

Joseph Awange

Food Insecurity & Hydroclimate in Greater Horn of Africa

Potential for Agriculture
Amidst Extremes

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Joseph Awange 
School of Earth and Planetary Sciences
Curtin University
Bentley, WA, Australia

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*To the memories of my late grandmothers
Amelea Gwada (Ere tekone dani nyar Mur)
and Rosalina Omulo Odera who tirelessly
toiled the land in scorching sun to provide
food for us. It is because of you two that I am
whom I am today. You are greatly missed.*

Joseph L. Awange

Perth Australia, September 2021

Foreword



The book represents a significant effort by Dr. Awange in trying to offer a comprehensive overview of the hydroclimate in the Greater Horn of Africa (GHA). He has stitched together several papers into four areas: 1. A hydroclimate overview of the GHA, 2. Water resources, 3. Extreme climate drought, and 4. Potential of irrigated agriculture in GHA; and within these parts are sub-sections based on his and other researchers. The GHA consists of Djibouti, Eritrea, Ethiopia, Kenya, Somalia, Sudan (now North and South Sudan), and parts of Uganda. While the book has substantial information from a scientific perspective, it fails in laying out the reasons why the people of the GHA are suffering from drought. I will try and fill in some of the policy and military conflicts that have impacted the GHA people. First, the GHA suffers from the combination of significant population growth (currently over 3%) and persistent military strife among various groups that resulted in great suffering among the people. Unfortunately, the climate variability, especially in the southern portion of the GHA, can't be addressed unless the poverty and migration from military strife are addressed. This point is crucial because the globalization of conflicts in the Horn led directly to militarization and its attendant consequences. As *Agyeman-Duah* (1966) states: "Arguably, governance and ethnic relations, as bad as they have

been in the region, were seriously jaundiced by the alacrity with which the global contestants were prepared to be dragged into the conflicts.”

As listed in Wikipedia, post-1960, there have been 17 conflicts including the current 2020 Tigray military intervention starting November 2020. Some examples from the post-colonial era (late 1950s to the present) show almost continuing and devastating inter-state wars that include the Ethiopian-Somali wars (1964, 1977–78, 2006–9), the Kenyan-Somali war (1963), the Ugandan-Tanzanian war (1978–79), the Ethiopian-Eritrean border war (1998–2000), the South Sudan-North Sudan conflict, and now the Tigray intervention. The *Daily Maverick* reports that this conflict is escalating out of control, threatening regional stability. The people have fled the area to neighboring states, stuck in camps and suffering terribly. How can they build up agricultural infrastructure to survive hydroclimate variability? They can't. Much can be said for the division of Sudan into northern and southern Sudan—lots of fighting, innocent people fleeing and stuck in camps that the UN (UN Office for the Coordination of Humanitarian Affairs), Doctors Without Borders, and other aid groups are providing help to. I could discuss this about every conflict in GHA. The problem in the GHA is that the United States and Russia (and Sweden, France, China, Czech Republic, Austria, and other countries) are providing arms to each side. The African Union (AU) has tried without much success for the cessation of hostilities.

My grandmother was 13 when she and her younger sister went with their mother (my Great Grandmother) from what is now Poland to Alberta, Canada, where she had an uncle. Her mother was given a ¼ section of land (about 250 acres), had to build a house and start farming to keep the land. How could they do this? Fundamentally, there was political and military stability. This allowed them to secure the land and grow crops within a region that has significant climate variability. So political and military stability is necessary.

The GHA countries, like other African countries, have short and/or fragmented hydroclimate (water, temperature, rainfall, and soil moisture) records, often as a result of armed conflicts at various times over the past 50 years and the sheer size of the region (> 6,000,000 km²). In some cases, the available records are inaccessible due to governmental red-tapes, and where accessible, some are too short, compounded by missing data lacking consistency or sparsely and unevenly distributed to be useful for adequate hydroclimate analysis. The book uses remote sensing to estimate the GHA hydroclimate. It's my sense that the remotely sensed data is also too short, ending in 1999 or early 2000s, to make statistically significant conclusions. Also, the tools being used have a variety of spatial and temporal resolutions that are used to estimate indices such as Total Water Storage (TWS) using GRACE and MODIS-2. Section 13.3.2 provides a list of the remote sensing products that are described in Sects. 13.3.3–13.3.5. What I find missing are careful validation studies that would indicate the best data for drought studies, both in a historical setting and in future projections. As Tierney et al (2015) stated

In contrast to 20th century drying, climate models predict that the Horn of Africa will become wetter as global temperatures rise. The projected increase in rainfall mainly occurs during the September-November "short rains" season, in response to large-scale weakening of the Walker circulation.

It seems that such projections should be central to any GHA study on drought and its impact on food production.

