



The Implications of Extreme Weather Events for Attaining the Sustainable Development Goals in Sub-Saharan Africa

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Sub-Saharan Africa is among the regions that contribute least to global climate change, yet it is among the most vulnerable to its impacts due to low levels of economic and technological development. The frequency and magnitude of extreme weather events in the region are rising at a faster rate than the population capacity to deal with the attendant disasters. This paper interrogates some emerging and existing evidence of the potential for extreme weather events to obviate countries' attainment of the Sustainable Development Goals (SDGs). Whilst previous studies have assessed the vulnerabilities of sub-Saharan African (SSA) countries to extreme weather events on specific sectors, a comprehensive assessment of the implications of these extreme events for attaining the SDGs remains largely untouched. This paper assesses the impacts of flooding, extreme heat and drought on five key SDGs—Zero hunger (Goal 2), Good health and well-being (Goal 3), Quality education (Goal 4), Clean water and sanitation (Goal 6), and Sustainable cities and communities (Goal 11). Based on empirical cases from different SSA country contexts, and guided by the SDG targets and indicators, we discuss the main interactions between extreme weather events and different SDGs, emerging with a framework for the climate change—sustainable development nexus. Such an assessment, with regard to specific national and local case studies, would inform policy formulation and implementation, research and investment toward sustainable development in the region. Integrating resilience strategies into national development policies will offer sub-Saharan African countries the opportunity to reduce the impacts of extreme weather events on attaining their targets for sustainable development towards Agenda 2030.

Keywords: extreme event, sustainable development goals, Sub-Saharan Africa, food security, health and wellbeing, water and sanitation, quality education, sustainable cities and communities

INTRODUCTION

Over the past two decades, African countries have experienced some remarkable economic growth, yet the continent is still home to over half of the world's poor population (Sustainable Development Goals Center for Africa (SDGC/A), 2019). As part of efforts to eradicate global poverty and ensure well-being for all, United Nations member states adopted the 2030 Agenda

for Sustainable Development in September, 2015 (United Nations, 2015). Prior, to that the African Union had adopted the Agenda 2063 as a comprehensive programme of action toward inclusive and sustainable development for the continent. Like all other relevant regional and multilateral programmes of action, the UN Sustainable Development Goals (SDGs) integrated the AU Agenda 2063 in its development and so both agenda are aligned (United Nations, 2015). Sub-Saharan Africa remains one of the least developed regions globally in socioeconomic terms. Sub-Saharan Africa comprises four major regions; West Africa, Central Africa, East Africa, and Southern Africa. There is an appreciable distinction between North Africa and the other regions toward the attainment of various SDGs (AU, ECA, AfDB, and UNDP, 2018). Various assessments of the progress of sub-Saharan African countries toward achieving the SDGs identify that the targets are somehow ambitious and may require enhanced commitment and targeted resource allocation (Nhamo et al., 2019). Emerging research and anecdotal evidence indicate that climate change and its attendant extreme weather events adversely impact development and human well-being globally. Indeed, climate change and its impacts can potentially erode the gains made from investments made by governments into education, health, water, and food security to enhance population development. However, while sub-Saharan African governments are actively pursuing their human development agenda by focusing on harnessing the potential of a demographic dividend from their youthful populations, climate change seems a remote concern for many (Ezeh, 2016). Considering that extreme weather events associated with climate change have considerable impacts on key thematic developmental issues, the paucity of studies on the implication of these extreme events for attaining the SDGs in SSA is a cause for concern.

According to the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), mean annual temperatures have increased over the past half century and are projected to increase by over 2°C by the end of the century (Niang et al., 2014). According to the 2018 IPCC Special Report on global warming, temperatures will reach 1.5°C above pre-industrial times between 2030 and 2052 (IPCC, 2018). Africa is one of the continents most likely to be adversely impacted by the manifestations of extreme climate variability even though it is among the lowest contributors to anthropogenic climate change. Climate change occurs over decades or centuries, however, short term extreme weather events are experienced periodically by populations. In fact, the frequency, duration, and magnitude of extreme events, including droughts, flooding, and extreme heat, have increased over the past half century (Niang et al., 2014). This increase in extreme events is unmatched by the capacity for governments and populations to effectively manage the consequences. Limited capacity due to poor infrastructure, inefficient governance mechanisms, informality and lack of preparedness are harbingers of disastrous effects of extreme events in many sub-Saharan African countries. Though with less confidence than for temperature, it is projected that the frequency of extreme rainfall days will increase over western and eastern Africa while general warming over recent past decades signal deficient rainfall and severe drought risks in parts of southern

