



Review

Flooding, Food Security and the Sustainable Development Goals in Nigeria: An Assemblage and Systems Thinking Approach

Adaku Jane Echendu

School of Social Sciences, Western Sydney University, Penrith 2751, Australia; adaku.chyoma@gmail.com

Abstract: Food is connected to sustainable development goals in numerous ways, as food security is key to achieving sustainable development. The world is currently not on track to achieve the set sustainable development goals (SDGs). In Nigeria, flooding is a recurrent disaster and constitutes a setback to success with the SDGs and sustainable development. Flooding disasters are a threat to food security due to their impact on the food system. This study is an integrative review that explores the link between Nigeria's flooding, food security, and the SDGs. It adopts an assemblage and systems thinking approach to analyze the impact of flooding on all components of food security. It finds that, despite the impact of flooding on food security, it is not recognized as a threat by policymakers, as evidenced by the lack of mention of disasters in the current Nigeria Agriculture Promotion Policy (APP). Attention is drawn to this oversight in this work by highlighting the interconnections between flooding, food security, and sustainable development. Recommendations on flood mitigation and adaptive practices that can alleviate the negative impact of flooding on food security to enhance the success rate of the SDGs are proffered. This work contributes to the literature by showcasing the impact of flooding on food security and its connection to sustainable development, which is an area that has not received adequate attention in research. The assemblage and system thinking approach adopted brings novelty and allows for a succinct understanding of how flooding impacts all four aspects of food security. This paper serves as the first time the problem has been explored in this manner.

Keywords: sustainable development; food; climate change; sustainability; flood risk management; assemblage thinking



Citation: Echendu, Adaku Jane. 2022. Flooding, Food Security and the Sustainable Development Goals in Nigeria: An Assemblage and Systems Thinking Approach. *Social Sciences* 11: 59. <https://doi.org/10.3390/socsci11020059>

Academic Editor: Nigel Parton

Received: 15 December 2021

Accepted: 27 January 2022

Published: 7 February 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Food is a primal need of humans and food security is central to sustainability. Food security is thus recognized as a crucial component of sustainability plans and a key concern of national security. It is key to building and sustaining a healthy economy and achieving social and environmental wellness, which are the three bottom lines of sustainable development (Fanzo 2019; Pérez-Escamilla 2017). Many countries are currently dealing with the hydra-headed problem of flooding and food insecurity amid the COVID-19 pandemic (Workie et al. 2020). In Kenya, for example, flooding, exacerbated by the effects of the pandemic, severely impacted food security and livelihoods (Aura et al. 2020). The number of people facing food insecurity globally was projected to double by the end of 2020 (Rondeau et al. 2020) in a world that was already off-track to achieve the SDGs by 2030 (United Nations 2020). The growing problem of food insecurity thus portends a significant setback. Food insecurity is linked to a mix of factors, one of which is recurrent flooding disasters (Banik 2019; Naylor 2018).

The achievement of the SDGs is directly dependent on food because, if there is no food, working towards achieving the goals is impossible. Of the 17 SDGs, 10 are directly impacted: No poverty; 2: Zero hunger; 3: Good Health and Wellbeing; 4: Quality education; 6: Clean

water and Sanitation; 8: Decent work and economic growth; 10: Reducing inequalities; 11: Sustainable cities and communities; 14: Life on water; and 15: Life on land (Echendu 2020a). Just as the SDGs are all interconnected, connections on the impact of flooding can be found in all the goals.

The SDGs recognize the centrality of food security to its success and map out targets for its achievement. While the SDGs are neither authoritarian nor binding, it proffers important guidelines that can be adjustable to local contexts. The SDG indicators are important as monitoring, operational, and evaluative tools. They are applicable across countries for measuring progress and determining where to channel resources to facilitate progress (Gil et al. 2019). The SDGs follow country-led execution even though they are global goals. Working towards achieving them on a country-specific basis is necessary as different countries have different needs and challenges. Paths to attain them will therefore differ among countries because of different physical, social, and economic environments.

In the face of rising flood disasters and the effect on food security, a realignment of response strategies and rapid and concerted mitigation efforts have been called for (The Lancet Public Health 2020; Mukarram 2020).

Climate change impacts are manifesting in Nigeria as increased incidences of dry spells and off-season rains which have caused variations in planting seasons in a country that depends mainly on rain-fed agriculture (Ologe et al. 2018). Climate projections indicate varying conditions in Nigeria, with the dryer regions experiencing more aridity with longer dry spells (Animashaun et al. 2020; Oguntunde et al. 2017; Orimoloye et al. 2021) while the humid regions will experience much more intense precipitation during the rainy season leading to more flooding events (Olaniyi et al. 2013). The coastal regions will also be exposed to more flooding due to the rising sea-level (Merem et al. 2019).

Nigeria experienced its worst flooding in recent history in 2012 (Nkeki et al. 2013; OCHA 2012; Toure 2014), wherein around 363 people died, more than 2.3 million people were displaced, and 16 million people were impacted (Echendu 2020a; OCHA 2012). This flooding received national and international attention due to its magnitude, as 32 out of Nigeria's 36 states were affected (OCHA 2012).

Many communities in Nigeria increasingly suffer localized perennial flooding during the rainy season between March and November (Echendu 2022). The local nature of this flooding makes them receive little to no attention. However, the immediate and cumulative effects of such smaller, locally occurring incidents are no less important than major events and necessitate more attention (Echendu 2019). Figure 1 below is a map of Nigeria that showcases areas prone to flooding.

Today, we face a situation whereby disasters are occurring back-to-back. The unpreparedness of the world to adequately respond to concurrent environmental and public health catastrophes highlights an urgent need to improve human resilience to shocks (Béné 2020; Ishiwatari et al. 2020). This necessitates ascertaining the connections among different global problems and seeking synergistic ways to solve them. More capacity building is especially paramount in vulnerable developing countries if global sustainability is to be attained (Adhikari et al. 2020; Bangar et al. 2020; Ouko et al. 2020).

In Nigeria, the impact of flooding on food security and the connection to sustainable development is an area that has not received adequate attention in research (Akukwe et al. 2020). This study, therefore, specifically investigates the impact of flooding on food security in Nigeria. It showcases the link with the sustainable development goals and proffers ways to mitigate and improve resilience to flooding. Despite the threat of disasters such as flooding to food security, it has not been acknowledged in Nigeria's national food security policy/policies. This work thus serves another purpose of highlighting the need to consider disaster impact in future agriculture and food policies and to seek mitigation strategies. This paper is organized into eight sections. Following this introduction section, which presents a general overview of the research and its significance, is the section on the theoretical approach adopted. This is followed by the research method. The next section discusses food security and the SDGs. This is followed by an analysis of flooding and food

security in Nigeria and the causes of flooding in the country. The impact of flooding on all components of food security is analyzed using the assemblage and systems thinking approach. Recommendations on how to address flooding to improve food security are made. The paper concludes by summarizing the key points and calling for the impact of disasters such as flooding to be considered in future food security policies.