December 2020

Eric F. Wood
NAE (USA); FRSC (Canada); Foreign
member, ATSE (Australia)
Professor of Civil and Environmental
Engineering
Princeton University
Princeton, USA

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Preface

This book, which will benefit various users in the fields of environment, agriculture, and water provides the first comprehensive analysis of the Greater Horn of Africa (GHA)'s food insecurity and hydroclimate (temperature, precipitation, drought extremes, and total water storage changes) using the state-of-the-art *Gravity Recovery and Climate Experiment (GRACE) and its Follow-on (GRACE-FO)'s water storage changes, centennial precipitation, hydrological models' as well as reanalysis'* products. This is informed by under utilization of remote sensing data to support the formulation of food security measures in the GHA region. For instance, FAO states¹:

Knowledge and information systems underlie a broad range of fields, including social safety net policies, agricultural knowledge, the environment, health and education, administration, marketing, and even political information. Their poor state of development in the region handicaps both households and communities in their efforts to survive and prosper under difficult conditions. It also limits the capacity of governments to formulate appropriate policies and programmes that address the problem of food insecurity. Knowledge enhancement services, early warning systems and management information systems underpin all other efforts to address food security. Information systems have been geared almost exclusively to the collection of performance data that are relevant to crop production areas, using a combination of remote sensing and field data-gathering networks to provide early warning of emerging food insecurity situations. In some countries, there is a multiplicity of early warning and vulnerability systems, operated by governments, donors and NGOs. Systems for providing a similar warning of impending disaster in pastoral systems have emerged only recently and are being tested on a pilot scale. Over time, there has been increased capacity to provide accurate early warning information. However, the ability or willingness to respond adequately to the warnings that are produced has not improved. The recent crisis has demonstrated that there are weak links in the chain between early warning, pledges of food aid, ultimate delivery and properly directed distribution. It has also highlighted the one-way nature of current information systems in the vulnerable areas, where the capacity to disseminate knowledge and information in order to improve the coping abilities of the population remains poorly developed.

GHA, a region bedevilled by poor governance and the donor syndrome, is of late (2020–2021) faced by the so-called “triple threat” of *desert locust infestation*,

¹ <http://www.fao.org/3/x8406e/X8406e02.htm>.

the *impact of climate change*, and the *COVID-19 pandemic*. Its climate extremes (floods and droughts) are becoming the new normal given its heavy reliance on rain-fed agriculture and as such, one of the most food insecure regions in the world whenever these extremes strike. GHA, a region prone to climate extremes (droughts and floods) and conflicts, has seen its meagre water resources increasingly coming under threat specifically from drought leading to perennial food insecurity. In fact, for the GHA region, rather than responding successfully to the frequent recurrent droughts that afflict the region, the communities are invariably devastated by famine crisis, instabilities in national economies, and political tensions. For example, the Ethiopian *biblical* famines of 1973–74 and 1984–85 left about 200,000 and 400,000, people dead, respectively. The 1973–74 famine resulted in the overthrow of Emperor Haile Selassie who fed his dogs as starvation raged and the 1984–85 famine marked the end of Mengistu Haile Mariam who was celebrating his decadal hold of power while people died.

In fact, for the GHA region, rather than responding successfully to the frequent recurrent drought, which is a fact of life in many parts of the GHA having been recorded from as far back as 253 B.C. and afflicts the region, the communities are invariably devastated by famine crisis, instabilities in national economies, and political tensions. GHA's climate extremes such as droughts due to low rainfall and the aridity nature of much of the region influence its meagre water resources leading to perennial food insecurity. This, coupled with frequent regional and local conflicts, high population growth rate, low crop yield due to poor water control, climate change and/or variability, invasion of migratory pests, contagious human and livestock diseases such as HIV/AIDs and currently (2020–2021) COVID-19, and poverty in the region, simply makes life for more than 310 million inhabitants unbearable. Alarming is the fact that drought-like humanitarian crises in the GHA are increasing despite recent progress in drought monitoring and prediction efforts. Notwithstanding these efforts, there remain challenges stemming from uncertainty in drought prediction, and the inflexibility and limited buffering capacity of the recurrent impacted systems.

Food security of the region is hugely connected to the agricultural sector, a major economic endeavor that on the one hand provides employment while on the other hand provides the nutrition needs of the people within the region. However, this vital ingredient, “agriculture”, is increasingly coming under threat from climate extremes given the fact that Greater Horn of Africa (GHA) is heavily reliant on rain-fed agriculture and as such, one of the most food insecure regions in the world whenever these climate extremes (droughts and floods) strike. This is perplexing given GHA's freshwater (surface and groundwater) potential! It is the home to the world's second largest freshwater lake (Victoria) and endowed with towers in the continent (Ethiopian Highlands) all of which could be tapped in a sustainable way to support irrigated agriculture. First, however, the obsolete Nile treaties that hamper the use of Lake Victoria (White Nile) and Ethiopian Highland (Blue Nile) have to be done away with.