and eastern Africa (Niang et al., 2014; IPCC, 2018). The lack of an effective adaptation policy and disaster response space in many sub-Saharan African countries suggest a lack of capacity to effectively deal with the impacts of extreme weather events, thus hampering efforts toward the attainment of the SDGs. In spite of this, few studies assess the implications of extreme weather events for achieving the SDGs by sub-Saharan African countries. Even though some studies examine the impact of climate change or extreme weather events on individual sectors of development such as food security (Connolly-Boutin and Smit, 2016; Tumushabe, 2018), water (Ziervogel, 2018; Nhamo et al., 2019), and health (Codjoe and Nabie, 2014; Dovie et al., 2017; Codjoe et al., 2020) among others there is no study that attempts to holistically address the challenges extreme weather events present to the attainment of the SDGs across the sub-Saharan African region. Given the foregoing, this paper attempts to answer the question, “How will extreme weather events impact the attainment of the Sustainable Development Goals by African countries?”

EXTREME WEATHER EVENTS AND THE SDGS

This paper focuses on the impacts of extreme weather events on five thematic issues including food, health, education, water and sustainable living in communities. These five key issues are not only development outcomes but are also in themselves means through which key development agenda such as poverty eradication and gender equity can be attained. These issues are at the core of sustainable development and are directly affected by the impacts of extreme weather events.

Zero Hunger (Goal 2)

Goal 2 of the SDGs aims to “end hunger, achieve food security and improved nutrition and promote sustainable agriculture” (Box 1). As shown in Box 1 below, the aim of the SDGs is to exceed eradicating hunger to include the ambitious targets of adequate nutrition and food safety (FAO, 2019). Recent evidence shows that, after years of continual decline until 2015, food insecurity and undernourishment are on the rise in many sub-Saharan African countries and the region has the highest burden of global food insecurity (FAO, 2019). All four SSA regions have severe food insecurity at levels more than twice the global average (Sustainable Development Goals Center for Africa (SDGC/A), 2019). Food insecurity levels are particularly highest in Central Africa and East Africa. In Central Africa, food insecurity has been worsened by rapid population growth, poverty, harsh environmental conditions, and political instability (Tumushabe, 2018). With this level of food insecurity in the region, therefore, it is important to assess the extent to which extreme climate events impede efforts toward attaining specific targets of the SDG 2.

Food production, which is at the core of food availability and specific to targets 2.3 and 2.4, is one of the targets most sensitive to extreme weather events. In low-income contexts, particularly in sub-Saharan Africa, where much of the food production is rain-fed, the implications seem more dire (FAO,

BOX 1 | SDG Goal 2: Zero hunger (United Nations, 2015).

Targets:

By 2030,

- 2.1 end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious, and sufficient food all year round
- 2.2 end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women, and older persons
- 2.3 double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists, and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets, and opportunities for value addition and non-farm employment
- 2.4 ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding, and other disasters and that progressively improve land and soil quality
- 2.5 maintain the genetic diversity of seeds, cultivated plants, and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional, and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed

2018). The lack of sophisticated crop production and storage technologies or infrastructure contribute immensely to food losses in SSA (Nyo, 2016). Climate change and variability continue to extensively impact the already deficient crop, livestock, and fisheries production, as well as change the prevalence of crop pests and diseases (Campbell et al., 2016). In arid and semi-arid areas of SSA, where temperatures are projected to increase over the next century, erratic rainfall and increased evapotranspiration threaten to exacerbate the impacts of droughts for agro-pastoralism which is the mainstay of about 80% of rural populations across SSA (FAO, 2018). Severe droughts in the Horn of Africa in the 2015–16 period devastated livelihoods for many households, particularly millions of pastoralists living in Ethiopia and Kenya (Tumushabe, 2018). Droughts significantly impact agricultural production systems, be they irrigated or rainfed.

Another impact of extreme weather events on food production is by creating suitable environment for pest breeding and migration. In mid-2019, unusual tropical cyclones in the Arabian peninsula led to an outbreak of desert locusts who thrived and migrated through Yemen and into East Africa by the end of 2019, facilitated by yet other tropical cyclones, wreaking havoc for local farmers and economies who were both unprepared and lacked the capacity to deal with the plague (Salih et al., 2020). Though the desert locusts have been in existence for eons, this outbreak has been spurred by unusual tropical cyclones in East Africa and the Near East, creating favorable

conditions for the locusts to reproduce rapidly and migrate over long distances (Kennedy, 2020). This is an indirect impediment to the attempts by affected communities and countries to attain Target 2.4 attributable to the occurrence of extreme events.