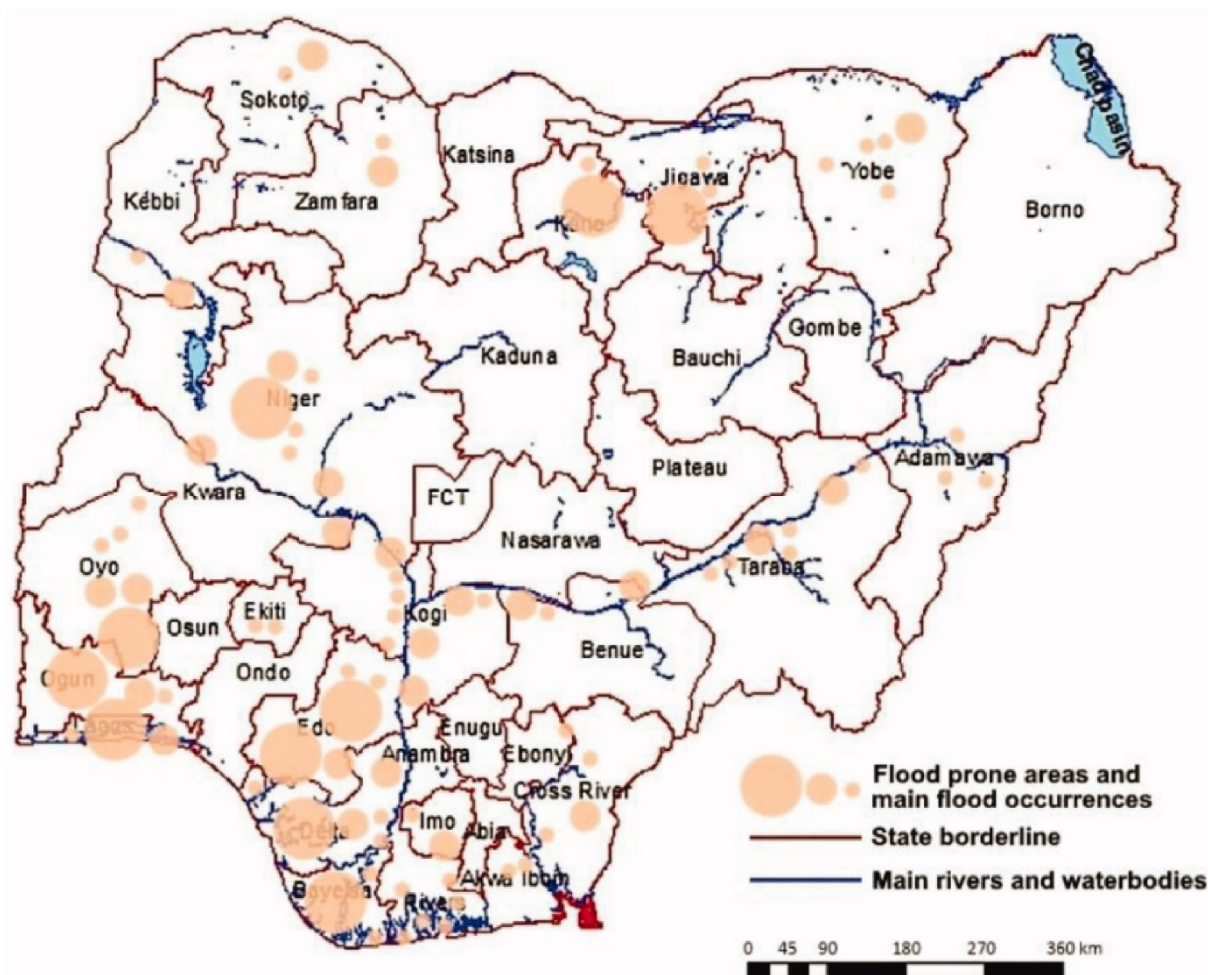


Figure 1. Parts of Nigeria prone to flooding (source: Cirella and Iyalomhe 2018).

2. Assemblage and Systems Thinking Approach

Assemblage thinking (AT) in its various descriptive, ontological, and methodological forms has gained the interest of social scientists in contemporary times, especially within the transdisciplinary critical policy field, where it has been used to gain new insights into the manner in which the governance and the political-economic domain evolve according to context, project, actors, and materials (Baker and McGuirk 2017; Clarke et al. 2015). AT encourages scholars to undertake a deeper analysis of socio-ecological issues, actively seek relationships among seemingly standalone concepts, problems, or terms, and advocates an overall openness to looking at issues with a new lens, remixing interventions and planning in an adaptive style approach. Assemblages are not serendipitous but are intentionally and unintentionally joined together (Briassoulis 2017). Bueger (2014) laments the philosophical and metaphorical overuse of AT, calling for its clearer application in practice in the form of an AT-inspired conscious posture that avoids binaries and looks at those overlooked details. McFarlane (2011) also invites scholars to ‘thickly’ ‘describe the relationalities of compositions’ that support the relationship between various actants and their material and contextual expressions. Assemblage-based approaches are capable of contributing to critical urban theory when they are linked to concepts and research agendas generated

from a revitalized geopolitical economy (Brenner et al. 2011). It is the author's view that its potential extends further into other fields, including disaster management and sustainable development, by its capability to draw together and seek connections between seemingly distinct subjects. For this reason, it was adopted as the analysis tool of choice in this work that brings together three distinct concepts—flooding, food security, and sustainable development. For Valzania (2021), AT needs to focus more on explaining the co-functioning of elements that make up an assemblage and not what assemblages are or mean. Explaining the co-functioning of an assemblage's element falls within the domain of the system's approach. The system approach of analysis takes into consideration every part that makes up the whole. It is a general approach that can be applied in various scenarios and fields even though it derives from system science and engineering (Fiksel 2006; Jackson et al. 2010; Virapongse et al. 2016). Adopting an assemblage and systems approach to assess and understand the effects of flooding on the different components of food security enables a holistic and comprehensive overview and understanding of all four different dimensions of food security and their interrelationships. This would then inform the development of integrated solutions that can promote achieving the SDGs.

3. Research Method

This work is an integrative qualitative review that critically assembles, studies, and consolidates the existing literature on the distinct areas of flooding, food security, and the SDGs. The goal is to ascertain and dissect the linkages between flooding, food security, and the SDGs. Drawing from previous studies to generate a new and concrete interpretation of problems fosters scholarship and advances theory (Post et al. 2020). Integrative reviews are broad and do not exclude studies based on design or the type of research to enable a holistic understanding of the phenomena under study (Iida et al. 2020).

This study followed the steps outlined by Paré and Kitsiou (2017) for conducting reviews that aim to stand as an original body of work in contrast to literature reviews conducted to identify gaps in the literature to justify or act as a base to a researcher's work. Academic databases, specifically Google Scholar and ProQuest, were searched by using keywords including 'flooding', 'food security', and 'SDGs' in Nigeria. The search focused on studies conducted within the past ten years. The abstracts of selected papers were screened to ascertain relevance to the research questions. A supplementary hand search was conducted, during which a few studies outside of the 10-year timeframe were included due to their relevance to the current study. Articles making the final selection were then reviewed, from which the findings of this work were made.

3.1. Food Security and the Sustainable Development Goals

Food security is access to reliable and adequate quantities of nutritious and affordable food. It comprises four elements: availability, access, utilization, and stability (Schmidhuber and Tubiello 2007). Food security is an issue of global importance that nations strive towards achieving (Osabohien et al. 2018). There are and have been several global partnerships and initiatives, most notably by the UN, to achieve food security, which sadly remains elusive today. The countries of sub-Saharan Africa (SSA) are particularly lagging in achieving food security. Eighteen of the twenty most food-insecure countries are in SSA, with 52% of the population being vulnerable to food insecurity and 20% being undernourished (Gellert 2020; Prosekov and Ivanova 2018).

Food is an important component of the SDGs as a result of its interconnectedness to many of the goals (Pérez-Escamilla 2017). The SDGs are a set of 17 goals and 169 targets that outline a shared pathway for all countries of the world geared towards achieving global prosperity and peace for the current and future generations. It succeeds the Millennium Development Goals which ended in 2015 and in which the need for food security as a development agenda was also a top priority (Matemilola 2017).

Goal 2 specifically aims to achieve food security and end hunger. The targets linked to Goal 2 are presented in Figure 2 below.

Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture

2.1 By 2030, 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 By 2030, 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 By 2030, 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 By 2030, 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 By 2020, 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

Figure 2. Adapted from the document “Transforming our world: The 2030 agenda for sustainable development.” United Nations 2015.

The centrality of food to the SDGs makes food security a major determinant of achieving success. While SDG 2 focuses mainly on food security, the connection to the other goals cannot be overemphasized. For example, SDG 1 is focused on poverty eradication. The poorest people globally and in Nigeria are small-scale farmers who are most impacted by flooding (Durodola 2019; Echendu 2020a; Fanzo et al. 2020; Mbah 2019). Ironically, farmers also comprise the majority of the food-insecure population (Ecker and Kennedy 2019). Poverty is generally worsening in Nigeria, as seen in the incidence of disease and hunger, decreased life expectancy, and low per-capita income (Ibikunle et al. 2019). The rising cost and unavailability of food exacerbated by perennial flooding disasters ensure that the poor cannot access this basic need (Echendu 2020a; Tunde 2021; Udegbumam 2020).

Food insecurity impacts SDG 3—good health and well-being. Nutritious food is the most important indicator of good health (Ohia et al. 2020). With a score of 29.2 in the 2020 Global Hunger Index (GHI), the hunger level in Nigeria is considered serious. The number of stunted children under 5 remains high in Nigeria, with over one-third of deaths among this group resulting from malnutrition (Ezeh et al. 2021).

Making the food sector robust and resilient to flooding will contribute to reducing poverty and hunger. However, this goal is still elusive in Nigeria, which has the highest number of global poor, with about 87 million people living below the poverty line (Abiodun et al. 2019; Amare et al. 2020; Dankumo et al. 2019; Okoi and Bwawa 2020). The goal of quality education is also impacted if children cannot go to school when the community is overwhelmed by floods. Access to clean water is affected when water sources become contaminated as a result of flooding. Moreover, food production from agriculture, aquaculture, and fishing contribute to SDG 10 (reducing inequalities) by helping mainly the poor to sustain their food supply and income (Blanchard et al. 2017), but flooding derails this. Life on water and land is also impacted, as flooding is known to cause human deaths,

destroy flora and fauna, and impact marine life. Food security is indeed a very important indicator of the success of the SDGs.