Furthermore, food insecurity in GHA is linked to low productivity, which is attributed to the fact that only less than 1% of the cultivatable land is irrigated due to

lack of proper utilization of groundwater. With climate extremes and high population growth projected to increase in future, food insecurity situation in the GHA region is also expected to worsen. To achieve greater food security, therefore, in addition to boosting GHA's agricultural output, the UN Office for the Coordination of Humanitarian Affairs opines that *inhabitants must create more diverse and stable means of livelihood to insulate themselves and their households from external shocks*, a task that they acknowledge will not be easy as the path ahead is "strewn with obstacles—two of the most important being *natural hazards* and *armed conflict*. Understanding GHA's hydroclimate, therefore, is a good starting point towards tackling the natural hazard on the one hand while understanding the impacts associated with extreme climate (drought) on the GHA's water resources and assessing the potential of its groundwater to support irrigated agriculture in the region would be the first step towards *coping with drought* on the other hand. This book looks at the hydroclimate of GHA with the view to assess extreme climate (drought), considers drought characteristics associated with coupled ocean-atmosphere phenomena in the region, and discusses food insecurity issues. This book will not be complete without thanking Associate Professor Freddie Mpelasoka (Curtin University, Australia), Professor Richard Anyah (Connecticut University, USA), the three anonymous reviewers and my wife Naomi Akoth Awange for their valuable comments that enriched the book. Thanks too to various publishers who granted permission to re-use the publications.

Perth, Australia

Joseph L. Awange

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Part I
Food Insecurity in GHA: Potentials
and Challenges

Chapter 1

Food Insecurity: Causes and Eradication



The main categories of chronically food-insecure people that emerged from discussions at the country level are: a) pastoralists and agro-pastoralists in arid and semi-arid areas; b) small-scale, resource-poor farmers; and c), the urban poor. The report identifies the underlying causes of long-term food insecurity as a dangerous conjunction of different factors. There is a high risk of natural hazards, especially drought, because of the aridity of much of the region and the fact that rainfall is low, unreliable and unevenly distributed. There is also evidence that the climate is becoming more unstable. Widespread regional and local conflict also triggers food insecurity. It drives people from their homes and disrupts marketing and distribution systems. Governments are using scarce resources on arms and, in 1997, the countries of the region devoted US\$2 billion to the military. This discourages donors, who are prepared to support people in need but want to avoid indirectly financing warfare. All this is compounded by high rates of population growth. The population of the Horn of Africa has more than doubled since the first of the modern droughts hit the region in 1974, and it is projected to increase by a further 40 percent by 2015. This puts intense pressure on natural resources. Many of the causes of food insecurity are in rural areas, where 80 percent of the population and most of the food-insecure are to be found. The natural resource base is fragile and degraded. The agriculture practised by almost all farmers is characterized by perhaps the lowest productivity in the world. A mere 1 percent of the cultivable area is irrigated, compared with 37 percent in Asia, denying farmers protection from the vagaries of the climate. The pastoral systems, which are well adapted to the vast arid lands, are nonetheless fragile and susceptible to climatic cycles and population pressure. For almost all rural people, household economies are narrowly based, and they have limited access to technology, knowledge and markets. Being only weakly connected to the market, few of the farmers have benefited from liberalization of the economy or from globalization. Indeed, they may well have suffered adverse consequences, having to pay more for inputs such as fertilizer, and receiving lower prices for their crops. All these factors serve to undermine the capacity of the people of the area to feed themselves or to be able to buy the food they need. – Food and Agriculture Organization of the United Nations (FAO) [37].

1.1 Greater Horn of Africa: Background

Greater Horn of Africa (GHA, Fig. 1.1a), one of the most food insecure regions in the world comprises of 11 countries; Burundi, Djibouti, Ethiopia, Eritrea, Kenya, Rwanda, Somalia, Sudan, Tanzania, Uganda and South Sudan, majority of which are classified as least developed where most of the societies survive on less than one dollar per day [2, 16]. Abshir [1] puts the area of Horn of Africa (which excludes Tanzania, Rwanda and Burundi) to 5.2 million square kilometers with a population of 230 millions. If Tanzania, Rwanda and Burundi are included to form the Greater Horn of Africa, it covers an area of over 6.2 million square kilometers and a population of over 310 million people with a growth rate that averages 3% a year. It is identified by the European Union [36] as a region of geo-strategic importance whose climate change exacerbates existing pressures in the region, including poverty, food insecurity and population growth, despite the fact that the countries of the Horn have little to no control over global carbon emissions [1].

Its climate may be classified as arid and semi-arid (Fig. 1.1b) with frequent recurrences of droughts (Fig. 1.1c and 1.3a) and floods (Fig. 1.1b and 1.3b), e.g., [4, 11, 20, 24, 27, 34, 35, 41, 42, 48, 58, 60, 81, 87]. The recurrences of floods and droughts have been associated with many socio-economic miseries. Furthermore, the region is often faced with serious food insecurity and resource-based conflicts. For example, 2010–2011 was shown to be the driest period in 60 years with more than 12 million people in need of emergency relief [9]. Intergovernmental Panel on Climate Change (IPCC) assessments [10] showed that climate change is real and the poor are the most vulnerable due to the already high level of vulnerability and low coping capacity. The vulnerability is amplified by the fact that many of GHA's livelihoods are dependent on farming and livestock; two sectors that are especially sensitive to perturbations in the climate system. For instance, drought, whose major episode has occurred at least once in each decade, is a fact of life in many parts of the GHA having been recorded from as far back as 253 B.C. [37]. Its impacts on agriculture include, e.g., crop losses, lower yields in both crops and livestock productions, increased livestock deaths, increase in insect infestation and plant and animal diseases [22]. Its impact on human health ranges from increased risk of food and water shortages to increased risk of malnutrition and a higher risk of water and food borne diseases [22, 38, 59, 73]. Climate change is, therefore, likely to set back development and food production in many of the predominantly agro-based economies of most communities.