Combined agro-ecologic and economic models of all regions in the world project that SSA will most likely be biggest bearer of the brunt of climate change impacts, generating the lowest incomes from agriculture (Schmidhuber and Tubiello, 2007). The IPCC in its AR5 on Africa declared with high confidence that climate change would result in yield losses for major cereal staples across SSA (Niang et al., 2014). Generally, analyses of rainfall patterns between 2004 and 2016 over the continent indicate that there has been shortening of growing season length in Southern Africa and West Africa (FAO, 2018) while days of extreme precipitation are projected to be more frequent (IPCC, 2018). Flooding across the Sahel is also associated with destruction of cropland for thousands of populations (Tschakert et al., 2010). Flooding can also lead to the loss of livestock and stored crop produce (Fiorillo et al., 2018).

Livelihood diversification seems a feasible economic adaptation strategy, however, some livelihood activities that are not sensitive to extreme events may adversely impact the environment (Niang et al., 2014). Also, while shifting from agriculture to other economic activities may improve income for households, it may lead to a reduction in agricultural outputs for countries and the region and ultimately a higher dependency on food imports. In Ghana, for instance, small scale farmers have transferred or lost farmlands and farms (including cocoa farms) to small-scale gold miners or even diversified from farming to mining, sometimes illegally (Boadi et al., 2016). This has implications for overall food price hikes due to production shortage amidst higher demand from miners and the general population. Usually, net producers of food crops will gain from price hikes due to food shortage as a result of extreme events (Grimm, 2011). However, majority of the SSA population engaged in agriculture are smallholder farmers who practice subsistence farming (Yaro, 2013) and lack the capacity to exponentially increase production.

To effectively reduce poverty, therefore, there is the need to enhance climate resilience in agricultural production to improve food availability and improve household incomes of farming communities. Also, the more affordable food becomes on the market the more accessible it will be and the lower the proportion of households' incomes that will be spent on food, leaving more disposable income to be spent on other needs and services.

Some African countries, with support from development partners and donor agencies, have undertaken programmes to increase the resilience of populations chronically affected by extreme weather shocks. For example, the Government of Malawi secured funding from the Green Climate Fund with the assistance of UNDP to expand early warning systems and climate information to communities in food-insecure districts¹. The government, with support from the FAO also secured funds to support selected communities against food crop and livestock loss by providing improved seed varieties, increasing access

¹<https://www.dodma.gov.mw/index.php/projects/m-climes-project>.

to water resources and livestock vaccinations² It behooves on governments to provide safety nets for perpetually vulnerable communities to safeguard against crop and livestock production loss in order to attain food security for all.

Good Health and Well-Being (Goal 3)

SDG 3 aims at ensuring health lives and promoting well-being for all people at all ages (Box 2).

The IPCC AR5 affirms with high confidence that climate change has significant influence on human health (Smith et al., 2014). Extreme weather events impact the socioeconomic and environmental determinants of health, causes of disease as well as the healthcare systems. Under-five mortality rates are highest in SSA and many countries, based on observed trends, many not be likely to reach the targets by 2030 [Sustainable Development Goals Center for Africa (SDGC/A), 2019].

Extreme weather events have direct and indirect effects on health across SSA. Due to variability in climate and environmental conditions by sub-region and country, the potential impact on health in each country is largely dependent on local environmental conditions as well as existing health systems. One of the key targets is to eradicate epidemics of vector-borne diseases including some whose vectors are influenced by extreme weather events. Flooding is associated with an increased outbreak of diarrhoeal diseases in urban areas of many SSA countries (Abu and Codjoe, 2018; Okaka and Odhiambo, 2018). In most African cities, where water vendors supply water to households using water tankers, the risk of pathogenic infections is higher. Flooding devastates health facility infrastructure and disrupts access to healthcare in SSA countries where health infrastructure are rarely climate-resilient (Codjoe et al., 2020).

A major omission from the SDGs is the inclusion of deaths associated with extreme events. Floods in East Africa between April and June, 2020 directly resulted in tens of deaths in Kenya, Rwanda, Somalia, and Uganda, at the same time as they were hit by locust invasion and were at the early stages of the global coronavirus disease pandemic³. Floods cause accidents and fatal injuries to affected populations due to inadequate early warning systems, poorly coordinated disaster risk preparedness, response, and management in many SSA countries. They can also exacerbate existing health hazards particularly in urban areas. In 2015, in Ghana, flooding exacerbated the disaster caused by leakage from a fuel station in the capital city, Accra, leading to fire outbreak that left over a 150 dead, many more injured dead and about \$100 million in asset losses in its wake (Erman et al., 2018). This example demonstrates the poor accident control mechanisms in efforts to “substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination (Target 3.9)” which are exacerbated by the occurrence of flooding.

Besides, flooding, like drought, can cause severe emotional and psychological distress for displaced households or those

BOX 2 | Goal 3: Good health and well-being (United Nations, 2015).