3.2. *Flooding, Food Security, and the Nigeria Agriculture Promotion Policy*

Nigeria is a food-insecure nation. It is one of the 10 countries most vulnerable and at risk of food insecurity due to climate change, economic crises, and conflict (World Food Programme 2020). It experiences annual flooding in many of its states and the impact on its food security is widely acknowledged (Durodola 2019; Metu et al. 2016; Week and Wizar 2020). In July 2021, the country's president blamed flooding for the rising food insecurity (Ogundele 2021). Although other factors impact food security, ranging from insecurity (which prevents farmers access to their lands) to communal clashes among farmers and herdsmen (Echendu 2021a; Furini 2019; Kralovec 2020; Lawal 2020; Ogundipe et al. 2020), flooding remains a top factor (Chukwu 2014; Madukwe et al. 2019; Week and Wizar 2020). Agriculture, fisheries, and aquaculture, the primary food sources in Nigeria, are all negatively affected by flooding.

Food insecurity is a longstanding and growing problem in Nigeria, with the government struggling to address it as the country is unable to meet its local food needs (Osabohien et al. 2018). The problem has worsened since 2020, when the country faced extreme food shortages and record-breaking flooding disasters (Gellert 2020). In a study on food security by Week and Wizar (2020) in a Nigerian community, 75.6% of the respondents reported experiencing acute food insecurity. Following major floods, a significant surge in malnutrition levels is experienced due to the impacts of flooding (Douglas 2017). The World Food Programme, in their 2020 global report on food crises, reported that, in 2019, flooding affected 32 of the 36 states in Nigeria. There was a major food crisis due to crop damage. In October of the same year, Adamawa, one of Nigeria's states was hit by its worst flooding event in 17 years, affecting more than 100,000 people (World Food Programme 2020). These recent examples illustrate the severity of the flooding incidents in the country. Nigeria's food security is highly dependent on its agricultural sector, which underperforms. Therefore, it imports large amounts of food for local consumption despite its huge agricultural potential. Over the years, there have been national policies in place to address food security issues. The latest is the Nigeria Agriculture Promotion Policy (APP).

The APP aims at improving food security and reducing food importation. It acknowledges a food production problem and links it to an ineffective farming model (Federal Ministry of Agriculture and Rural Development 2016). Improving productivity thus formed the key focus of the policy. Even though agricultural productivity is impacted by climate change, which has led to increased disasters over the years, the impact of disasters such as flooding was not acknowledged in the policy. Despite food production being the focus of the APP, flooding, a recurrent problem in the country that directly impacts food production, did not earn a mention. This is notwithstanding the devastating impact flooding has had on the Nigerian agricultural sector over the years. The negative impact of flooding on farmers has been widely reported (Chukwu 2014; Madukwe et al. 2019). Climate change impacts such as rising flooding incidences cause decreased food production and are projected to worsen in Nigeria (Blanchard et al. 2017; Durodola 2019; Echendu 2020a). This lack of mention of the role of disasters in food insecurity is a significant oversight that needs to be addressed in future policies, because, no matter the gains in the policy focus area of food production, a single flooding event can reverse them. This necessitates a more comprehensive approach to addressing food insecurity.

The importance of addressing food security issues in Nigeria is even more compelling given the rapid population growth in Nigeria, a country predicted to become the third most populous nation in the world by 2050 (Gil et al. 2019). This necessitates looking into the factors that directly and indirectly impact food security and finding ways to eliminate or reduce these negative factors which comprise environmental, social, and economic factors. Socio-economic factors impacting food security encompass income, sex, gender, marital status, household size, etc. Environmental factors include climate impacts such as flooding

and drought. Even though flooding is believed to portend benefits to agriculture and fish production in some aspects and locations due to the deposition of rich nutrients in the aftermath of flooding (Otomofa et al. 2015; Talbot et al. 2018), this does not appear to be the case in Nigeria, as flooding has mainly been credited with serious and negative impacts. The impact of flooding on food security deserves adequate attention in national food security policies.

3.3. Flooding in Nigeria and Causes

Flooding is a complex issue because of its various types, causes, and impact. Nigeria mainly experiences pluvial and fluvial flooding. Pluvial flooding is when heavy rainfall causes flooding despite the absence of a nearby water body. It can occur even in areas situated above coastal or river floodplains. Fluvial or river flooding occurs when a river bursts its banks due to high rainfall over a period. Flooding in Nigeria is mainly caused by:

- (i) **High Precipitation:** Climate change is a global phenomenon, but the developing countries of the world are disproportionately suffering from the impact (Akeh and Mshelia 2016; Azadi et al. 2019). The weather pattern in many parts of the globe has changed and, in Nigeria, climate-related events are manifesting in disasters such as flooding and droughts. Climate change will steadily and continuously increase flood risk in the coming years by inducing changes in sea levels, an increase in river flows, and heavier, prolonged rainfall durations (Akeh and Mshelia 2016). Major flooding incidents in Nigeria have particularly been witnessed after high rainfall events. Climate change effects manifest according to the region; for instance, the dry northern arid areas are becoming drier while the wet southern areas are experiencing increasingly wetter conditions (Olaniyi et al. 2019). The river basins of Niger-Benue, Anambra, and Sokoto-Rima are also exposed to flooding due to the bursting of river banks (Nemine 2015). The impact of climate-induced flooding will be enormous, particularly in the coastal areas, where rising sea levels and precipitation are expected to be higher. Rainfall-induced flooding is considered serious because many parts of Nigeria lack the needed infrastructure to conduct and channel rainwater and surface run-off water, which exacerbates flooding risk;
- (ii) **Poor physical planning and implementation of planning regulations:** The state of urban planning in Nigeria leaves a lot to be desired. Poor urban planning practices and implementation are a leading cause of flooding in Nigeria. Lack of adherence to planning regulations has seen the construction of buildings on floodplains and drainage pathways that cause flooding. The urbanization rate is high at over 50% and is set to increase in the coming years (Aliyu and Amadu 2017; Ojo et al. 2017). This is not accompanied by appropriate urban planning and infrastructural development to cater to the growing population (Adekola and Lamond 2018; Echendu and Georgeou 2021). Good planning practices incorporate sustainable drainage management to cater to the needs of the population, which is lacking in the country (Adedeji et al. 2012). On paper, urban planning laws and policies compare to global standards, but the implementation leaves a lot to be desired (Echendu 2019). Development control and zoning are not being enforced. Along with this, infrastructural decay, the indiscriminate construction of buildings, and informal settlements that characterize the urban planning sphere, all contribute to flooding in Nigeria; The importance of spatial planning in mitigating environmental disasters and achieving sustainable development cannot be overemphasized (Adedeji et al. 2012; Meyer and Auriacombe 2019). However, the planning system in Nigeria leaves a lot to be desired and has been criticized for its ineffectiveness (Olalekan 2014; Tasantab 2019). Urban planning presents opportunities for regulating the environment, mitigating global warming, and achieving sustainable development. Human activities tied to urbanization have increased flood risks. However, the detachment of urban planning and implementation from reality worsens the problem (Echendu 2021b). Poor physical planning also manifests in the indiscriminate construction of buildings, including on drain

paths and waterways in Nigeria, which contribute to flooding. The urban planning sphere in Nigeria is not lacking in knowledgeable professionals or laws and policies to manage the physical environment, but a gap lies in implementation and control, incurring these laws to be critiqued as only existing on paper (Echendu 2019; Gyau 2018; Ikelegbe and Andrew 2012). The poor planning and regulation of development has majorly contributed to the country's flooding problem;

- (iii) Poor Drainage infrastructure and waste management: The lack of adequate stormwater management infrastructure and drainage is one of the leading causes of flooding in Nigeria (Salami et al. 2017). Poorly constructed and managed drains are hallmarks of Nigerian cities, where storm drains in many places are open and small (Echendu and Georgeou 2021). Their small size makes them unable to support large volumes of water during heavy rainfall. The absence of covers makes them easy dumping sites by undisciplined citizens. Most of the drains are also characterized by their poor or absent connectivity to adequate discharge points (Frimpong 2013). It is not uncommon to see drains flood settlements due to poor connectivity and suboptimization whereby drains from a community can discharge into another community and cause flooding. The poor conditions of existing drains make them likely to cause, rather than prevent, flooding. The construction of infrastructure lags urban development. As a result, the existing drainage is not adequate enough to discharge run-off, thereby increasing the risk of flooding (Cirella and Iyalomhe 2018). Poor infrastructure is a problem in this country that contributes enormously to flood risk (Lamond et al. 2012).

3.4. Understanding the Impact of Flooding on the Different Components of Food Security

The concept of food security encompasses the availability, access, utilization, and stability of food. Flooding impacts all these different aspects. However, the majority of food security programs and policies have focused on food availability by seeking to increase production while neglecting other areas (Firdaus et al. 2019). This approach is evident in Nigeria's current APP, where production alone formed the focus of the policy.

