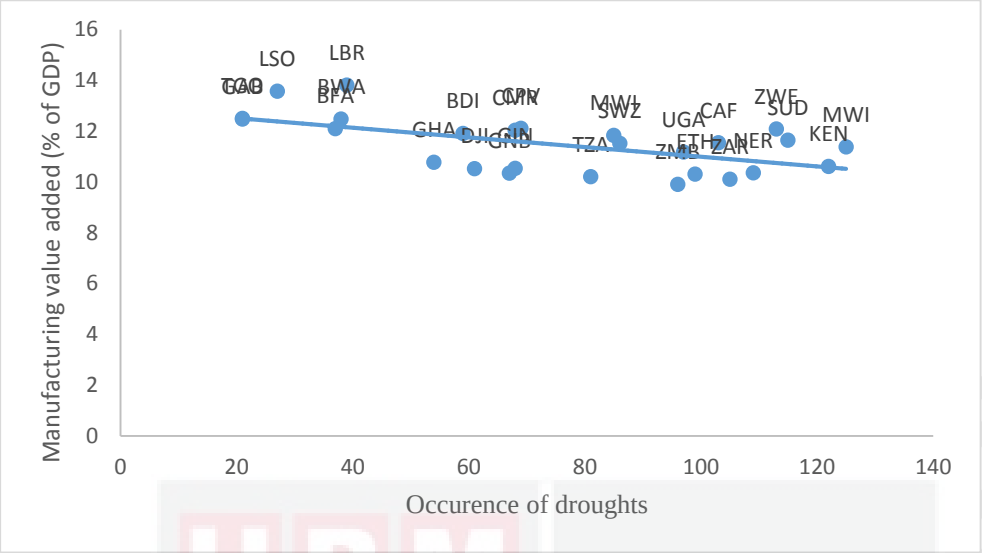

Figure 1.9 : Occurrences of droughts and manufacturing value added in Africa from 1980-2014
(Source: Author's calculation from EM-DAT and WDI)

If the economic impact of drought is not addressed in African countries, it is likely to have some social implication in the continent. It is expected to increase food insecurity, caused by disruptions along the food chain, reduction in agricultural sectoral output, lowering manufacturing sector growth, and national growth. These depend on nature, size of agricultural sector, and the relative importance of agricultural sector to employment opportunity (FAO, 2017a). For example, agricultural sector contributes approximately 30% of GDP, 40% of export and 70% of employment in Kenya (FAO, 2008). Furthermore, as recent as 2014, a report indicates that agriculture sector supports more than 75% of its population, including those who reside in its urban areas and contributes around one third its GDP (UNDP, 2015). Nevertheless, agriculture sector consumes more fresh water than any other use sector and significantly contributes to national economies, employment, and food supply. According to the Togo's National Adaptation Programme of Action (NAPA), the country's economy depends on the agriculture (mainly coffee, cocoa, and cotton). Agricultural activity represents about 40% of GDP (comprises 50% of the country's export earnings) and employs 70% of the population (GDFRR, 2011i).

In addition, the 2016 rainfall decrease in South Africa resulted in the loss of 49 000 agricultural jobs and 20,000 formal jobs in non-agricultural sectors (FAO, 2017b). In fact, FAO (2008) reveals that 212 million people suffer from food crisis and 1 billion more people would be experiencing hunger by 2050. The vulnerability of agricultural sector to drought will likely affect huge employment opportunities and food security of the continent. In addition, given the inter-linkage between agricultural and manufacturing sector, it is important to understand systematically how drought will affect growth by sectors and seek ways to mitigate the challenge.

Literature has focus on the impact of drought shock in the horns of Africa because of higher occurrences of droughts in Ethiopia, Kenya, and Uganda. A recent report by FAO (2015b) adds that the impact of drought on agricultural sector and food security in sub-Saharan Africa using a sample of four countries: Kenya, Ethiopia, Uganda, and Mozambique, lead to the reduction in agricultural production in the sample countries. However, the study suggests further systematic studies need to address the possible linkage between the agricultural sector and non-agricultural sector.

Although, drought affects agricultural sector, it can also be a hydrological phenomenon. The direct impact of reduction in rainfall can affect a country's artificial surface storage and natural storage capacity of an economy, and indirectly, the impact of drought on non-agricultural sectors will depend on intensity of water use by those sectors. Moreover, African countries depend on surface water storage for irrigation and rely heavily on hydro-electricity as an important source of energy. This is also because droughts are likely to decrease the growth rate of sectors that heavily depend on water as input of production in Africa. In other words, some industries have high intensity for water use; with less availability of water supply for their labour force affecting their operations and productivity (see Figure 1.10, Figure 1.11). Figure 1.10 depicts a two-way correlation between occurrences of droughts and mining, manufacturing, and utility (MMU) sector contribution to African countries. Figure 1.11 show the correlation between economic impacts of drought with construction sector to African countries respectively. Figure 1.10 indicates a negative and positive correlation between drought and MMU sector per capita. On the other hand, Figure 1.11 suggests a positive correlation between occurrences of droughts and construction sector contribution to Africa's GDP.