Targets:

By 2030,

- 3.1 reduce the global maternal mortality ratio to <70 per 100,000 live births
- 3.2 end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births
- 3.3 end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases, and other communicable diseases
- 3.4 reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being
- 3.5 Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol
- 3.6 halve the number of global deaths and injuries from road traffic accidents
- 3.7 ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes
- 3.8 Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality, and affordable essential medicines and vaccines for all
- 3.9 substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination

that lose loved ones and properties. Severe droughts can cause devastating impacts that can lead to emotional distress for individuals. The sight of dead cattle and failed crops following a drought can be a source of great emotional distress for farming households (Babugura, 2008). Acute water shortage can cause great emotional and physical distress for people, particularly women, who have to trek over long distances to collect water for household consumption and use (Arku and Arku, 2010; Asaba et al., 2013; Graham et al., 2016). Based on models of yellow fever transmission across countries in West, East, and Central Africa that incorporate future temperature projections that assume a 1.5°C temperature increase between 2030 and 2050, and keeping vaccination rates constant at 2018 levels, temperature increases by year 2050 will lead to increase in force of infection particularly in Central and East Africa. Similarly, mortality due to yellow fever is projected to increase under RCP scenarios 4.5, 6.0, and 8.5. This has the potential to increase the yellow fever burden across all endemic regions (Gaythorpe et al., 2020).

Extreme heat potentially increases temperature-related morbidity in many parts of SSA where housing quality is low and occupational conditions are dire. In South Africa, extreme heat impacts the domestic environment in informal settlement houses made of inferior poorly-insulated materials increasing heat-related stress and sleeplessness (Chersich et al., 2018). In a study of the impacts of climate change on occupational stress, manual workers from two sites in South Africa (Johannesburg and Upington) associated extreme summer temperatures with reduced productivity and myriad of poor health outcomes

²<http://www.fao.org/emergencies/fao-in-action/stories/stories-detail/en/c/1180394/>.

³[https://www.bbc.com/news/world-africa-52571322#:~:sim\\$=text=Flooding%20as%20a%20result%20of%20have%20killed%2016%20in%20Somalia](https://www.bbc.com/news/world-africa-52571322#:~:sim$=text=Flooding%20as%20a%20result%20of%20have%20killed%2016%20in%20Somalia).

including dehydration, skin irritations, burning eyes, headaches, exhaustion, sinus problems, and dizziness among others (Mathee et al., 2010). The working conditions of manual workers is similar across the sub-region with many occupational activities conducted outdoors or in the open.

In addition, extreme heat affects the delivery of healthcare for many in urban heat islands across the region. A study in Ghana revealed that many health facilities are poorly designed to be resilient to high indoor temperatures and may lack adequate cooling systems, thereby increasing both patient and health worker irritability as well as affecting drug quality (Codjoe et al., 2020). Health facilities must be designed to provide optimum room temperature as well as sited with proper drainage systems to ensure access during flooding. Particular communities noted for vulnerabilities to disease outbreaks and other health challenges should be specifically targeted for early warning systems, public health education and interventions. It is to be noted that good health and well-being are greatly linked with water and food security, thus, efforts must be strengthened to improve access to safe water and sufficient nutritious food for all.

Quality Education (Goal 4)

Goal 4 of the SDGs is for governments and stakeholders to “ensure inclusive and equitable quality education and promote lifelong learning opportunities for all” (United Nations, 2015) (Box 3). Education is vital for the psychosocial and economic development of children and youth. While many SSA countries have endeavored to improve enrolment rates it is still unclear the extent to which there is equity in access and quality of education.

Extreme weather events potentially impede the attainment of this goal by affecting school attendance and dropout rates through their impacts or critical livelihood resource such as water and food. Analyses of school enrolment and attendance data from primary schools and climate (temperature and rainfall) data between 1970 and 2006 in the arid Zamfara State in Northern Nigeria, show that school attendance is low during drought and high when the rains come (Adejuwon, 2016). Household water collection is typically the responsibility of women and children in many rural communities across the region. Hence, during droughts, school attendance is affected when school time is spent fetching water and with prolonged droughts, dropout rates increase. This reflects the indirect impacts of droughts on Goal 4.5 which seeks to “eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations.” Improving water availability for water-scarce communities will help remove this barrier to school attendance for young girls.

On the other hand, household income from crop and livestock production drops in times of drought and affects the households' capacity to afford school expenditure. School enrolment and attendance is further affected when schoolchildren have to take up extra household chores when their guardians migrate or work extra hours, engage in economic activities to augment household

BOX 3 | Goal 4: Quality education (United Nations, 2015).