The importance of agriculture in GHA is underpinned by the fact that it engages about 65% of the labour force (i.e., contributing to 42% of GHA's gross domestic products), where smallholder farmers who depend on rain-fed agriculture for subsistence farming contributes about 90% [3, 22, 73]. According to [22], the per capita food availability over Sub-Sahara Africa, to which GHA belongs, is below the world's average due to high population growth rate, slow and sometimes negative growth rate in agricultural production, climate variability, and poverty [51]. GHA's food insecurity, therefore, is a result of [22] natural hazards (frequent droughts and occasional floods), conflicts, population growth, fragile ecosystems, low agricultural

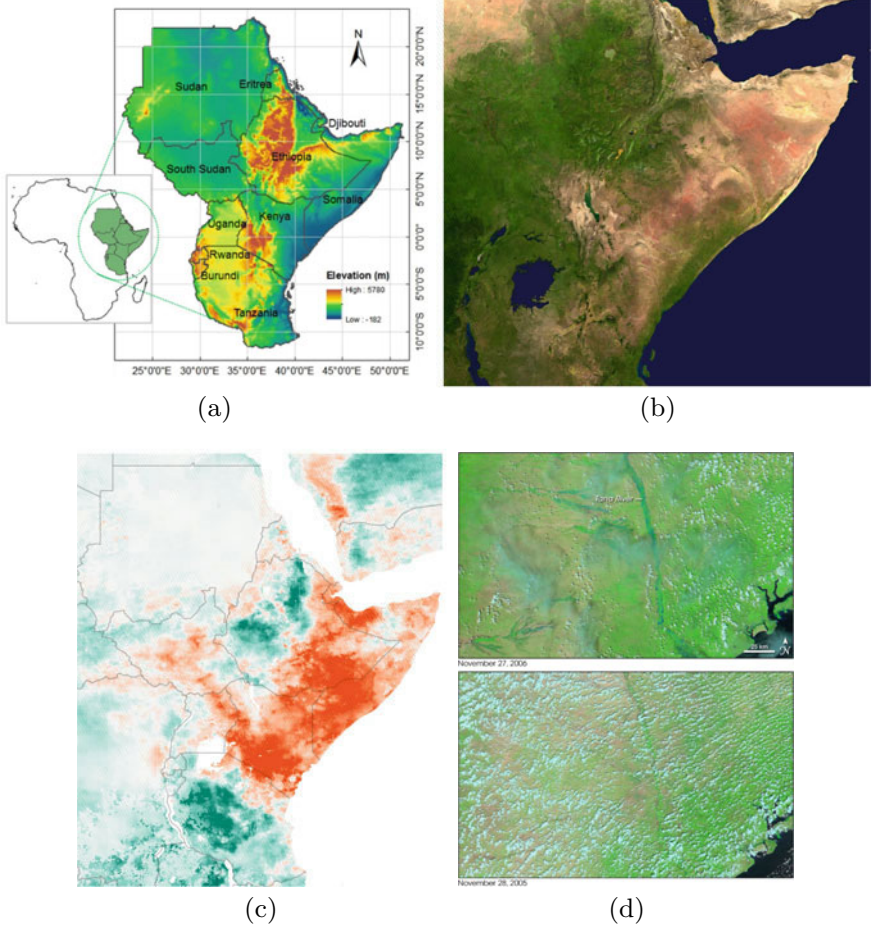


Fig. 1.1 **a** The African continent (left), indicating the location of the Greater Horn of Africa (GHA). The zoomed out image indicates the countries within GHA (Source [74]-<https://www.mdpi.com/2073-4433/9/3/112>), **b** the location of the major surface water bodies within GHA, specifically the dominant Lake Victoria Basin (LVB) (Source NASA, https://upload.wikimedia.org/wikipedia/commons/2/23/Nasa_Horn_of_Africa.JPG), **c** soil moisture anomalies in April 2019 in GHA depicting drought and its effect on growing crops (source <https://earthobservatory.nasa.gov/images/145116/food-crisis-grows-from-dry-soils>), and **(d)**, flooding of River Tana in GHA on November 27, 2006 (top), compared to its normal state on November 28, 2005 (bottom). Source <https://www.earthobservatory.nasa.gov/images/7164/flooding-in-the-horn-of-africa>

productivity, climate variability/change, poverty, and “*poor governance-donor help syndrome*” see e.g., [2, 30, 38, 51, 59, 78]. Indirectly, it has led to economic losses in growth of countries in the region [73].