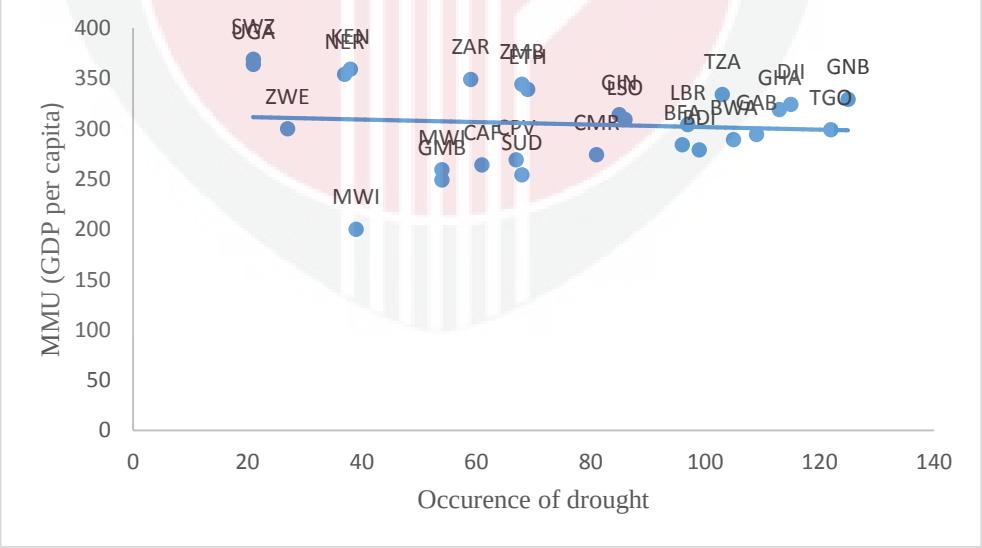

Figure 1.10 : Occurrences of droughts with mining, manufacturing and utility value added from 1980-2014
(Source: Author's calculation from EM-DAT and UNSD)

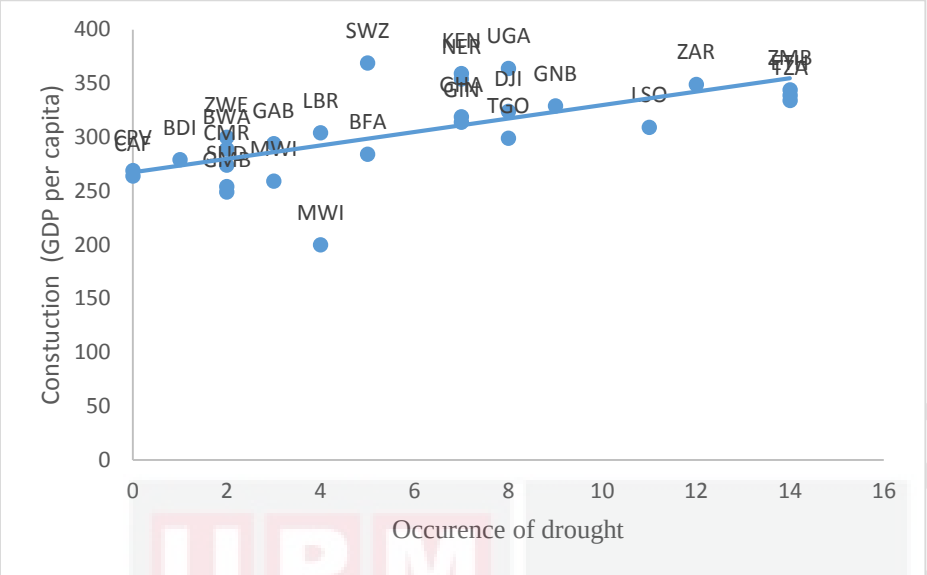

Figure 1.11 : Occurrence of drought and construction sector between 1980-2014 (Source: Author's calculation from EM-DAT and UNSD)

African region has only 1200 dams and around 60% of these dams are in South Africa and Zimbabwe (FAO, 2008). Furthermore, the region used more than 50% of the dams to facilitate irrigation agriculture, and only 6% are used for energy generation. In fact, outside western Africa, only 20% of the household have access to electricity. Figure 1.10 shows the correlation between occurrences of drought with mining, manufacturing, and utility sector (MMU) per capita income. The figure suggests a negative correlation between occurrences of droughts and MMU sector contribution to African economies. The challenge of securing safe and plentiful water for all regions of the world will prove to be one of our most daunting tasks. Water stresses is already a grim fact in many regions and climate change will disrupt the water cycle on a global scale. The impact of global society and especially the poor can be therefore devastating.

Although, droughts are likely to have a negative economic impact on manufacturing sector because the sector uses water in production process and utilises agricultural input as means of production. Utility sector can also be affected by droughts because of a prolong decrease in rainfall below the average mean in a geographical area, leading to a reduction in a region's water storage facilities in dams and reservoirs that is use for energy generation. In contrast, mining sector is expected to be relatively immune to the impact of droughts because of the relatively less use of water as a factor of production. The sectors that relatively use water as input of production are likely to be impacted by droughts than sectors that use less amount of water as input of production.

1.1.2 Income Inequality and Global warming

Global warming is all about inequality, both in who will suffer most its effects, and in who created the problem in the first place. Certainly global warming threatens everyone on the planet, but some places and some people in those places will suffer much sooner and much more than others. For example, many poor nations, especially African nations and those with large populations in vulnerable areas, are likely to experience increase in frequency and intensity of extreme climate events such as drought (IPCC, 2013). Inequality has great relevance to the question of whether human life and economic activity are sustainable. The ecological economics perspective argues that developed nations way of life is not sustainable, because it over uses non-renewable resources and creates multiple form of negative externality. If the less developed countries become more like developed nations, then the limits of sustainability will be reached sooner. The world as a whole is incapable of sustaining a situation in which all people lives on average like its richer nations' households today. According to this argument the burden which humans impose upon the earth is unequal: the lives of the households of developed countries are more damaging because they use more materials and they create the negative externality.