Targets:

By 2030,

- 4.1 ensure that all girls and boys complete free, equitable, and quality primary and secondary education leading to relevant and effective learning outcomes
- 4.2 ensure that all girls and boys have access to quality early childhood development, care, and pre-primary education so that they are ready for primary education
- 4.3 ensure equal access for all women and men to affordable and quality technical, vocational, and tertiary education, including university
- 4.4 substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship
- 4.5 eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations
- 4.6 ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy
- 4.7 ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development

income or migrate altogether with their parents for succor (Babugura, 2008). Dropping out of school and absenteeism disproportionately affects more girls than boys even within same communities.

Not only enrolment is affected by droughts, learning outcomes can be somehow impacted by droughts. Thus, drought experiences can be linked with the attainment of Target 4.6 to “ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy” and Target 4.7 to “ensure that all learners acquire the knowledge and skills needed to promote sustainable development” particularly in rural areas. A comparative study among girls from drought-affected and unaffected rural Zimbabwe, found that, in spite of advancing in school due to automatic grade progression, droughts were associated with worsened learning and leadership test outcomes, suggesting adverse mental health consequences of droughts (Nordstrom and Cotton, 2020). The effects of drought especially for education gendered considering that social roles and responsibilities are gendered for children of school-going age.

Besides droughts, flooding contributes significantly to educational outcomes. Flooding can have direct destructive impacts on school buildings and can lead to internal displacement which affects education in many countries. However, the effects of flooding, though sudden, has shorter durations of effect on education. Evidence from Eswatini shows that flooding may not keep people out of school for long, as rebuilding after floods is much faster compared with severe droughts (International Displacement Monitoring Centre, 2020).

It is clear that droughts, extreme heat, and flooding can adversely affect the efforts toward attaining the targets of the SDGs on education. This relationship, as demonstrated with the examples above, is indirect through the direct impacts of drought on Goals 1 (No poverty), 2 (Zero hunger), and 6 (Clean water and sanitation). Therefore, to consolidate gains made by investment into increasing access to education, governments must specifically target communities affected by drought or by perennial floods with interventions to increase in times of extreme weather events. Interventions toward enhancing water, food, and livelihood resilience will impact school attendance and completion especially for young girls.

Clean Water and Sanitation (Goal 6)

SDG 6 seeks to “ensure availability and sustainable management of water and sanitation for all” (Box 4). Beside safe water being a physiological need for human survival, it is essential for human well-being and socio-economic development and ecosystem sustainability.

Attaining water security is central to the SDGs. This is a very critical goal which directly underlies other goals including no poverty, zero hunger, good health and well-being, oceans, and biodiversity. In spite of increased access to safe drinking water and improved sanitation in SSA over the past two decades, the regional coverage rate is lowest for any region with less than half the global average with remarkable disparities between and within countries (AU, ECA, AfDB, and UNDP, 2018). In fact, by 2015 which is the baseline for the SDGs, whereas about 89% of the global population were served by at least basic water services—an improved water source within 30 min’ round trip to collect water—this was only true for about 58% of the SSA population (WHO UNICEF, 2017). Only 24% of SSA population had access to safely managed water sources compared with the global average of 71% while about two-thirds of the 159 million people dependent on surface water sources for drinking were in SSA (WHO UNICEF, 2017).

Precipitation, surface and ground water resources are unequally distributed across the region, with significant limitations in the Sahelian regions of West Africa, and in Southern and East Africa. Preexisting conditions of water scarcity in these regions challenge the resilience of populations toward achieving water security. Climate change is a key challenge toward the attainment of water security particularly in arid and semi-arid regions of SSA and for urban slums without adequate pipe systems. The availability, quality, and stability of water resources for human consumption are adversely impacted by the occurrence of extreme weather events in many SSA countries. A huge proportion of infectious disease burden and child mortality is attributable to unclean water and poor sanitation. Achieving water security is indirectly linked to the attainment of other goals related to education, gender equality, sustainable cities and communities, energy, jobs, etc. (Mugagga and Nabaasa, 2016).

Droughts directly affect SDG Target 6.1 which aims to “achieve universal and equitable access to safe and affordable drinking water for all.” Droughts can result in severe water crisis for both rural and urban communities, particularly for rural

BOX 4 | Goal 6: Clean water and sanitation (United Nations, 2015).