The food system comprises the chain of activities involved in producing, assembling, processing, storing, transporting, consuming, and disposing of food and food products (Firdaus et al. 2019; Nguyen 2018). It includes broader governance and management and how food production affects the natural environment and social and economic life (HLPE 2017). Flood impact studies have mainly focused on the agricultural sector even though Nigeria is also a top aquaculture producer in Africa (Ahmed and Solomon 2016; Ipinjolu et al. 2013; Oluwatobi et al. 2017). Numerous fish farmers have had their productivity negatively impacted by perennial flooding due to their reduced catch, destruction of fishing tools, and environmental pollution (Chukwu 2014; Oyebola et al. 2018). Despite the recognized threats of flooding to food security, there has been no integrated response or approach to mitigate flooding, which would have positive impacts that extend far beyond food security. For example, the millions of children who are denied education due to flooding would be able to attend school. Epidemics linked to flooding would also be averted if adequate flood mitigation strategies are in place.

The interwoven interactions and feedbacks in the food system mean that interventions need to be holistic to avoid intervention in one area creating or exacerbating problems in another. The focus on food production leads to the neglect of other components of food security, with the implication that the root causes of the food system's underperformance are missed. The various ways flooding impacts all aspects of food security is thus enumerated in this section for a more holistic understanding of the impacts. Here, the different assemblages that encompass food security are looked at individually. By taking the assemblage and systems approach, we are able to not only look at the holistic concept of food security but also take a deeper dive into how flooding affects the different subcomponents.

- (i) Flooding and Food availability: Food availability refers to the availability of sufficient amounts of food. Regular availability is dependent on sufficient production levels that only a healthy, disaster-free environment can ensure (Gil et al. 2019). Food

production levels in Nigeria are below demand despite agriculture being the second most important economic activity after crude oil. The perennial nature of flooding disasters further impacts production levels on both the aquatic and terrestrial ecosystems, the two main food production interfaces. Flooding degrades the environment, destroys crops, farm settlements, livestock, and seedling stores (Echendu 2020a). This reduces harvest and impacts the next planting season, culminating in a food shortage crisis. Human production capital is also impacted as, during floods, people are at risk of physical injuries and ill-health. Floods, therefore, have a chain reaction effect and represent a threat to food security by affecting the production of food (Armah et al. 2010). Farming communities are disproportionately impacted not only because they lose income, but also because they lack the cash to purchase the other food and non-food items that they need. Inundated farmlands are unsuitable for cultivation. Livestock is not spared either during floods. Depending on the type of sediments deposited on farmlands during floods, some can be rendered uncultivable for a period, creating a cycle of food scarcity and hunger (Armah et al. 2010). Nigeria has no social security net and, for most of the affected, there is no other source of income except agriculture. This becomes a direct hit on SDGs 1 and 2, as the people become further impoverished and exposed to starvation and hunger. Moreover, floods impact the natural flora and fauna of an ecosystem. Floodwaters destroy land by striping soils and eroding shorelines taking out the natural vegetative cover in its path (Smith 2017). The hazardous conditions it causes pose a threat to every form of life. The fact that water systems are also contaminated is a hazard to life. Flooding destroys both farms and harvest, contributing to hunger and jeopardizing the nation's path to sustainable development (Kwari et al. 2015). Aquaculture and fish farming are not spared either, as floods wash away fish stock, leading not only to a loss of income for the farmers, but a loss of valuable protein sources for the general population. Floods negatively impact the aquatic ecosystem, and more frequent flood occurrences worsen the impact by leaving an insufficient recovery time in between flood occurrences which can last from months to years (Talbot et al. 2018). This negatively impacts communities that rely on subsistence fishing and farming for food. Flooding thus negatively affects food availability;

- (ii) Flooding and Food access: Flooding impacts access to food, which is the ability to secure or obtain food as determined by purchasing power and affordability. It is the capacity to obtain sufficient nutritious food. Shocks on the food system due to flooding directly impacts accessibility. High prices of food due to limited supply in the aftermath of flooding deny access to the majority of the population who live in abject poverty (Hallegatte et al. 2020). Food scarcity ensues and the forces of demand and supply come into play, increasing food prices beyond that which the poor can afford. Smallholder rural farmers who cultivate, process, and eat directly from their farms are the worst impacted by flooding disasters. Their primary source of income is impacted, and they are further plunged into poverty and lack the resources to purchase food in the market. This volatility in food prices caused by flooding puts an additional constraint on households, leading to inaccessibility. Thus, a cycle ensues where high costs also deter farmers from purchasing new seedlings, impacting their productive capacity. Flooding is known to collapse bridges in Nigeria, cutting off physical access between communities (Ede et al. 2019). Access is further limited by the destruction of the already weak transportation infrastructure and road networks required to transport food. The result is that those communities not directly affected by flooding also suffer income loss due to a disruption in the transport services needed to transport food products to the buyers. Rural communities become further isolated and farmers cannot access the needed inputs and markets for their goods (Osabohien et al. 2018). Supply chain disruptions, increased prices, the destruction of farm produce and stored reserves, and scarcity are some of the ways flooding affects food accessibility;

- (iii) **Flooding and Food utilization:** Food utilization is the most important but least researched aspect of food security due to its complexity (Zewdie 2014). It is the ability of the body to absorb the needed nutrients from food. It is having the necessary nutritional intake and encompasses food safety and quality issues. According to FAO (2008), it is the nutritional worth of food, makeup and ways of food preparation, the social values attached to food that determine the type of food consumed at different times and events, and the safety and quality of food supply which can result in nutrient loss and food-borne diseases if the standards are poor. Food availability and access are the precursors to food utilization. A varied and healthy diet is necessary to furnish the necessary nutrients (Hwalla et al. 2016). However, availability and access do not guarantee adequate utilization of the necessary nutrition from food (Zewdie 2014). Nutrient and soil loss occurs as a result of flooding (Sánchez-Rodríguez et al. 2017). This subsequently reduces the nutritional composition of food cultivated on nutrient-poor soil, since degraded soil produces low-quality food (Lal 2009). The impact of flooding on the loss of nutritional quality of food is recognized. In a recent study in southern Nigeria, 71.4% of the respondents reportedly believed that flooding causes a loss of nutritional quality of food (Week and Wizer 2020).

Flooding can affect the yield and quality of food crops. Plant tissue damage also occurs due to flooding, which promotes the development of bacterial and fungal diseases impacting crop quality (Lauer 2008). Micronutrient consumption is affected if the nutrient composition of foods is altered. Farmers may decide to grow different types of crops of less nutritional value that are not affected by flooding. This, therefore, impacts the availability of nutrient-rich crops and the food utilization capacity of the general population. The impact of flooding on the general flora and fauna has also reduced the availability of wild food and game, which are rich nutrient sources. Financial access to food also has a significant correlation to food utilization than physical access (Abbade 2017). The economic losses due to flooding also affect access to food.

- (iv) **Flooding and Food stability:** Food stability is ensuring that there is food availability, access, and utilization at all times (Hwalla et al. 2016; Matemilola 2017). Vulnerabilities and shocks on the food system due to flooding impact food stability. This is because of the impact on other aspects of the food system, as enumerated in the previous sections. A decline in agricultural productivity because of flooding impacts the availability of food. Subsequent shortfalls in supply increase prices of food, making it inaccessible to a large section of Nigeria's population. This renders the already vulnerable population in the country more so among the poorer, small-scale farmers. The high prices and unavailability of certain types of food force consumers to limit their consumption and opt for less nutritious but more filling food, which impacts food utilization. Flooding thus presents a severe shock to the entire food system in Nigeria.

3.5. Addressing Flooding to Improve Food Security in Nigeria

Strategies to manage flooding are necessary to cushion its impact on food security and achieve more success with the SDGs. The complexity of the flooding problem necessitates a tailored response specific to locations and types of flooding. The negative impact of flooding on food security, which is the heart of the SDGs, necessitates seeking ways to tackle the flooding menace. As the causes of flooding in Nigeria have been identified as mainly anthropogenic, measures that can help address them and mitigate the impact on food security are highlighted here.