The 1995 Intergovernmental Panel on Climate Change (IPCC) report, bringing together over 2000 scientists from around the world, predicted that Africa will face devastating droughts, which will destabilize Governments and bring strife and suffering to the region (Robert, 2001). The African continent may warm up during the next century with higher intensity of droughts than the global average. The drier sub-tropical regions may warm above the moister tropics. Precipitation is likely to decrease in northern Sahara, Mediterranean Africa, but it is likely to increase in central Africa. That means that the world's largest desert, the Sahara can widen and the desertification of that region can go further. Meanwhile the increase of tropical rainfall can amplify the problem of malaria in central Africa, as the mosquitoes that carry the disease likes rainy weather. So, more rain means more mosquitoes (Hopkin; 2005)

These poor nations are least able to handle the massive dislocations that come with natural disasters, which can set their development back for decades. Within the poor nations, poor households often never fully recover from devastating disasters brought on by the increasing climate variability. While effects of and the ability to handle climate change are unequally distributed, responsibility for the problem is even more unequally distributed. Poor nations remain far behind us in terms of CO_2 emissions per person. For example, the average North American consumer dumps as much greenhouse gas into the atmosphere as 20 times as an average Africans consumer, the average consumer in Germany dumps as much as 13 times CO_2 relative to the average citizen of African countries. (See Figure 1.3). Overall, the richest 20% of the world's population is responsible for over 60% of its current CO_2 emissions of greenhouse gases (See Figure 1.2). African continent has the lowest total CO_2 emissions from fossils-fuels and cement production from 1960 to 2014. It may be investigated, since CO_2 is the main contributor to the greenhouse effect, remains in the atmosphere for 120 years (IMF, 2017). This situation is simple a matter injustice, because African

nations' household are suffering the effects of something (over consumption of the developed countries) from which they drew little or no benefit.

Some will point out that there is another very different side to this story. China and India, with massive populations and rapid industrialization may surpass the wealthy countries in total CO_2 emissions of greenhouse gases to the atmosphere (Sach, 2008). It may be true that environmentally speaking, one cannot handle this problem of global warming without addressing the boom of emissions in the developing countries. But, the withdrawal of the United States from Paris Agreement has brought about more uncertainty and have mobilized think tanks, journalists, scientists, and senators to block any progress on the Kyoto treaty until the poor nations also agree to limits on their CO_2 emissions (Robert, 2001). However, to ask these nations to stop development at a level we would never consider returning to seems inequitable (Shue 1992). What's more, by their importance in the problem and their sheer numbers in negotiating efforts, the poor nations hold a veto power over efforts to enact a global climate treaty.

The very top of the economic pyramid sees trillions of dollars of wealth in the hands of a very small group of household, predominantly men, whose fortune and power grow exponentially. Billionaires have now more wealth than the 4.6 billion people who make up 60 percent of the planet's population. Meanwhile, around 735 million people are still living in extreme poverty (Oxfam, 2018). The cited report shows that the world's richest 1% have more than twice as much wealth as 6.9 billion people.

While the richest Africans get ever richer, extreme poverty in the continent is rising. Africa is the second most unequal continent in the world, and home to seven of the most unequal countries (Oxfam, 2019). The cited report shows that the richest 0.0001% own 40% of the wealth of the entire continent. Africa's three richest billionaire men have more wealth than the bottom 50% of the population of Africa, approximately 650 million people. Meanwhile, Africa is rapidly becoming the epicenter of global extreme poverty. While massive reductions in the numbers living on less than $1.90 a day have been achieved in Asia, these numbers are rising in Africa. The World Bank estimates that 87% of the world's extreme poor will be in Africa by 2030, if current trends continue (World Bank, 2015).

Of the world's 7.7 billion people, almost 2 billion live in countries where the average income is less than $3 a day (World Bank, 2014). Despite substantial progress in reducing poverty rates, around 735 million people still live in extreme poverty (World Bank 2016). At the same time, on average, the households in the high-income countries get to live on 23 times that much, and the gap between the two groups is widening (World Bank, 1995 and Sach, 2008). About one out of four people in the world lives in absolute poverty, defined as "too poor to afford an adequate die". Recent data suggest that the number of extremely poor households continue to rise in sub-Saharan Africa, while falling rapidly in all other regions around the world (World Bank, 2015).

There are two pollutions, that of wealth and that of poverty (Redcliff and Sage, 1998). In CO_2 emission terms, the worst is unquestionably the pollution of wealth. In the poorer countries, the greater environmental problems are simply survival: having enough to eat, a safe place to sleep, a way to take care of children. So there is great inequality of wealth, as well as, CO_2 emissions between nations and also within nations. Given data on regional variation in CO_2 emissions (especially in African countries), it can be said from data that the world's richest nations' households cause higher CO_2 emissions relative to the world's poorest nations' households (See Figure 12 and Figure 13).

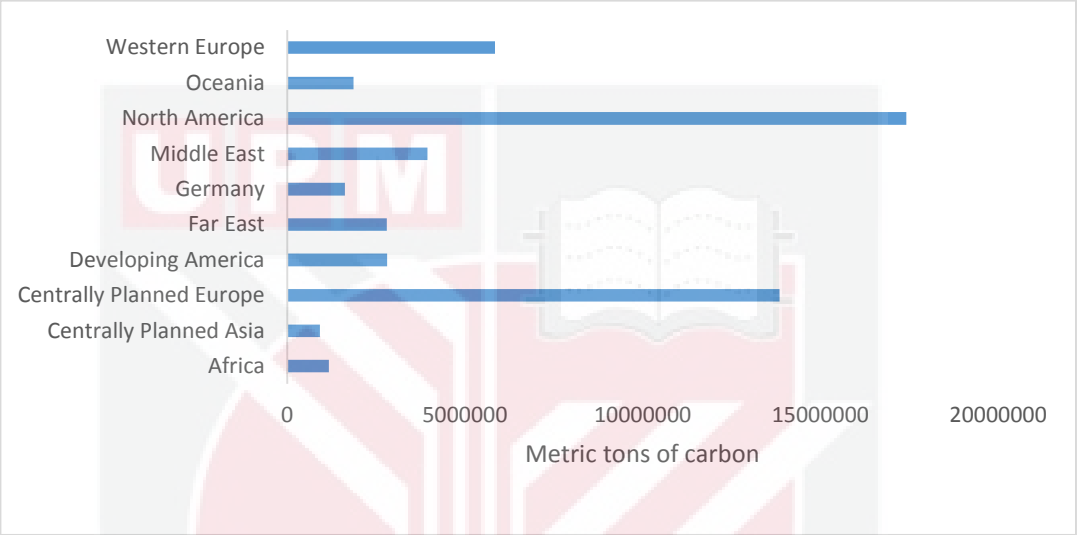

Figure 1.12 : Emissions from gas fuel consumption between the periods of 1960-2014
(Source: Carbon Dioxide Information Analysis Centre Database)