Targets: By 2030,

- 6.1 achieve universal and equitable access to safe and affordable drinking water for all
- 6.2 achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations
- 6.3 improve water quality by reducing pollution, eliminating dumping, and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally
- 6.4 substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity
- 6.5 implement integrated water resources management at all levels, including through transboundary cooperation as appropriate
- 6.6 protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes

households dependent on surface water or rainwater harvesting and underground water sources. Besides the stress for water encountered by rural communities in semi-/arid area, there is the increasing evidence of the impact of droughts and extreme heat on urban water supply in urban areas. A 2018 study in Accra with officials of the city water treatment facility reported about an 18% shortfall in water production where there is little rain resulting in intermittent water supply to residents (Gough et al., 2019). The non-availability of water during droughts is directly linked to the attainment of SDG Target 6.2 which requires that populations “achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.” There is evidence of drought affecting household water use relating to sanitation and hygiene, even in sophisticated cities such as Cape Town (Ziervogel, 2018; Matikinca et al., 2020). Cape Town recorded a record-breaking period of drought between 2015 and 2018 since the 1930s (Enqvist and Ziervogel, 2019; Matikinca et al., 2020). This led to household changes in water use, such as reducing number of times showered, collecting water from showering and using that to flush toilets. Indeed, the occurrence of such extreme events potentially undermine efforts to increase access to safe drinking water for all even if more and more households are connected to urban water supply systems. In fact, the Southern African Development Community (SADC) region is no stranger to extreme events with increasingly significant variability in temperature and rainfall (Ziervogel, 2018).

Flooding is associated with contamination of water bodies from pathogens as well as chemicals used in farming and fishing. Flooding leads to overland flow with the potential to contaminate sources of water supply for treatment plants thus posing a challenge to the provision of safe and affordable water for all people (Rickert et al., 2019). Implementation of strict regulatory regimes is not without challenges in many SSA countries due

to the informality and rapid urbanization that outstrip the regulatory capacity of city authorities and governments.

In this regard, the UNDP, in partnership with the government, has initiated an Adaptation Fund project to help rehabilitate existing dams and build new multi-purpose dams where feasible in parts of semi-arid Northern Ghana⁴ This initiative which also includes boreholes, solar irrigation, rainwater harvesting, and irrigation systems in a sustainable water management approach also supports all-year farm productivity toward the attainment of targets 2.3 and 2.4. It also underscores the need for multi-purpose water intervention resources whilst ensuring an integrated water management system to enhance availability and ensure equitable access to water and efficient water-use.

Sustainable Cities and Communities (Goal 11)

SDG 11 seeks to “make cities and human settlements inclusive, safe, resilient, and sustainable” (Box 5). Sub-Saharan Africa is the most rapidly urbanizing region though it is the least urbanized region of the world, with an urban share of about 40% in 2018 from 13% in 1950s (UN, 2019). Since the year 2000, the annual urban population growth in sub-Saharan Africa has averaged around 4%. That notwithstanding, the patterns and trends of urbanization have followed different trajectories in different countries.

Urbanization in the region is mainly driven by internal migration, natural increase and, to a little extent, by decentralization and area reclassification. Commonly, the rapid urbanization due to migration into existing urban areas or cities is characterized by rapidly increasing population in peripheral informal settlements and the informal sector that is not matched by commensurate urban development, governance, resource allocation, and service provisioning. Hence, there seems to be a deficit in the provision of quality housing, water and sanitation, health, education, transport, and other modern services to make cities safe and comfortable to live in. Sub-Saharan African cities are plagued by social, economic, and health challenges which have implications for health and well-being of urban populations (Serdeczny et al., 2017). These include poverty, unemployment and hazardous economic activities, lack of housing and poor housing conditions and poor access to electricity, water and sanitation services and poor healthcare. For instance, the conurbation along the coast of West Africa from Benin City to Accra, with its fulcrum being Lagos, is potentially the single largest footprint of urban poverty by 2020 (Davis, 2006).

Flooding presents a great challenge for attaining Target 11.5 which is to “reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.” Flood disasters wreak widespread havoc for urban communities,

BOX 5 | Goal 11: Sustainable cities and communities (United Nations, 2015).

Targets: By 2030,

- 11.1 ensure access for all to adequate, safe, and affordable housing and basic services and upgrade slums
- 11.2 provide access to safe, affordable, accessible, and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities, and older persons
- 11.3 enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries
- 11.4 Strengthen efforts to protect and safeguard the world’s cultural and natural heritage
- 11.5 Significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations
- 11.6 Reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
- 11.7 Provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities

particularly those in informal settlements. The earlier referred to June 3rd flood disaster in Accra affected over 50,000 inhabitants destroying livelihoods and properties and displacing hundreds. Two years after the disaster, the most vulnerable households in informal settlements had yet to recover from the impacts of the disaster (Erman et al., 2018) and 5 years after the disaster flooding persists in the affected areas with massive devastation. In the first half of 2020 alone, flash flooding resulted in 100s of deaths across cities such as Lagos, Mogadishu, Abidjan, Bangui, Nairobi, and others. The floods left in their wake many properties, houses, and power lines destroyed. Such experiences demonstrate the potential for flooding to disrupt access to safe housing, health, transport, and other basic service to improve sustainable livelihoods in lums.