- (i) **Improved physical planning:** Urban planning has a role to play in reducing the impact of flooding on food security. The unregulated or poorly regulated nature of urban development in Nigeria has contributed majorly to flooding incidences due to developments on floodplains and natural drain paths (Echendu 2020b; Idoko 2016). The urban growth pattern, therefore, deserves closer attention, with good regulations and effective implementation put in place. Zoning is important. As much as possible, agricultural lands should be sited further away from flood-prone areas. Riparian

zones need to be restored. Restricting the building of impervious surfaces near water bodies will help manage flooding. Planning for, and construction of, flood control infrastructure is the purview of physical planning and needs to be factored in during the planning process. This is important to enable a flood-free environment in which farming can thrive and cater to the food needs of the population. Waste management is a core part of urban governance and citizen waste management sensitization is needed to discourage the indiscriminate dumping of refuse which blocks drainages and causes flooding. Adequate waste collection and treatment facilities need to form a core part of urban management and governance;

- (ii) Improved farming practices: More support, effort, and investment in research and development to develop flood-resistant, high yield, and a quick-maturing variety of crops will help in improving food security. This is necessary because, despite the best efforts to manage and control flooding, there may still be pockets of flood occurrences. Early maturing varieties, as was introduced in Bayelsa state in the aftermath of the 2012 flooding disaster in Nigeria (Nemine 2015), should be made widely available because many farmers do not readily have access to such varieties (Fakayode et al. 2016). Similar improved varieties offer the chance for the plants to mature before the onset of heavy rains associated flooding. Coping with flooding necessitates responding to changes in agricultural practices. Mixing crops and livestock with cash crops and trees to reduce the impact and losses due to crop failure is another strategy (Reddy et al. 2019). Cultivating in the dry season with improved irrigation, especially in southern Nigeria, where it is not a common practice, is another way of mitigating the impact of flooding. This is because flooding occurs mostly during the rainy season, which doubles as the planting season. In the fisheries and aquaculture sector, technical innovations such as pond embankment modifications, fencing, caging and netting, and riverbank modifications are proven techniques that minimize flood threats to fish farming (Oyebola et al. 2018). Farmers need support and training to apply these improvements. The integration of various extension education methods have proven effective in enhancing Nigerian farmers' adoption of new and improved practices, but farmers in some areas lack access to extension services (Abubakar et al. 2019; Madukwe et al. 2019). Expanding the availability and reach of agricultural extension services will help in educating and encouraging farmers to adopt new and improved farming practices;
- (iii) Indigenous practices: Indigenous practices such as the use of mounds commonly practiced in Rivers, Akwa Ibom, and Ondo states as a flood mitigation strategy (Nemine 2015) should be introduced in other parts of the country that do not employ similar practices. Undocumented local meteorological knowledge based on traditional beliefs, practices, and observation has been known to help locals predict flooding on a long-term and seasonal basis (Nemine 2015). Curating and documenting such knowledge, which could be transferable, can help in calculating the best farming periods and strategies and help in managing flooding. This knowledge could be applied during research for the development of new crop varieties to factor in the flooding window. Infusion of scientific and indigenous knowledge and practices could further enrich practices;
- (iv) Grey and green infrastructure: Grey infrastructure consists of structures made of concrete and steel, for example, dams, dykes, and drains, hence the grey connotation. They have traditionally been used in managing flood risks with good performance (Alves et al. 2018). Green infrastructure refers to multipurpose natural solutions that also provide ecosystem services such as recreation while also providing flood protection (Dipeolu and Ibem 2020). A combination of grey and green infrastructure in managing flood risks is advocated as a better way to improve resiliency (Alves et al. 2018; Pamungkas and Purwitaningsih 2019). The construction and improvement of the drainage system, the construction of buffer dams in needed areas, dredging, and the desilting of rivers and other water bodies are measures that can help control

flooding. Dams can serve a dual purpose of providing electricity and a source of water for irrigation, boosting agriculture (Durodola 2019). Farmlands in areas particularly prone to flooding where grey infrastructure is insufficient to control the flooding could be converted to wetlands and artificial lakes. Owners could then be adequately compensated and relocated with their active involvement. Pervious/permeable surfaces where possible should be encouraged to promote underground water absorption.

4. Conclusions

Food insecurity remains a serious and growing problem in Nigeria. Currently, the nation cannot provide a sustainable means of nutritious and sufficient food for its large and growing population. Food insecurity is widespread across the country, presenting in both direct and indirect forms. It exists at the individual, household, community, sub-national, and national levels. In the quest to achieve food security, the impact of flooding needs to come to the forefront of discussions and policies. Improving food security demands that those factors that increase vulnerabilities and pose threats or risks such as flooding be better understood, managed, or eliminated. The assemblage and systems thinking approach adopted in this study has helped shed light on the interconnections of flooding, the various components of food security, and sustainable development. It is important to tailor solutions considering the different geographical and topological zones of the country. For instance, indigenous knowledge and improved varieties could be deployed more in the southern lowland areas, while grey and green infrastructure and improved varieties could be employed in the areas surrounding the Niger–Benue and Sokoto–Rima basins. Flooding can be controlled by sustainable land-use management and planning and the provision of environmental infrastructure, the most important being drainage and solid waste management. The international community is encouraged to aid Nigeria by directly investing in flood mitigation and control projects which would positively impact Nigeria's food system and help achieve global food security, as is hoped for in the SDGs. Better knowledge on flooding and its impact on food security and the SDGs can help get to the heart of the issue, enabling actions to solve the problem. This paper is a call to action to the Nigerian government to consider disasters such as flooding which are set to rise in the coming years due to climate change in future food security policies while taking immediate actions to control flooding. The changing landscape and climate necessitate changing approaches to ensure food security and sustainability. Most importantly, rising global disasters have brought to the fore the need to build resilient and sustainable food systems. Those controllable factors that impact food security such as flooding deserve urgent attention.

Funding: This research received no external funding. The APC was funded by Western Sydney University, Australia.

Informed Consent Statement: Not Applicable.

Conflicts of Interest: The author declares no conflict of interest.

References

- Abbade, Eduardo Botti. 2017. World Journal of Science, Technology and Sustainable Development. *Development* 14: 322–35.
- Abiodun, Temitope Francis, Oluwasolape Onafowora, and Ifeoluwa Ayo-Adeyekun. 2019. Alarming rate of child poverty in Northern Nigeria: Implications for national security. *American Research Journal of Humanities Social Science* 2: 1–10.
- Abubakar, H. N., Y. Garba, and A. K. Gana. 2019. Factors influencing adoption of rice improved production practices by farmers in adopted villages, Niger state, Nigeria. *Advances in Plants & Agriculture Research* 9: 183–89.
- Adediji, Oludare Hakeem, Bashir Olufemi Odufuwa, and Olusegun Hezekiah Adebayo. 2012. Building capabilities for flood disaster and hazard preparedness and risk reduction in Nigeria: Need for spatial planning and land management. *Journal of Sustainable Development in Africa* 14: 45–58.
- Adekola, Olalekan, and Jessica Lamond. 2018. A media framing analysis of urban flooding in Nigeria: Current narratives and implications for policy. *Regional Environmental Change* 18: 1145–59. [\[CrossRef\]](#)
- Adhikari, Jagannath, Jagadish Timsina, Sarba Raj Khadka, Yamuna Ghale, and Hemant Ojha. 2020. COVID-19 impacts on agriculture and food systems in Nepal: Implications for SDGs. *Agricultural Systems* 186: 102990. [\[CrossRef\]](#)