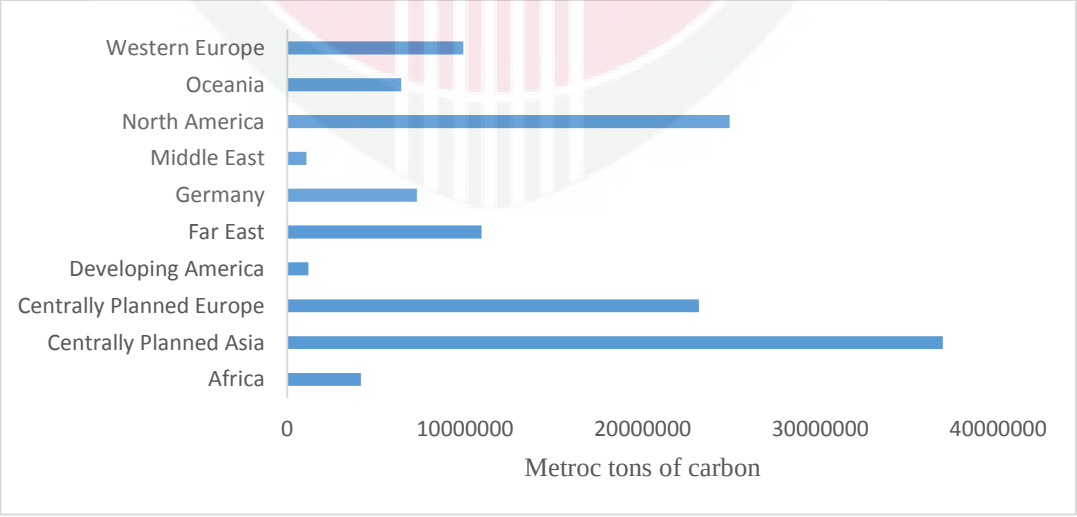

Figure 1.13 : Emission from solid fuel consumption by region between the periods of 1960 to 2014
(Source: Carbon Dioxide Information Analysis Centre Database)

It is basic ethics that those who create a mess should be responsible for cleaning up their share of the mess. Since CO_2 burned now stays in the atmosphere for over 100 years, shouldn't accounting for all the damage the rich nations have done in the past be considered (Neumeyer 2000)? This is a highly contentious issue indeed, but one that we have to consider if we are to address inequality and climate change impact[19]. When emissions since 1960 are summed, not surprisingly, the gap between rich and poor nations is much higher and is not narrowing or going away anytime soon. The summed emissions from the high-income nation's amount to 900 trillion tons of carbon, from the 28% of the world who live in middle income nations only 500 trillion tons, and the poorest majority of the world have dumped only 200 trillion tons.

A major sticking point in the Kyoto round is precisely this: how to calculate who is polluting how much, and how much they should be required to reduce their emissions. One alternative that has been proposed is to look at total CO_2 emissions per country and seek a reasonable international level per capita (Robert, 2001). Kim (2012) reported in a global study that the poor are twice expose and vulnerable to natural disasters than the non-poor are on the average globally. Although, there is substantive variation across regions, the lacuna by Kim (2012) findings is that the level of poverty between the poor and non-poor is persistent overtime, resulting to higher level of inequality. The poor measured by number of people affected in the study are more expose to natural disaster, not only because of occurrence of events, but as also a result of residing in disaster prone region, which account to about 26% of the total share. The persistency of poverty might result into wider variation of income between the poor and non-poor, which will result to increase in income inequality.

An IMF (2016) report shows that natural disasters; drought, flood, storms, and epidemic increase income inequality in sub-Saharan African countries between the periods of 2011 and 2013. In addition, these disasters worsen financial development indicator measured by non-performing loans. Yamamura (2015) inferred that flood, storms, and earthquake increase income inequality in a panel framework from 1970 to 2004. However, the study neglected to examine the impact of drought within his framework.

Figure 1.4 shows the correlation between the occurrence of drought in African countries and income inequality in the period of our study. The figure indicates a positive correlation exist between the occurrences of drought and income inequality. The most noteworthy point in the previous illustration is that South Africa is the most unequal country in Africa. Gambia and Gabon has the least level of income inequality in the continent. Income inequality is based on the Lorenzo scale of 0 to 100, where zero means there is no income inequality within the area, or between countries, while 100 means the economy is highly unequal. From the illustration, South Africa has a scale of 71 points, while Gambia and Gabon have the same point of 20 each.