The rapid uncontrolled expansion of SSA cities also pose a risk factor for managing extreme heat impacts. A study of land surface temperature in four African cities (Lagos, Nairobi, Addis Ababa, and Lusaka) revealed high urban heat island intensities with 3–4°C warmer surface and air temperatures in up to 1 km radius of city centers relative to surrounding areas (Simwanda et al., 2019). Extreme heat events have the potential to exacerbate the challenges associated with urban heat islands such as discomfort to humans and poor health outcomes due to heat. Extreme heat in urban settlements increase the need for indoor cooling which may require more expensive energy consumption, particularly for vulnerable and poor persons who live in crowded spaces and densely populated informal settlements. In Accra and Tamale in Ghana, increased energy demand for cooling exerts additional pressure on electricity supply at a time when the extreme heat wears out transmission cables and transformers, leading to

⁴<https://www.adaptation-fund.org/project/increased-resilience-to-climate-change-in-northern-ghana-through-the-management-water-resources-and-diversification-of-livelihoods/>.

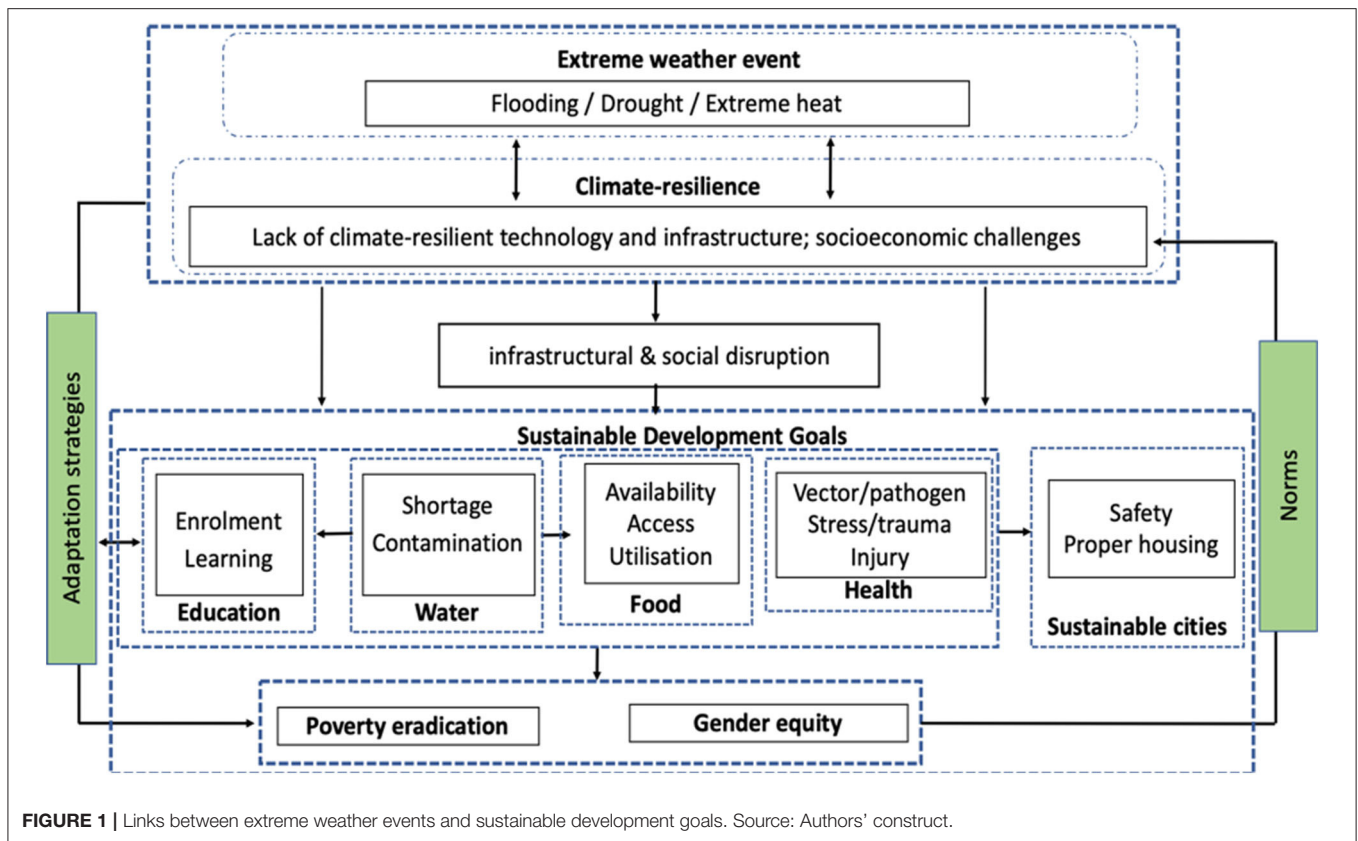


FIGURE 1 | Links between extreme weather events and sustainable development goals. Source: Authors' construct.