- Ahmed, Onada Olawale, and Ogunola Oluniyi Solomon. 2016. Climate smart aquaculture: A sustainable approach to increasing fish production in the face of climate change in Nigeria. *International Journal of Aquaculture and Fishery Sciences* 2: 012–017.
- Akeh, Gabriel Igbe, and Alfred D. Mshelia. 2016. Climate change and urban flooding: Implications for Nigeria's built environment. *MOJ Ecology & Environmental Science* 1: 1–4.
- Akukwe, Thecla Iheoma, Alice Atieno Oluoko-Odingo, and George Okoye Krhoda. 2020. Do floods affect food security? A before-and-after comparative study of flood-affected households' food security status in South-Eastern Nigeria. *Bulletin of Geography. Socio-Economic Series* 47: 115–31. [\[CrossRef\]](#)
- Aliyu, Alhaji A., and Lawal Amadu. 2017. Urbanization, cities, and health: The challenges to Nigeria—A review. *Annals of African Medicine* 16: 149. [\[CrossRef\]](#)
- Alves, Alida, Berry Gersonius, Arlex Sanchez, Zoran Vojinovic, and Zoran Kapelan. 2018. Multi-criteria approach for selection of green and grey infrastructure to reduce flood risk and increase CO-benefits. *Water Resources Management* 32: 2505–22. [\[CrossRef\]](#)
- Amare, Mulubrhan, Kibrom A. Abay, Luca Tiberti, and Jordan Chamberlin. 2020. *Impacts of COVID-19 on Food Security: Panel Data Evidence from Nigeria*. Washington, DC: International Food Policy Research Institute, vol. 1956.
- Animashaun, I. Murtala, Philip G. Oguntunde, Akinola Shola Akinwumiju, and Obafemi O. Olubanjo. 2020. Rainfall Analysis over the Niger Central Hydrological Area, Nigeria: Variability, Trend, and Change point detection. *Scientific African* 8: e00419. [\[CrossRef\]](#)
- Armah, Frederick A., David O. Yawson, Genesis T. Yengoh, Justice O. Odoi, and Ernest K. A. Afrifa. 2010. Impact of floods on livelihoods and vulnerability of natural resource dependent communities in Northern Ghana. *Water* 2: 120–39. [\[CrossRef\]](#)
- Aura, Christopher Mulanda, Chrisphine S. Nyamweya, Cyprian O. Odoli, Horace Owiti, James M. Njiru, Patrick W. Otu, Edna Waithaka, and John Malala. 2020. Consequences of calamities and their management: The case of COVID-19 pandemic and flooding on inland capture fisheries in Kenya. *Journal of Great Lakes Research* 46: 1767–75. [\[CrossRef\]](#)
- Azadi, Yousof, Masoud Yazdanpanah, and Hossein Mahmoudi. 2019. Understanding smallholder farmers' adaptation behaviors through climate change beliefs, risk perception, trust, and psychological distance: Evidence from wheat growers in Iran. *Journal of Environmental Management* 250: 109456. [\[CrossRef\]](#)
- Baker, Tom, and Pauline McGuirk. 2017. Assemblage thinking as methodology: Commitments and practices for critical policy research. *Territory, Politics, Governance* 5: 425–42. [\[CrossRef\]](#)
- Bangar, Vaibhav, Rajat Goyal, and Rajiv Pandey. 2020. Climate Change Responses and Sustainable Development: Integration of Mitigation and Adaptation. In *Sustainable Development Goals: An Indian Perspective*. Edited by Somnath Hazra and Anindya Bhukta. Cham: Springer International Publishing, pp. 203–14.
- Banik, Dan. 2019. *Achieving Food Security in a Sustainable Development Era*. Berlin: Springer.
- Béné, Christophe. 2020. Resilience of local food systems and links to food security—A review of some important concepts in the context of COVID-19 and other shocks. *Food Security* 12: 805–22. [\[CrossRef\]](#)
- Blanchard, Julia L., Reg A. Watson, Elizabeth A. Fulton, Richard S. Cottrell, Kirsty L. Nash, Andrea Bryndum-Buchholz, Matthias Büchner, David A. Carozza, William W. L. Cheung, and Joshua Elliott. 2017. Linked sustainability challenges and trade-offs among fisheries, aquaculture and agriculture. *Nature Ecology & Evolution* 1: 1240–49.
- Brenner, Neil, David J. Madden, and David Wachsmuth. 2011. Assemblage urbanism and the challenges of critical urban theory. *City* 15: 225–40. [\[CrossRef\]](#)
- Briassoulis, Helen. 2017. Why I fell for assemblages: A response to comments. *Dialogues in Human Geography* 7: 212–20. [\[CrossRef\]](#)
- Bueger, Christian. 2014. Thinking assemblages methodologically: Some rules of thumb. In *Reassembling International Theory: Assemblage Thinking and International Relations*. London: Palgrave Macmillan UK, pp. 58–66.
- Chukwu, Maureen N. 2014. Impact of Flooding on Fishermen's families in Pedro Community, Iwaya-Lagos, Nigeria. *Journal of Applied Sciences and Environmental Management* 18: 647–51. [\[CrossRef\]](#)
- Cirella, Giuseppe, and Felix Iyalomhe. 2018. Flooding conceptual review: Sustainability-focalized best practices in Nigeria. *Applied Sciences* 8: 1558. [\[CrossRef\]](#)
- Clarke, John, Dave Bainton, Noémi Lendvai, and Paul Stubbs. 2015. *Making Policy Move: Towards a Politics of Translation and Assemblage*. Bristol: Policy Press.
- Dankumo, Ali Madina, Suryati Ishak, Yasmin Bani, and Hanny Zurina Hamza. 2019. The Relationship between Public Expenditure, Corruption and Poverty in Nigeria. *Jurnal Ekonomi dan Studi Pembangunan* 11: 76–89. [\[CrossRef\]](#)
- Dipeolu, Adedotun Ayodele, and Eziyi Offia Ibem. 2020. Green infrastructure quality and environmental sustainability in residential neighbourhoods in Lagos, Nigeria. *International Journal of Urban Sustainable Development* 12: 267–82. [\[CrossRef\]](#)
- Douglas, Ian. 2017. Flooding in African cities, scales of causes, teleconnections, risks, vulnerability and impacts. *International Journal of Disaster Risk Reduction* 26: 34–42. [\[CrossRef\]](#)
- Durodola, Oludare Sunday. 2019. The impact of climate change induced extreme events on agriculture and food security: A review on Nigeria. *Agricultural Sciences* 10: 487–98. [\[CrossRef\]](#)
- Echendu, Adaku Jane. 2019. Urban Planning, Sustainable Development and Flooding: A Case Study of Port Harcourt City, Nigeria. Master's thesis, Western Sydney University, Penrith, Australia.
- Echendu, Adaku Jane. 2020a. The impact of flooding on Nigeria's sustainable development goals (SDGs). *Ecosystem Health and Sustainability* 6: 1791735. [\[CrossRef\]](#)
- Echendu, Adaku Jane. 2020b. Urban Planning—"It's All About Sustainability": Urban Planners' Conceptualizations of Sustainable Development in Port Harcourt, Nigeria. *International Journal of Sustainable Development and Planning* 15: 593–601. [\[CrossRef\]](#)

- Echendu, Adaku Jane. 2021a. Poverty and Climate Change: Two Important Global Policy Issues of our Generation. *Queen's Policy Review* 12: 17–27.
- Echendu, Adaku Jane. 2021b. Relationship between urban planning and flooding in Port Harcourt city, Nigeria; insights from planning professionals. *Journal of Flood Risk Management* 14: e12693. [CrossRef]
- Echendu, Adaku Jane. 2022. Flooding in Nigeria and Ghana: Opportunities for partnerships in disaster-risk reduction. *Sustainability: Science, Practice and Policy* 18: 1–15. [CrossRef]
- Echendu, Adaku Jane, and Nichole Georgeou. 2021. 'Not Going to Plan': Urban Planning, Flooding, and Sustainability in Port Harcourt City, Nigeria. *Urban Forum* 32: 311–32. [CrossRef]
- Ecker, Olivier, and Adam Kennedy. 2019. *Transforming Agriculture to Improve Food and Nutrition Security in Nigeria*. Food Security Policy Research Brief 99. East Lansing: Michigan State University.
- Ede, Anthony, Chinyere Nwankwo, Solomon Oyeibisi, Oluwarotimi Olofinnade, Chukwueloka A. Okeke, and Ayobami Busari. 2019. Failure Trend of Transport Infrastructure in Developing Nations: Cases of Bridge Collapse in Nigeria. *IOP Conference Series: Materials Science and Engineering* 640: 012102. [CrossRef]
- Ezeh, Osita K., Tanvir Abir, Noor Raihani Zainol, Abdullah Al Mamun, Abul H. Milton, Md R. Haque, and Kingsley E. Agho. 2021. Trends of Stunting Prevalence and Its Associated Factors among Nigerian Children Aged 0–59 Months Residing in the Northern Nigeria, 2008&–2018. *Nutrients* 13: 4312. [CrossRef] [PubMed]
- Fakayode, S. Bukola, Abraham Falola, D. Obakeye, and Adedayo Adeyemo. 2016. Socio-economic and flood precautions of flood affected households in lower Niger basin areas of Nigeria. *Research on Crops* 17: 633–39. [CrossRef]
- Fanzo, Jessica. 2019. Healthy and Sustainable Diets and Food Systems: The Key to Achieving Sustainable Development Goal 2? *Food Ethics* 4: 159–74. [CrossRef]
- Fanzo, Jessica, Namukolo Covic, Achim Dobermann, Spencer Henson, Mario Herrero, Prabhu Pingali, and Steve Staal. 2020. A research vision for food systems in the 2020s: Defying the status quo. *Global Food Security* 26: 100397. [CrossRef]
- FAO. 2008. *Climate Change and Food Security: A Framework Document*. Rome: FAO.
- Federal Ministry of Agriculture and Rural Development. 2016. *The Agricultural Promotion Policy (2016–2020)*; Abuja: Federal Government of Nigeria.
- Fiksel, Joseph. 2006. Sustainability and resilience: Toward a systems approach. *Sustainability: Science, Practice and Policy* 2: 14–21.
- Firdaus, R. B. Radin, Mahinda Senevi Gunaratne, Siti Rahyla Rahmat, and Nor Samsinar Kamsi. 2019. Does climate change only affect food availability? What else matters? *Cogent Food & Agriculture* 5: 1707607.
- Frimpong, Agyemang. 2013. Perennial Floods in the Accra Metropolis: Dissecting the Causes and Possible Solutions. *African Social Science Review* 6: 1.
- Furini, Gustavo. 2019. The influence of climate change on the escalating communal conflict between Herdsmen and farmers: The case of the Fulani ethnic group in Nigeria. *Janus.Net: e-Journal of International Relations* 10: 33–52. [CrossRef]
- Gellert, Tess. 2020. Floods and Food Shortages Threaten to Push Nigeria into a Food Crisis. Available online: <https://theowp.org/reports/floods-and-food-shortages-threaten-to-push-nigeria-into-a-food-crisis/> (accessed on 28 January 2022).
- Gil, Juliana Dias Bernardes, Pytrik Reidsma, Ken Giller, Lindsay Todman, Andrew Whitmore, and Martin van Ittersum. 2019. Sustainable development goal 2: Improved targets and indicators for agriculture and food security. *Ambio* 48: 685–98. [CrossRef] [PubMed]
- Gyau, Kwasi Awuah Baffour. 2018. Urban development and governance in Nigeria: Challenges, opportunities and policy direction. *International Development Planning Review* 40: 27–49.
- Hallegatte, Stéphane, Adrien Vogt-Schilb, Julie Rozenberg, Mook Bangalore, and Chloé Beaudet. 2020. From Poverty to Disaster and Back: A Review of the Literature. *Economics of Disasters and Climate Change* 4: 223–47. [CrossRef]
- HLPE. 2017. *Food Systems*. A Report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. Rome: HLPE.
- Hwalla, Nahla, Sibelle El Labban, and Rachel A Bahn. 2016. Nutrition security is an integral component of food security. *Frontiers in Life Science* 9: 167–72. [CrossRef]
- Ibikunle, Ganiyu Abiona, Elizabeth Remilekun Orefuwa, and Akintoye Benjamin Mafo. 2019. Analysis of the Causes and Effects of Unemployment in Nigeria towards a Solution for Graduate Idleness and Poverty Alleviation. *IOSR Journal Of Humanities and Social Science* 24: 36–44.
- Idoko, Ikani Daniel. 2016. An Impact Assessment of Flooding on Food Security among Rural Farmers in Dagiri Community, of Gwagwalada Area Council, Abuja, Nigeria. *Agricultural Development* 1: 6–13. [CrossRef]
- Iida, Kieko, Assumpta Ryan, Felicity Hasson, Sheila Payne, and Sonja McIlpatrick. 2020. Palliative and end-of-life educational interventions for staff working in long-term care facilities: An integrative review of the literature. *International Journal of Older People Nursing* 16: e12347. [CrossRef]
- Ikelegbe, Onovughe, and Onwuemele Andrew. 2012. Planning the Nigerian environment: Laws and problems of implementation. *Contemporary Journal of Social Sciences, Ayimgba* 1: 151–61.
- Ipinjolu, Joseph Kayode, Ibrahim Magawata, and Bilkisu Aminu Shinkafi. 2013. Potential impact of climate change on fisheries and aquaculture in Nigeria. *Journal of Fisheries and Aquatic Science* 9: 338–44. [CrossRef]
- Ishiwatari, Mikio, Toshio Koike, Kenzo Hiroki, Takao Toda, and Tsukasa Katsube. 2020. Managing disasters amid COVID-19 pandemic: Approaches of response to flood disasters. *Progress in Disaster Science* 6: 100096. [CrossRef] [PubMed]