[19] Effects on natural and human systems from extreme weather and climate events and of climate change. Impacts generally refer to effects on lives

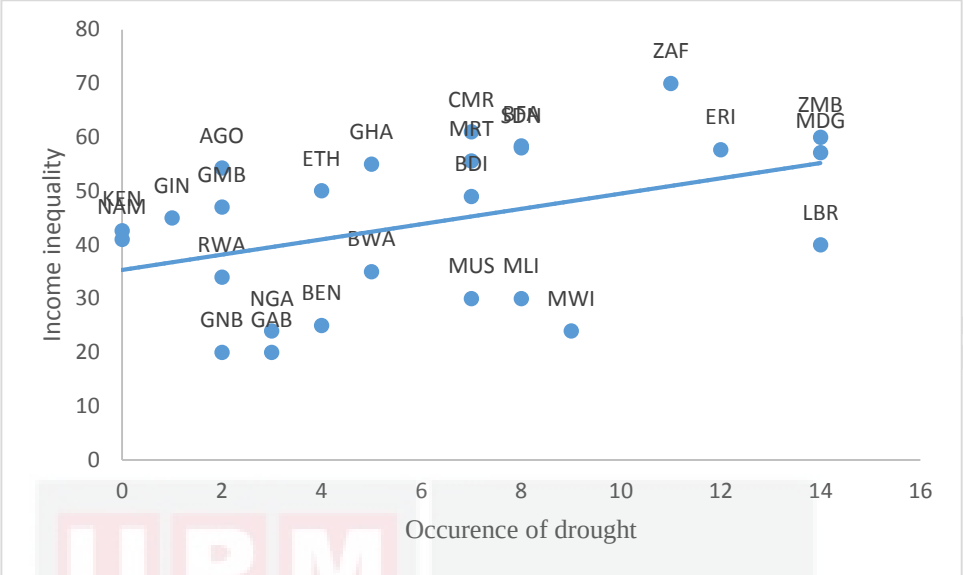

Figure 1.14 : Occurrences of droughts and income inequality from 2000-2009

1.1.3 Determinant of drought fatality

Benson and Clay (1994) mentioned that drought postulates an inverted U shape relationship between drought fatalities and level of economic development. The hypothesis inferred that Least Developing Countries (LDC) would have higher drought fatalities than advance countries, because of lower mitigation factor in terms of per capita income. Concisely, the model suggests that in earlier stage of economic development, due to low-income level in LDCs and higher opportunity cost of investing in mitigation facilities, drought fatalities are expected to be higher in developing countries, and drought fatalities are anticipated to be lower in higher income countries due to better risk mitigating factors. Drought fatalities are the unit of measurement for the total number of people affected from the direct impact of drought disaster (CRED, 2008). It can also be inferred to as the number of fatalities.

Diversification nature of an economy plays an important role in determine the impact of drought on income inequality. This is because the size of and structure of a given financial sector, including banks and capital market will have an implication on how the economy responds to the impact of drought and recovery process. In the face of occurrence of drought, there might be reduction in the rate of borrowing by the private sector, due to lesser demand for raw material and lower expectation of yields from crops. Consequently, reduction in the rate of borrowing affects the need for extension of credit facilities to farmers. However, the public sector demand for foreign currency for importation of emergency supply during an event may also add additional strain to the financial sector of developing countries (Benson and Clay, 2004).

African countries tend to have weak financial and institutional capacity to cope with drought event. The lacks of institutional and financial market in the region may

increase the number of fatalities from this disaster. Noy (2009) also suggests that higher literacy level, higher degree of openness to trade, better institutions, higher per capita income and higher ability of both government and Private sector to mobilize resources after disaster determine the fatalities. Further, lack of access to agricultural insurance schemes for farmers makes it harder for financing in post disaster relief and reconstruction. Africa lags behind compared to other regions around the world, with only around 0.5% of the world premium paid in that region (See Figure 1.15).

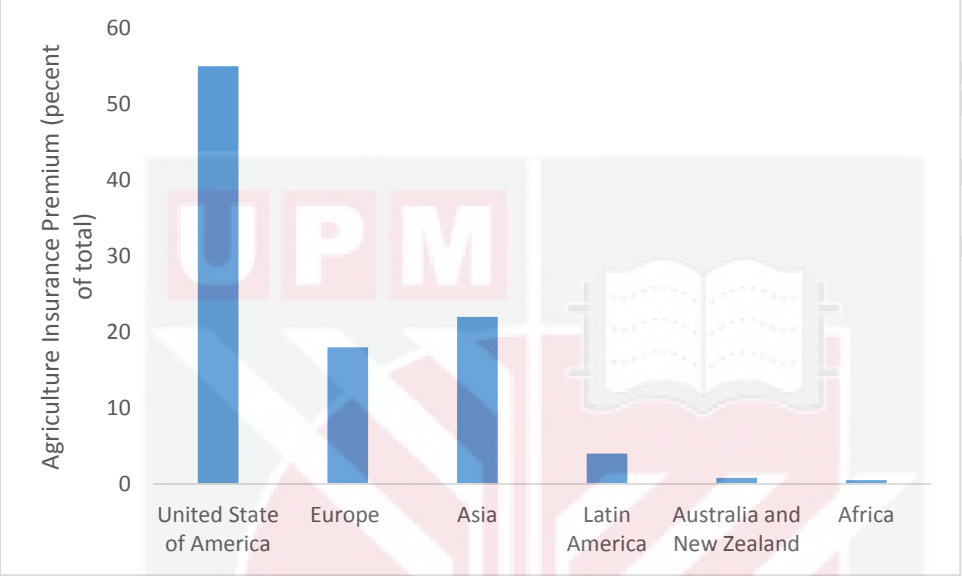

Figure 1.15 : Distribution of agricultural insurance premium across different region of the world
(Source Swiss Re. 2013)

Out of the 664 droughts events around the world between the periods of 1900 to 2014, 297 occur within the continent of Africa (see Table 1.2). In simple facts, Africa has the highest occurrence of drought in the 20th century. In terms of number of people killed, around 867 131 people have perished due to hunger. Moreover, between the periods of 1975 to 2014, 99% of the people killed as result of droughts are within the continent. In addition, these phenomena have affected more than 376 million people since 1900 and the total economic damage is estimated at $3.5 billion. Drought fatalities focus on the direct impact on natural disaster. This includes number of people affected, number of homeless and level of economic damage (Cavallo and Noy, 2011). Since drought is an exogenous variable, the number of events and the duration of the disaster will have practical policy implication on reducing the direct impact of drought in African countries.