Most regions of GHA (with the exception of the Ethiopian highlands, southern parts of Kenya and Uganda, and equatorial Sudan) experience low (c.a. 500 mm) and highly unreliable inter-annual and intra-annual rainfall that cannot sustain agricultural activities. These areas, designated as arid and semi-arid areas, amount to about 67% of the total area [37]. Spatial variability of seasonal rainfall over GHA from 1979 to 2010 is shown in Fig. 1.2, with Fig. 1.2a indicating the dry season of January–March. The long rains over equatorial GHA region mostly occur during March–May (MAM, Fig. 1.2b) while over the Ethiopian highland, this occurs from June to September (JJAS, Fig. 1.2c). The short rains occur in October–December (OND, Fig. 1.2d) corresponding to the migration of the intertropical convergence zone (ITCZ) from south to north and vice versa [12]. Furthermore, Ethiopia, South

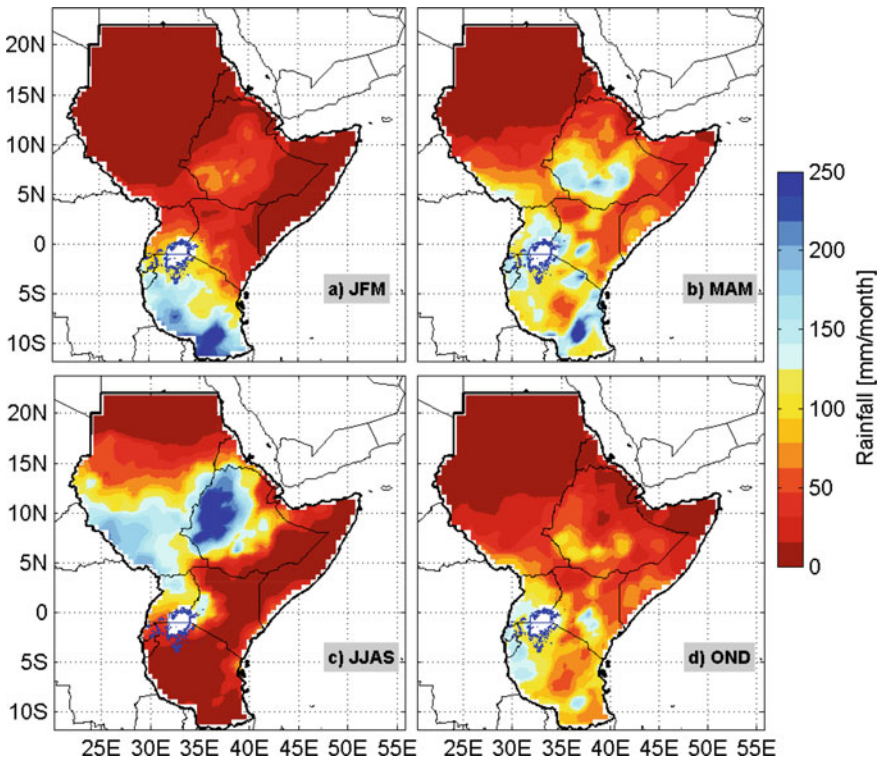


Fig. 1.2 Spatial variability of seasonal rainfall over GHA from 1979–2010 shown for different period of change based on GPCC v6 data: **a** January–March (JFM), **b** March–May (MAM), **c** June–September (JJAS), and **(d)**, October–December (OND). Note that the signals over Lake Victoria has been masked out in the analysis to avoid spurious trends due to varying lake levels. *Source* [4]



(a)



(b)

Fig. 1.3 **a** Drought in the Greater Horn of Africa is widespread, triggering a regional humanitarian crisis with food insecurity skyrocketing, particularly among livestock-owning communities, and devastating livelihoods, **b** floods in GHA, *Source* [37]

Sudan, Sudan, and parts of Uganda experience a single rainy season from June–September (JJAS; Fig. 1.2c).

Apart from its seasonal differences, rainfall variability over the GHA is closely associated with the large-scale regional and global circulations such as El Niño

Southern Oscillation ENSO [50], fluctuation of the Indian Ocean and Atlantic Ocean Sea Surface Temperature (SST), and moisture fluxes over the Congo region [11, 13, 15, 86]. Mean temperature patterns over GHA follow the annual rainfall pattern. The major water bodies found within GHA are shown in Fig. 1.1b.

1.2 Causes of Food Insecurity

1.2.1 *Poor Governance and the Donor Syndrome*

Reading most scholarly articles and organizational bodies' reports on the causes of famine/food insecurity in the GHA region, the usual culprits (climate, conflicts, and population growth) are mentioned. Seldom is the elephant in the room "poor governance and the donor syndrome" mentioned. For example, Food and Agricultural Organization (FAO) discusses it not under causes for food insecurity but rather under the supportive environment where it states [37]:

Although most governments of the region have food security policies or poverty reduction strategies and programmes that encompass food security issues, the allocation of national resources to achieving food security does not reflect the level of commitment that is needed. For example, throughout the region, budget allocations to supporting the agricultural sector are small and declining while, in many cases, expenditures on arms have soared. There has been a tendency to increase dependence on external assistance for meeting food security goals, especially when humanitarian considerations play a part.