TABLE 1 | Extreme events and impacts on specific SDG Targets.

Impact on SDG Targets	Extreme Event		
	Extreme droughts	Floods	Extreme heat
Direct impacts	2.4 6.1, 6.2, 6.4	3,3, 3.9 6.1, 6.3, 6.4 11.5	11.1
Indirect impacts	2.1, 2.3 3.3 4.5, 4.6, 4.7	3.1, 3.8 4.6, 4.7	

intermittent power supply and load shedding when production capacity is low (Gough et al., 2019; Codjoe et al., 2020).

The siting of urban infrastructure must take into consideration their resilience against extreme heat and flooding especially. A comprehensive approach to building sustainable cities and communities incorporates climate resilience in urban service provisioning.

DISCUSSION AND CONCLUSION

This study highlights the implications of extreme weather events for sustainable development in the sub-Saharan African context. The study draws examples of the impacts of flooding, drought and extreme temperatures on achieving the sustainable development goals related to food security, health, education,

water and sanitation, and sustainable cities and communities. It is evident from the aforementioned evidence that for SSA countries to remain on course toward attaining the targets of the sustainable development goals, attention must be paid to building resilience against extreme weather events as these have the potential to erode the gains made in investments into health, food, water, education, and urban infrastructure.

Figure 1 illustrates the pathways through which extreme weather events impact the attainment of the SDGs in Ghana. This is a modified framework by Codjoe et al. (2020) which showed the links between extreme weather events and health in poor urban areas. In fact, it is evident that human actions or inactions in the context of SSA potentially amplify the risks and vulnerabilities associated with extreme weather events. The framework from this study indicates that there exist poor infrastructure that are not climate resilient together with socioeconomic challenges in many sub-Saharan African countries. This makes them sensitive to the impacts of flooding, droughts, and extreme temperatures. The disruption of these existing infrastructure and socioeconomic conditions create problems in various sectors including food security, water and sanitation, education, health and sustainable cities and communities. Evidently, extreme events have direct impacts on attaining the targets for SDG 6 related to water and sanitation with implications for different goals including SDGs 1, 3, 4, and 11 (Table 1). Indeed, this supports the proposition that water is central to the realization of the SDGs on the African continent (Mugagga and Nabaasa, 2016). For instance, flooding interrupts housing conditions, road access, and educational

infrastructure. This adversely impacts both access to and the utilization of school and health care services with implications for future poverty reduction. Droughts interact with lack of adequate water supply infrastructure to impact water availability. Water unavailability has implications for food security as well as health, education and living in sustainable communities. Without adequate water for household use, especially in rural areas, women and girl children are per social norms in some setting responsible for collecting water. This may adversely impact girl children's time spent at school or even their enrolment as well as impact the ability of older women to engage in other economic activities, thus affecting gender equity and poverty reduction.

The evidence presented in this paper shows that, in sub-Saharan Africa, flooding, drought, and extreme temperatures obviate successful attainment of the sustainable development goals. By focusing on examples from sub-Saharan Africa, this review contributes some evidence to guide policy formulation and implementation. Given the poor state of infrastructure, extreme weather events potentially exacerbate harsh living conditions and interfere with key development sectors that can contribute toward alleviating poverty and improving well-being for all persons in sub-Saharan African countries. The consequences of extreme weather events for development are dire for sub-Saharan African countries and reducing these risks is not without challenges for a region with among the highest poverty rates in the world. Different countries in different parts of the region will experience the effects of individual extreme weather events on the attainment of the SDGs differently because climatic conditions and existing levels of socioeconomic and human development differ. Similarly,

countries differ in policy formulation and implementation of disaster risk management, adaptation and resilience strategies toward the impacts of extreme weather events. Early warning systems differ by country and even within countries the implementation of these may not be equitably distributed. It is important to note that even though sociocultural norms and traditions may deepen the vulnerability of women, children, and other vulnerable groups, lack of resilience, and appropriate adaptation strategies could further reinforce the existing norms and values that create inequalities and inequity for these groups. Concerns about gender mainstreaming in the climate change and development discourse have largely been based on rhetoric with very little active representation in decision-making and policy implementation (Simon and Leck, 2015).

The investments into various sectors of development notwithstanding, progress toward attaining sustainable development depends, to some extent, on building resilience to extreme weather events. It is important for governments and development partners in the sub-Saharan African region to incorporate climate-resilience strategies into all sectors of development as they are largely interrelated. There arises a greater need to further examine the extent to which extreme weather events potentially disrupt efforts toward the attainment of the sustainable development goals for sub-Saharan Africa.

AUTHOR CONTRIBUTIONS

All authors conceptualized the research, did the literature search, and drafted the manuscript.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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