Eastern Africa has the highest number of people killed and people affected within the continent. In addition, the number of people killed and the number of people affected was estimated at 523,561 and 223 million people respectively. Furthermore, Ethiopia was the most affected country in the sub region, with 66 million people affected; while, Kenya was the most affected in terms of economic activity, with an estimated loss of

US$48 million. Although eastern region of Africa incur more human fatalities than all other regions in the continent, Southern Africa incurred the highest economic damage valued at US$1.62 billion. South Africa alone suffered US$1 billion lost within Southern Africa sub-region. In comparison to Eastern Africa high death toll, southern Africa had 500 human casualties and western Africa has sustained 170,000 losses of human lives. Moreover, in comparison to Eastern Africa high number of people affected, 26 million numbers of people and 79 million numbers of people were affected in Southern Africa and West African regions respectively.

In Northern African region alone, 31 million people were affected and a total economic value of US$900 million was lost within the sub-region. Sudan experienced nine droughts in 1980, 1983, 1987, 1990, 1991, 1996, 1999, 2009, 2012. Over 150,000 people were killed and the total number of people affected was estimated at 30 million between the periods. However, Morocco incurred the highest economic damage valued at US$900 million; over periods of droughts in 1966, 1971, 1983, 1984, and 1999.

Fatalities (number of people killed, people affected, and economic damages) are determined by some factors which make African countries to be more impacted by drought than other developed regions. Earlier literature by Benson and Clay (1994) suggest that the level of economic development, the percentage of agriculture in GDP and exports, the arid and semi-arid nature of land, number of rural dwellers and household resilience to drought are very importanT in determining the vulnerability of African economies. Moreover, an IMF report indicated that structural factors that makes African countries more directly impacted by drought includes; weak adaptive capacity, high share of agriculture in GDP, and limited financial development (Mills and Thakoor, 2016).

1.2 Problem Statement

One of the core challenges of the science of economic development is to understand the regional differences and another is to understand how to unlock faster economic growth in the laggard regions. Drought has an economic and social implications to many African countries. As an event, for example, droughts exhaust the availability of water as input in agriculture leading to reduction of labour productivity through hunger, starvation, and dearth of one of the key factors of production i.e. labour, which can further threaten GDP growth or the growth effects in African countries. In Malawi, a 1-in-10-year drought event could have an estimated adverse impact of 4% on the annual growth of Central African region country, with even larger impact for 1-in-25-year event.

Climate variability is already a major constraint on food security, environment, and poverty reduction, because of the high dependence on the primary sector of agriculture. The impacts are observable and increases the stress on African countries' vulnerable sectors: agriculture, water resources, and energy production. Climatic

extremes, results to periods of severe drought, reduces crop production and livestock herds, and account for the severe food shortages experienced in many African countries. The African savanna, and even more the African Sahel, is characterized not only by low levels of rainfall, but also by extreme variability of rainfall. Drought risk is very high and in many years, the rain fails entirely, without enough precipitation to produce crop. Brown and Lall (2006) suggest that countries with high rainfall variability tend to have poorer population, and Brown and Lall (2006) findings highlights the need for better storage of water during the rainy season and adequate irrigation during the dry season in countries with high rainfall variability. The very poorest of the poor are found in regions with low average water availability per person, high variability of rainfall, lack of irrigation, and low water storage capacity(for example, no dams, lack of irrigation, reservoirs) (Sach, 2008).

The phenomena of droughts are more frequented in African countries than all other regions of the world, excluding Asia in terms of number of fatalities. On the impact of droughts on sectoral output growth, the focus of the literature has been on the impact of natural disasters on the aggregate growth. This is because the growth effect of natural disasters in general is framed within one-sector models using aggregate production function instead of multi-sector models that will examine different type of disasters on sectoral output growth. There is no reason to assume that the impact of droughts on agricultural, industrial, and service sector will .be the same. The few studies that examined the impact of droughts on sectoral output growth focused on agricultural activities.

This is understandable because agricultural sector plays an important role in employment opportunity for most African countries, and droughts is closely link to agricultural activities in the region. For example, a report indicates that agriculture sector supports more than 75% of its population in Kenya, including those who reside in its urban areas and contributes around one third of its GDP (UNDP, 2015). Mills and Thakoor (2016) revealed that 95% of African countries depend on rainfall water as input for agricultural production. Hence, the effect of drought on an economy will have higher order effect, when the sectors in an economy are interdependent.

Although, drought is also a hydrological phenomenon that affects inland water navigation and hydropower plants, it has a negative effect on the water storage capacity of a country, through its underground storage capacity, dams, and reservoirs. The phenomenon is expected to affect the other sectors of an economy through backward and forward linkages effect, for instance, in utility sector, because droughts are expected to decrease the output of sectors that heavily depend on water as input of production in Africa. African region has only 1200 dams and around 60% of these dams are in South Africa and Zimbabwe (FAO, 2008). The region has the least number of dams in comparison to the other regions of the world. Moreover, African region used more than 50% of its dams to facilitate irrigation agriculture, and only 6% were constructed for energy generation. The implication is that the dependency of African countries on rainfall water as input of production and the lower level of investments

in dams for energy generation is expected to have a higher order effect on different sectors of the economy.