Now, before we blame the usual culprits (conflicts, climate and population growth rate), it could be argued that the greatest cause of food insecurity in the GHA region could be the issue of poor governance and the perennial reliance on donor support. As a start, let us get some historic perspective in order to understand the argument that poor governance and reliance on donor support causes food insecurity and exacerbates famine in the region. Most countries within GHA are now almost 60 years since they attained independence. Since then, most lessons on the traditional causes of famine should have been learned and strategies for copying up formulated. Take the case of the perennial floods in Kenya as an example. Year in, year out, the rivers Nyando and Nzoia feeding into Lake Victoria bursts causing floods that destroys crops and displaces the riparian peasants living within the banks of these rivers. Sixty years along the line, has no successive government seen the need to address the problem? Another problem is the sustained killing of the local/rural agricultural activities. In Kenya for example, cotton used to be grown but the encouragement by the successive governments of second-hand imported clothes known locally as "mitumba" ultimately killed the cotton industry. On the chop board appears to be the sugarcane growing, where greed has crippled in and the "who is who" in the pecking order allowed to import foreign refined sugar at the expense of the local industry. The list goes on and on.

Then comes the donor. During one of the floods episode of river Nyando in Kenya mentioned above, a woman was captured begging the Kibaki government “Serikali saidia sisi”, a Swahili saying, which means government please help us. Her statement/voice is now popularly used by the Kenyan mobile giant Safaricom. But this seems to echo what the respective governments within the GHA are perennially telling donors. “Donors, please help us!” And the donors respond. Due to the so called “triple threat” of locust invasion, climate change impacts and the COVID-19 pandemic from 2020, the European Union donated about EUR 149 Million in humanitarian aid to the Greater Horn of Africa.¹ Will this money ever be reported to have achieved its aim? And yet this is not something new to the donors. Times without number, they know very well that the help they have been giving most often than not does not achieve its aims, yet they choose to turn a blind eye. Reports abound in newspapers where food meant to help the famine stricken communities have been found in the markets being sold or the money given for aid finding its way to fund armed conflicts. Could it be a symbiotic relationship between the donors and the respective governments? That 60 years along the line, the nations still have not learned any lessons to ameliorate the perennial food insecurity is baffling.

1.2.2 *Natural Hazards*

GHA, a region that is either arid or semi-arid with unreliable low and unevenly distributed rainfall, consist of many subsistence farmers who rely heavily on rain-fed agriculture, which in turn relies on the good will of the weather and climate. Climatic extremes (droughts and floods) are, therefore, one of the major factors contributing to vulnerability to food insecurity in GHA, where there is no year or season in which the whole region receives normal rainfall and is free from climatic anomalies such as flood or drought [37], (see also Fig. 1.3). For instance, just two years after the 2016/2017 drought and one year after flooding in 2018, back-to-back droughts and floods in 2019 led to rising needs and compounded the humanitarian consequences of conflict and violence in multiple locations. In addition to loss of lives, livestock and crops (Fig. 1.3a), as well as population displacement, the above normal rains and cyclonic activity in late-2019 and early-2020 contributed to a desert locust upsurge that affected Djibouti, Eritrea, Ethiopia, Kenya, Somalia, Sudan and spread to Uganda, South Sudan and Tanzania.² With sufficient rainfall, crops will perform well and food production will increase where farmers see bumper harvests. This good will, is however, not forthcoming with rain-fed agriculture increasingly becoming vulnerable to drought events, see e.g., [41, 45, 49, 63, 67, 76], leading to food insecurity [46, 49, 61, 62]. Between the two climate extremes (floods and

¹ https://ec.europa.eu/echo/news/eu-allocates-149-million-humanitarian-aid-greater-horn-africa-region_en.

² <https://reliefweb.int/report/ethiopia/greater-horn-africa-region-humanitarian-snapshot-february-2020>.

droughts), [56] opine that drought, which has a unique impact on agricultural systems due to its duration that often extends over several seasons, is the main cause of food insecurity over GHA leading to malnutrition and famine, and affecting all the four dimensions of food security; availability, accessibility, utilization, and stability, see also [38, 78]. This is captured by FAO who state [37]:

Drought has a perhaps unique impact on agricultural systems because of its duration, which often extends over several seasons. The people of the region have, over centuries, evolved mechanisms for coping with the risks of the environment in which they live. Farmers have, up to a point, learned to cope with late rains or with the mid-season cessation of rains, spreading risk by planting different crops and at different times, through on-farm storage and by resorting to hunting and gathering at times of stress. For the pastoralists, travelling with their herds and flocks to follow the rains and the growth in pasture is a natural part of their system, while setting areas aside for grazing reserves and splitting herds to minimize risk are elements of their coping mechanism. Increases in population have, however, disturbed the equilibrium between people and natural resources.