- Jackson, Scott, Derek Hitchins, and Howard Eisner. 2010. What Is the Systems Approach? *Insight Incoase* 13: 41–43. [\[CrossRef\]](#)
- Kralovec, Sophie. 2020. *Food Insecurity in Nigeria*. Malmo: Malmo University.
- Kwari, Joshua Williams, Mari Kuceli Paul, and Luka Bobby Shekarau. 2015. The Impacts of Flooding on Socio-Economic Development and Agriculture in Northern Nigeria: A Case Study of 2012 Flooding in Yola and Numan Areas of Adamawa State Nigeria. *International Journal of Scientific & Engineering Research* 6: 1433–42.
- Lal, Rattan. 2009. Soil degradation as a reason for inadequate human nutrition. *Food Security* 1: 45–57. [\[CrossRef\]](#)
- Lamond, Jessica, Namrata Bhattacharya, and Robin Bloch. 2012. The role of solid waste management as a response to urban flood risk in developing countries, a case study analysis. *WIT Transactions on Ecology and the Environment* 159: 193–204.
- Lauer, Joe. 2008. Flooding impacts on corn growth and yield. *Agronomy Advice*. University of Wisconsin. Agronomy Department, Field Crops 28: 49–56.
- Lawal, Azariah. 2020. *Food System Resilience in Nigeria: Farmers Perspective*. Lincoln: University of Nebraska-Lincoln.
- Matemilola, Saheed. 2017. The challenges of food security in Nigeria. *Open Access Library Journal* 4: 1. [\[CrossRef\]](#)
- Madukwe, Michael Chukwunke, Ifeanyi Innocent Nwoye, E. G. Osegbue, and A. O. Kadiri. 2019. Effects of flooding on small scale farmers in Anambra, Nigeria. *Noble International Journal of Agriculture and Food Technology* 20: 31–40.
- Mbah, S. O. 2019. Determinants of rural poverty among small-holder farmers in Afikpo-north Local Government Area of Ebonyi state, Nigeria. *International Journal of Agric and Rural Development* 22: 4420–31.
- McFarlane, Colin. 2011. The city as assemblage: Dwelling and urban space. *Environment and Planning D: Society and Space* 29: 649–71. [\[CrossRef\]](#)
- Merem, Edmund C., Yaw Twumasi, Joan Wesley, Mohammed Alsarari, Siddig Fageir, Marshand Crisler, Coney Romorno, D. Olagbegi, Andre Hines, and G. S. Ochai. 2019. Regional assessment of climate change hazards in Southern Nigeria with GIS. *Journal of Safety Engineering* 8: 9–27. [\[CrossRef\]](#)
- Metu, Amaka G., Kenechukwu O. Okeyika, and Olisa D. Maduka. 2016. Achieving sustainable food security in Nigeria: Challenges and way forward. Paper presented at 3rd International Conference on African Development Issues (CU-ICADI), Ota, Nigeria, May 9–11.
- Meyer, Natanya, and Christelle Auriacombe. 2019. Good Urban Governance and City Resilience: An Afrocentric Approach to Sustainable Development. *Sustainability* 11: 5514. [\[CrossRef\]](#)
- Mukarram, Manuar. 2020. Impact of COVID-19 on the UN sustainable development goals (SDGs). *Strategic Analysis* 44: 253–58. [\[CrossRef\]](#)
- Naylor, Rosamond L. 2018. The Elusive Goal of Global Food Security. *Current History* 117: 3–9. [\[CrossRef\]](#)
- Nemine, Erekpokeme Lucia. 2015. Flood Disasters in Nigeria: Farmers and Governments' Mitigation Efforts. *Journal of Biology, Agriculture and Healthcare* 5: 150–54.
- Nguyen, Hanh. 2018. *Sustainable Food Systems: Concept and Framework*. Rome: Food and Agriculture Organization of the United Nations.
- Nkeki, Felix Ndidi, Philip John Henah, and Vincent Nduka Ojeh. 2013. Geospatial techniques for the assessment and analysis of flood risk along the Niger-Benue Basin in Nigeria. *Journal of Geographic Information System* 5: 29778. [\[CrossRef\]](#)
- OCHA. 2012. *Nigeria: Floods Situation Report No. 2*. Nigeria: OCHA Humanitarian Advisory Team.
- Ogundele, Bolaji. 2021. Buhari blames flood, insecurity, middlemen for rising food prices. *The Nation*, July 19.
- Ogundipe, Adeyemi A., Sophie Obi, and Oluwatomisin M. Ogundipe. 2020. Environmental Degradation and Food Security in Nigeria. *International Journal of Energy Economics and Policy* 10: 316–24. [\[CrossRef\]](#)
- Oguntunde, Philip G., Gunnar Lischeid, Babatunde J. Abiodun, and Ottfried Dietrich. 2017. Analysis of long-term dry and wet conditions over Nigeria. *International Journal of Climatology* 37: 3577–86. [\[CrossRef\]](#)
- Ohia, Chinenyenwa, Adeleye S. Bakare, and Tauseef Ahmad. 2020. COVID-19 and Nigeria: Putting the realities in context. *International Journal of Infectious Diseases* 95: 279–81. [\[CrossRef\]](#)
- Ojo, Stephen S., Daniel Barau Tpl, and Martina A. Pojwan. 2017. Urbanization and Urban Growth: Challenges and Prospects for National Development. *Journal of Humanities and Social Policies* 3: 65–71.
- Okoi, Obasesam, and Tatenda Bwawa. 2020. How health inequality affect responses to the COVID-19 pandemic in Sub-Saharan Africa. *World Development* 135: 105067. [\[CrossRef\]](#) [\[PubMed\]](#)
- Olalekan, Bakare Ganiyu. 2014. Urbanization, urban poverty, slum and sustainable urban development in Nigerian cities: Challenges and opportunities. *Developing Country Studies* 4: 13–19.
- Olaniyi, Olumuyiwa Akin, Isaac O. Olutimehin, and Okanlawon A. Funmilayo. 2019. Review of climate change and its effect on Nigeria ecosystem. *International journal of Rural Development, Environment and Health Research* 2: 70–81.
- Olaniyi, Olumuyiwa Akin, Z. O. Ojekunle, and Brenda Temitope Amujo. 2013. Review of climate change and its effect on Nigeria ecosystem. *International Journal of African and Asian Studies—An Open Access International Journal* 1: 57–65.
- Ologeh, Idowu O., Joshua B. Akarakiri, and Francis A. Adesina. 2018. Constraints and Limits to Climate Change Adaptation Efforts in Nigeria. In *Limits to Climate Change Adaptation*. Edited by Leal Filho and Johanna W. Nalau. Cham: Springer, pp. 159–74.
- Oluwatobi, Amosu Albert, Hammed Ayofe Mutalib, Togunde Kasaliyu Adeniyi, Joseph Olufemi Olabode, and Adekoya Adeyemi. 2017. Possible aquaculture development in Nigeria: Evidence for commercial prospects. *Journal of Agricultural Science and Technology B* 7: 194–205.