The African continent is very likely to warm during the next century with higher intensity than the global average. The drier subtropical regions warm above the moister tropical region. Precipitation is likely to decrease in northern Sahara, Mediterranean Africa, but it is likely to increase in Central Africa. That means that the world's largest desert, the Sahara can widen and the desertification of that region can go further. These poor nations in Africa are least able to handle the massive dislocations that come with natural disasters, which can set their development back for decades. Within the poor nations, poor households often never fully recover from devastating disasters brought on by the increasing climate variability.

The criticism against modern economic development is that it leads to an excessive emission of negative externality (pollutants). Many of these have a harmful local effects, but others spread their effect more widely. Concern centers on the emission of CO_2, which is believed by most climatologist to lead to rising CO_2 concentration in the earth's atmosphere, which in turn cause global warming, and the consequences includes climatic extremes in the form drought, and that may negatively affects the production of food and other aspect of human life. In other words, this is part of the argument that the pattern of development in recent time is not sustainable. Modern economic growth is in some aspect negating in that it destroys the basis for its own continuation. This argument supplements the many aspects of human life, which leads to a critique of conventional development from the point of view of its desirability. The ecological critique questions its continued possibility and the income inequality between the nations and among people is at the heart of the debate.

While the effects and ability to mitigate drought are unequally distributed, because of different level of income between countries, the responsibility for the problem is even more unequally distributed. Poor nations remain far behind us in terms of CO_2 emissions per person. African continent lag behind all the other regions of the world in terms of total CO_2 emission from fossil fuel and cement, per capita CO_2 emissions, emissions from solid fuel consumption and emissions from gas fuel consumption. Given data on regional variation in carbon emissions (especially in African countries), it can be argued with facts that the world's richest countries' households cause higher CO_2 emissions more that of the world's poorest countries' households. Yet, African region may warm up during the next century, with higher intensity of climatic extremes like droughts on the horizon. The African countries are suffering the effects of something (our consumption) from which they drew little or no benefit.

While the richest Africans get ever richer, extreme poverty in the continent is rising. Africa is the second most unequal continent in the world, and home to seven of the most unequal countries (Oxfam, 2019). The cited report shows that the richest 0.0001% own 40% of the wealth of the entire continent. Africa's three richest billionaire men have more wealth than the bottom 50% of the population of Africa, approximately 650 million people. Meanwhile, Africa is rapidly becoming the

epicenter of global extreme poverty. While massive reductions in the numbers living on less than $1.90 a day have been achieved in Asia, these numbers are rising in Africa. The World Bank estimates that 87% of the world's extreme poor will be in Africa by 2030, and the current trends may continue up to 2050 (World Bank, 2015).

Another contention is the economic impact of level of development on drought fatalities in Africa. Africa had the highest occurrence of drought in the 20th century and the second number of people affected among the regions of the world. Nevertheless, African region has experienced a surge in growth after the turn of the millennium. The economic structural problem of high dependency on agricultural sector, low level of financial development can serve as an obstacle to mitigating the impact of droughts. Thus, understanding the key factors that peculiarly determine the number of fatalities in Africa is important.

1.3 Research Question

The study seeks to answer the following questions

- What is the impact of droughts on sectoral output growth in African countries?
- What is the impact of droughts on income inequality in African countries?
- What are the determinants of droughts fatalities in African countries?

1.4 Objective of research

The general objective of this thesis to examine the determinants of droughts and its impact on sectoral output growth and income inequality in African countries. Specifically, the objectives are

- To investigate the impact of droughts on sectoral output growth.
- To examine the impact of droughts on income inequality.
- To determine the factors affecting droughts fatalities.

1.5 Significance of research

This study has some significance. Due to the increased human activities, resulting to the concentration of CO_2 in the air has stepped up since the Industrial Revolution, climate change will increase climatic extremes in form of drought. As the problem has become worse and worse, it has turned out that the damage will move further and will result into an additional warming of the Earth's surface and atmosphere and may adversely affect natural ecosystems and humankind. Counter actions were needed. It was clear that these problems should be handled at the international level; countries have to solve the revealed problems together, so a multi-level cooperation is needed.

The first international negotiations started in 1979 with an international conference on climate change held in Geneva. In 1987 Montreal Protocol on Substances that deplete the Ozone Layer came into existence with the aim of reducing emission of chlorofluorocarbons (CFCs). This was the first time when wide range of countries approved an international agreement on the topic. The most important step against climate change was the creation of the UN Framework Convention on Climate Change (UNFCCC) in which there was documentation of not only the reasons of climate change, namely greenhouse gas (GHG) emission, but also the possible threats to mankind in the form of natural disasters. Furthermore, the general principles, commitments were codified and a new institutional framework was established for the sake of the cause. After considerable discussions and work, the Convention was accepted in 1992, at the Earth Summit held in Rio de Janeiro. Article 2 of the UNFCCC states the Treaty's goal as ''stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". The Treaty gave the opportunity for the cooperating Parties to meet regularly, create further action plans and fix targets in protocols.

As a response to climate change, the UNFCCC sets out both adaptation and mitigation strategies, while the first form has become fashionable only lately. The Treaty focused originally rather on reducing the source of climate change, so policy on the issue emerged first as a mitigation policy. The reason for that is very simple, at the time of writing the Convention; it was widely believed that mitigation is more effective. Nevertheless later adaptation projects have also increased in number (Schipper, 2006). Since the UNFCCC entered into force, the Parties have been consulting regularly in the Conferences of the Parties (COP). The COP is often called the supreme decision-maker body of the Convention, as it monitors the states' efforts and the overall completion of the Convention; and ensures the continuity of the fight against climate change. The first COP session was held in 1995, where the Parties reached agreement on the Berlin Mandate. At that point, an ad hoc group was established with the aim of implementing some type of legal instrument to strengthen the commitment of Annex I Parties (Weyant, 2004).