For the GHA region that experienced severe droughts in 1973/74, 1984/85, 1987, 1992 to 1994 and 1999/2000, [56] notes that rather than responding successfully to the frequent recurrent droughts that afflict the region, the communities are invariably devastated by famine crisis, instabilities in national economies and political tensions. For example, [56] point out that the Ethiopian “biblical” famines of 1973–74 and 1984–85 left about 200,000 and 400,000 people dead, respectively, with the former disaster resulting in the overthrow of Emperor Haile Selassie. The latter contributed to the end of the Marxist regime of Mengistu Haile Mariam. These numbers differ from those provided by Food and Agricultural Organization (FAO) that states [37]:

In Ethiopia alone, the 1984 drought affected 8.7 million people, about 1 million died and 1.5 million livestock perished. In the Sudan 8.5 million people were affected by the same drought, and about 1 million people and 7 million livestock died. In 1987, about 2 million people in the Sudan, more than 5.2 million in Ethiopia, 1 million in Eritrea and 200 000 in Somalia were severely affected. The current drought, which started in 1998, is affecting about 16 million people in the Horn of Africa. Drought is, therefore, a recurring phenomenon in the region and there will always be certain locations experiencing localized drought conditions.

To underscore this point, climate variability/change is projected to increase irrigation water demand on the one hand [73], and on the other hand, accelerate drought frequency, severity, spatial extents, and duration and its impacts [11, 35, 38, 41, 45, 56, 59, 60, 63, 71, 73, 84, 85]. Floods, when they occur (see Fig. 1.3b), as witnessed during the 1997/98 El Niño Southern Oscillation (ENSO; [5, 50]), lead to vulnerability in food security as they cause animal death (see Fig. 1.3a), siltation of reservoirs and destruction of crops, all which impact on the livelihood of both pastoralist and peasants of GHA. In this regard, therefore, increase in frequency and severity of climate extremes (floods and droughts), and increased irrigation water demand are likely to further decrease crop water availability and threaten the productivity of rain-fed agriculture over the region, e.g., [73], thus increased food insecurity [22].

1.2.3 *Conflicts: Regional and Local*

Although the region is largely stable politically, Greater Horn of Africa (GHA) is not new to conflicts, see e.g., [43, 44]. Be it the ship piracy in the Indian ocean, frequent militia attacks in Somalia, or the disputed Grand Ethiopian Renaissance Dam (GERD) being built by Ethiopia, GHA will always be on news. The dire conflict situation in GHA is captured by FAO who states [37]:

The Horn of Africa has been plagued by conflict since time immemorial. Although the war between Ethiopia and Eritrea has attracted the most media attention, the region has suffered from almost continuous civil conflicts over the last 30 years in Ethiopia (as formerly defined), the Sudan, Somalia and Uganda, and these have spilled over into Djibouti. The countries of the region devote between 8 and 50 percent of central government expenditure, or between 2 and 8 percent of gross national product (GNP), to the military, totalling US\$2 billion in 1997. These figures rise substantially, of course, whenever conflict flares up. Conflicts in the region undoubtedly exacerbate the famine and food insecurity triggered by drought. Even before the recent hostilities between Ethiopia and Eritrea, more than 1 million people from the region were refugees. Large populations of internally displaced persons (IDPs) were to be found in the Sudan, Somalia and Uganda. Conflict removes able-bodied men from agricultural production and, incidentally, places an extra work burden on women. It also diverts resources, directly and indirectly, from more productive and socially beneficial uses, and tests the willingness of the international community to provide assistance.

Somalia and South Sudan have experienced internal armed conflicts, e.g., within Somalia, there exists the Alshebab threat while within South Sudan fighting have occurred between supporters of the current President Silver Korr and his Vice President Riek Machar. Armed conflicts between countries have also occurred in the region, e.g., within/between Ethiopia and Eritrea. Abshir [1] points out that sometimes countries often intervene in their neighbours' conflicts, either directly by sending troops or indirectly by sponsoring proxies or supporting rebel groups. Besides cross-border conflicts, another common feature in the region is the regularity of ethnic overlaps, affinities and loyalties that transcend national borders (e.g., Somalis in Ethiopia-Kenya-Djibouti; Karamajong in Uganda, Kenya, and South Sudan; Afars in Djibouti-Eritrea-Ethiopia; Borans in Kenya-Ethiopia) [1]. Abshir [1] states: "*On one hand, these overlaps facilitate informal trade and commerce, but on the other they are seen by state authorities as a liability and a potential source of insecurity*". At the time of writing this book (2021), three agencies; The Food and Agriculture Organization of the United Nations (FAO), the United Nations World Food Programme (WFP), and United Nations International Children's Emergency Fund (UNICEF) have sounded an alarm over acute food insecurity in northern Ethiopia's conflict-ravaged Tigray region, where more than 350,000 people have been afflicted by famine. In fact, the Integrated Food Security Phase Classification (IPC), a system used by humanitarian aid agencies and governments to determine the scale of a hunger crisis placed Tigray in Phase 5 (i.e., IPC5, i.e., catastrophe/famine),³ and blamed the conflict for triggering massive population displacement, widespread destruction of livelihoods

³ <https://www.nytimes.com/2021/06/10/world/africa/ethiopia-famine-tigray.html>.