- Orimoloye, Isreal Ropo, Adeyemi Oludapo Olusola, Olusola Ololade, and Samuel Adelabu. 2021. A persistent fact: Reflections on drought severity evaluation over Nigerian Sahel using MOD13Q1. *Arabian Journal of Geosciences* 14: 1997. [CrossRef]
- Osabohien, Romanus, Evans Osabuohien, and Ese Urhie. 2018. Food security, institutional framework and technology: Examining the nexus in Nigeria using ARDL approach. *Current Nutrition & Food Science* 14: 154–63.
- Otomofa, J. O., Benedicta N. Okafor, and Ernest A. Obienusi. 2015. Evaluation of the impacts of flooding on socio-economic activities in Oleh, Isoko South Local Government Area, Delta State. *Journal of Environment and Earth Science* 5: 155–171.
- Ouko, Kevin Okoth, Robert Ouko Gwada, Getrude Okutoyi Alworah, Zephaniah Mayaka Onganga, Sharon Vera Ochieng, and John Robert Ouko Ogola. 2020. Effects of Covid-19 pandemic on food security and household livelihoods in Kenya. *Review of Agricultural and Applied Economics (RAAE)* 23: 72–80. [CrossRef]
- Oyebola, O. Oyediran, Jackson Efitre, Augustine Eyiunmi Falaye, Taiwo M. Dada, and Funmilayo C. Idowu. 2018. Agriculture in the Face of Climate-Mediated Flooding in Tropical Africa: Technical Innovations of Fish Farmers in Southwestern Nigeria. In *Handbook of Climate Change Resilience*. Edited by Walter Leal Filho. Cham: Springer. [CrossRef]
- Pamungkas, Adjie, and Santika Purwitaningsih. 2019. Green and grey infrastructures approaches in flood reduction. *International Journal of Disaster Resilience in the Built Environment* 10: 343–62. [CrossRef]
- Paré, Guy, and Spyros Kitsiou. 2017. Methods for literature reviews. In *Handbook of eHealth Evaluation: An Evidence-Based Approach [Internet]*. Victoria: University of Victoria.
- Pérez-Escamilla, Rafael. 2017. Food security and the 2015–2030 sustainable development goals: From human to planetary health: Perspectives and opinions. *Current Developments in Nutrition* 1: e000513. [CrossRef] [PubMed]
- Post, Corinne, Riikka Sarala, Caroline Gatrell, and John E Prescott. 2020. Advancing theory with review articles. *Journal of Management Studies* 57: 351–76. [CrossRef]
- Prosekov, Alexander Y., and Svetlana A. Ivanova. 2018. Food security: The challenge of the present. *Geoforum* 91: 73–77. [CrossRef]
- Reddy, Vangimalla, Mura Jyostna Devi, and Venkatachalam Anbumozhi. 2019. Ensuring Food and Nutritional Security in the Face of Disasters and Climate Change: What is the Adaptive Solution? In *Towards a Resilient ASEAN Volume 1: Disasters, Climate Change, and Food Security: Supporting ASEAN Resilience*. Jakarta: ERIA.
- Rondeau, Daniel, Brianna Perry, and Franque Grimard. 2020. The Consequences of COVID-19 and Other Disasters for Wildlife and Biodiversity. *Environmental and Resource Economics* 76: 945–61. [CrossRef]
- Salami, Rafiu O., Jason K. Von Meding, and Helen Giggins. 2017. Vulnerability of human settlements to flood risk in the core area of Ibadan metropolis, Nigeria. *Jambá: Journal of Disaster Risk Studies* 9: 1–14. [CrossRef]
- Sánchez-Rodríguez, Antonio R., Paul W. Hill, David R. Chadwick, and Davey L. Jones. 2017. Crop residues exacerbate the negative effects of extreme flooding on soil quality. *Biology and Fertility of Soils* 53: 751–65. [CrossRef]
- Schmidhuber, Josef, and Francesco N. Tubiello. 2007. Global food security under climate change. *Proceedings of the National Academy of Sciences of the United States of America* 104: 19703–8. [CrossRef]
- Smith, Frankie. 2017. How Are People Affected by Floods? Available online: <https://sciencing.com/how-are-people-affected-by-floods-12510012.html> (accessed on 15 January 2022).
- Talbot, Ceara J., Elena M. Bennett, Kelsie Cassell, Daniel M. Hanes, Elizabeth C. Minor, Hans Paerl, Peter A. Raymond, Rodrigo Vargas, Philippe G. Vidon, and Wilfred Wollheim. 2018. The impact of flooding on aquatic ecosystem services. *Biogeochemistry* 141: 439–61. [CrossRef]
- Tasantab, Jerry C. 2019. Beyond the plan: How land use control practices influence flood risk in Sekondi-Takoradi. *Jambá: Journal of Disaster Risk Studies* 11: 1–9. [CrossRef]
- The Lancet Public Health. 2020. Will the COVID-19 pandemic threaten the SDGs? *The Lancet. Public Health* 5: e460. [CrossRef]
- Toure, D. 2014. Resident/Humanitarian Coordinator Report on the Use of Cerf Funds Nigeria Rapid Response Floods. Available online: https://cerf.un.org/sites/default/files/resources/18-RR-NGA-33345-NR03_Nigeria_RCHC.Report.pdf (accessed on 15 January 2022).
- Tunde, Oso. 2021. RISING POVERTY: No End in Sight to High Food Prices—MAN, Others. Available online: <https://www.vanguardngr.com/2021/06/rising-poverty-no-end-in-sight-to-high-food-prices-man-others/> (accessed on 15 January 2022).
- Udegbuma, Oge. 2020. Why prices of food items have increased in Nigeria. Available online: <https://www.premiumtimesng.com/news/headlines/428471-why-prices-of-food-items-have-increased-in-nigeria.html> (accessed on 10 January 2022).
- United Nations. 2020. *The Sustainable Development Goals Global Report*. Edited by Lois Jensen. New York: United Nations.
- Valzania, Giacomom. 2021. Assemblage Thinking for Urban Design research: Planning and adapting methods for studying international immigrants in Toronto's modernist suburbs. In *Proceedings of the Royal Roads University Applied Research Conference 2021*, Victoria, Canada, August 20–22.
- Virapongse, Arika, Samantha Brooks, Elizabeth Covelli Metcalf, Morgan Zedalis, Jim Gosz, Andrew Kliskey, and Lilian Alessa. 2016. A social-ecological systems approach for environmental management. *Journal of Environmental Management* 178: 83–91. [CrossRef] [PubMed]
- Week, Doodei A., and Collins Hanachor Wizar. 2020. Effects of flood on food security, livelihood and socio-economic characteristics in the flood-prone areas of the core Niger Delta, Nigeria. *Asian Journal of Geographical Research* 3: 1–17. [CrossRef]
- Workie, Endashaw, Joby Mackolil, Joan Nyika, and Sendhil Ramadas. 2020. Deciphering the impact of COVID-19 pandemic on food security, agriculture, and livelihoods: A review of the evidence from developing countries. *Current Research in Environmental Sustainability* 2: 100014. [CrossRef] [PubMed]

World Food Programme, WFP. 2020. *2020 Global Report on Food Crises*. Rome: WFP.

Zewdie, A. 2014. Impacts of climate change on food security: A literature review in Sub Saharan Africa. *Journal of Earth Science & Climatic Change* 5: 225.