Critics of the Protocol's future Adoption had historically put the convention ramification under a lot of pressure. It has come under attack on why it could not stop the increase of greenhouse gas emission. According to critics it has no long term view. It is unfortunate that the regulation covers only a part of the world, developing countries were not involved as responsible Parties, and many developed countries have changed their opinion and refused to comply with the rules (e.g. the United States and Canada). The lack of proper institutional infrastructure has meant that the platform can be seen rather as a forum of discussions; it deteriorates the efficiency that there is no strong enforcement and penalty. Consequently, natural disasters will be on the rise in most developing countries, including, Africa, that may lack the mitigative and adaptive instruments to cope with the events.

Natural disasters, as result of climate change, such as drought can have devastating short-term impact on an economy. Hence, the impacts of climatic shocks like drought

will adversely affect progress towards achieving sustainable development goals. Droughts cause loss of life, social disruption and affect economic activities. This is particularly true for low-income groups. The events also cause environmental damage, such as loss of fertile agricultural land, and water shortage. The general increase in number of fatalities as a direct result of drought worldwide has resulted to higher social, economic, and environmental effects. In fact, the overall number of people affected by disasters has been growing by 6% each year since 1960. This trend is expected to continue primarily because of increased concentration of people and values in the areas exposed to natural hazards. This is observed in most African countries were most people live in drought prone arid regions

Moreover, taking into consideration the effect droughts have on food security, through agricultural sector, and its impact on sustainable development, It is important to address the issue because Africa has not yet met the targets of achieving food security set by Sustainable Development Goals in 2015 or ending hunger. Increasing risks associated with disasters such as droughts might have a huge implication on employment opportunities within the region. This study contributes to the economic literature on the impact of drought in African countries, to help policy makers benefit from disaster risk mitigation and adaptation.

This study also hopes to provide estimates of the human and economic impact of drought, to measure the changes in sectoral output growth and to determine which sectors of a country or province is becoming more prone to the effects of drought as result of reduction of rainfall water. In other words, the aim of the thesis is also to assist policy makers to work with the findings in understanding which sectors are likely be more impacted by droughts. The study will be different from other studies in this area by examining the impact of drought on agricultural, manufacturing, construction, utility, mining, wholesale, and retail, restaurant, and hotel sectoral growth. This is as argued as a result of strong linkage between the agricultural sector and agro-business sector in African countries. Most studies focus on the impact of drought on agricultural activities, without examining the role of drought in affecting other sectors, through intermediate input of water and reduction in labour productivity that may have a ripple impact on different sectors of the economy. Understanding these mechanisms will enable some African countries to build on climatic resilient development as advocated by the African Review Commission.

Another contribution of this work is examining the impact of drought as a single disaster on income inequality that is prevalent in African countries, because of the availability of dataset from SWIID on between and within income groups. This enables us to examining the impact of drought on income inequality for 44 African countries and moreover, income inequality is a political decision to be made by policy makers, this thesis provide an insight on how drought will have an impact on income inequality, taking into cognizance of the global financial crises of 2008/2009 and in addition, income inequality is closely connected to poverty. Poor people are likely to hold lesser asset before and in times of disasters, which makes the level of income to

between the poor and well off to widen. A country study might be more important for policy framework, since each country has its own unique nuance.

1.6 Scope of the Study

The study covers broadly the impact the determinant of droughts and its impact on sectoral output growth, income inequality in African countries. Generalized Method of Moments was the preferred estimation technique used to achieve all the three objectives estimation, because of the nature of the data. Specifically, objective one investigated the impact of drought on agricultural sectoral output growth; manufacturing sectoral output growth; mining, manufacturing, and utility (MMU) sectoral output growth; and construction sectoral output growth. Objective one of the study uses a time series of data between the periods of 1980-2014 and was averaged in 5 years. The averaged data in 5 years is in accordance with economic growth literature. The periods of the data used in the objective one was also from 1980 to 2014. Forty-four panels of African countries were used as sample of study for the objective. Data on manufacturing and agricultural sectors indicator was obtained from World Development Indicator, while data for MMU and Construction sector indictors was accessed from United Nations Statistics Division (UNSD). The study harmonized the data from WDI and UNSD for objective one. The data for the core independent variable is calculated from Climate Knowledge Portal of the World Bank and University of East Anglia' Climate Research Unit.

Objective two specifically investigates the impact of drought on income inequality. The time series of the data used in estimations was from 2006 to 2014. The second objective specifically investigated the impact of drought on income inequality, holding other indicators like economic growth, financial development and so on constant within the time period. The data for income inequality was accessed from Standardized World Income Inequality Database (SWIID) and the control variables were obtained from World Development Indicator (WDI).

The third objective of the study investigated the factors affecting drought fatalities in African countries. The third objective focused on the direct impact of droughts in African countries. The third objective includes the sample of 44 countries are categorise under West African countries; North African countries; Central African countries and Eastern African countries and Southern African countries. The study reported the difference and system GMM results, but system GMM results were used for casual inference.

1.7 Organisation of the study

The thesis is divided into five chapters. Chapter 1 introduces the research issue motivation of the study. The problem statement, research questions, research objectives, significance of the study and the scope the study are reported sequentially in chapter one of the study. Chapter 2 focused on the theoretical and empirical literature on the relationship between drought and sectoral output growth. Theoretical and empirical literature for objective two and three were presented also in Chapter 2. The literature gap from literature review was the last sub-section in this chapter. Chapter 3 presented the three objectives' theoretical frameworks, empirical models, variable description, sources of data use in the study, and empirical estimation strategies. Chapter 4 reported the descriptive statistics, correlation matrix, and the estimation results of each objective. Chapter 5 concludes the study, and then followed by recommendation of the study, implication of the study, limitation of the research, and finally areas for further research sequentially.

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