and critical infrastructure, loss of employment, and limiting access to markets.⁴ The IPC Acute Food Insecurity (IPC AFI) classification provides strategically relevant information to decision makers that focuses on short-term objectives to prevent, mitigate or decrease severe food insecurity that threatens lives or livelihoods, and provides differentiation between different levels of severity of acute food insecurity in five distinct phases; IPC1 (minimal/none), IPC2 (stressed), IPC3 (crisis), IPC4 (emergency), and IPC5 (catastrophe/famine). Each of these phases has important and distinct implications for where and how best to intervene, and therefore influences priority response objectives.⁵ IPC data showed that of 5.5 million people facing food insecurity in Tigray and neighboring zones during May and June, 350,000 were now in Phase 5 as a result of cascading effects of conflict, including population displacements, movement restrictions, limited humanitarian access, loss of harvest and livelihood assets, and dysfunctional or nonexistent markets.⁶ These armed conflicts impact on agricultural productivity, see e.g., [66, 69, 78].

On the one hand, some of these conflicts are lethal and impact on establishing hydroclimate monitoring stations and/or collection of the recorded data. On the other hand, the link of conflicts to food insecurity means that each can trigger the other as scramble over resources is associated with population increase. As food security is linked to smallholder rain-fed subsistence agriculture, any factor that prevents the population from day to day farming e.g., population displacements witnessed in South Sudan and Somalia and/or deviation of agricultural allocated funds to military use is likely to put additional pressure on food resources of those countries thus making them vulnerable to food insecurity [22]. Pastoral areas are not spared either nor are the internally displaced people (IDPs). FAO states [37]:

Pastoral areas, which are under pressure from the expansion of cropping into marginal areas and increasingly degraded rangelands, are especially susceptible to local conflict and cattle raids, which break out when people have ready access to modern weapons. Northern Kenya and northern Uganda have been particularly prone to prolonged outbreaks of such violence. Such tendencies are exacerbated when drought hits and the scramble for limited grazing and water intensifies. Conflict, whether transboundary or internal, exacerbates the vulnerability of poor people, displacing them from their homes and depleting their assets. It makes emergency relief operations directed towards IDPs difficult and dangerous for those involved. Conflict also has a much more insidious impact on long-term development efforts, diverting scarce resources, both national and external, away from development activities and into war. The fungibility of funds means that donors face the risk of funding conflict when their intention is to alleviate poverty through development programmes.

⁴ <https://www.unicef.org/press-releases/un-agencies-concerned-looming-famine-northern-ethiopia-call-urgent-life-saving>.

⁵ <http://www.ipcinfo.org/ipcinfo-website/ipc-overview-and-classification-system/ipc-acute-food-insecurity-classification/en/>.

⁶ <https://www.nytimes.com/2021/06/10/world/africa/ethiopia-famine-tigray.html>.

1.2.4 Population Growth: Rural Urban Migration

The population of the 11 countries that comprise GHA, which has more than doubled since 1974 is currently more than 310 million [1, 37], with an average population growth rate for the region being 3% [6], and where the population is expected to double every 23 years [17], see Fig. 1.5. This rapid increase in population growth where young people form the majority [17], will certainly exert pressure on the natural resources (water and land) on the one hand, and increase in rural urban migration on the other hand leading to impact on food security [3, 40, 51, 53, 59, 73, 78, 82]. Traditionally, land in GHA is passed largely to the sons through subdivision and as such, a rapid increase in population, therefore, would see increase in land fragmentation that is unhealthy for subsistence agricultural productivity and subsequently food security, see e.g., [55].

Another problem, which is closely associated with population growth is that of environmental degradation, i.e., land and vegetation. Population increase puts pressure on energy demand [64, 65], which is supplied mainly by wood and animal manure. This in turn leads to land degradation as the forests that have been harvested to provide fuel leads to exposed land that favour soil erosion during rainy seasons. Eventually, this overall degradation leads to increase in rainwater losses through runoff that triggers soil erosion, which in turn exacerbates drought impact resulting in further land productivity decline, loss of biodiversity and continuing desertification [37]. Furthermore, soil erosion leads to siltation of water bodies, e.g., Lake Victoria, which are essential for livelihood. Besides deforestation for fuel purposes, there is also the problem of urban encroachment on arable land that could be used for crop production. The encroachment takes the form of the land being converted to other uses, e.g., biofuel production [2] and the expansion of cities. Morgan et al. [54] have shown (see Fig. 1.4) that for the Ugandan cities of Jinja, Kampala, Masaka and Mbarara; Kigali in Rwanda, and Kisii in Kenya, the outward urban expansion was the primary contributor for the long-term vegetation decline. To this end, FAO states [37]:

To the extent that there has been any increase in the area of land being farmed, this has taken place largely in marginal areas, using systems that may not be sustainable. Shrinking land resources have not been compensated for by increases in land productivity. Average cereal yields are a mere 860 kg/ha and, where comparative data are available, statistics confirm the general impression that yields are declining. For example, in the Sudan and Uganda, average yields have dropped by 12 and 18 percent, respectively, over the last decade.

1.2.5 Poverty

Poverty is connected to food insecurity [2]. This connection is more important in GHA where most food is produced in rural areas where a majority of the population is poor. For these poor, subsistence farming and pastoralism form their main source