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Vulnerable Populations: The Role of Population Dynamics in Climate Change Resilience and Adaptation in Africa

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# Information

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EDITORIAL INTRODUCTION:

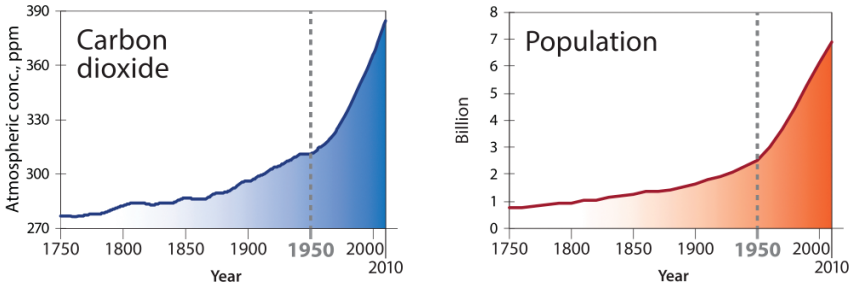
# Vulnerable Populations: The Role of Population Dynamics in Climate Change Resilience and Adaptation in Africa

David Samways

It is intuitively appealing to read the simultaneous growth in population and $CO_2$ emissions shown in Figure 1 as a simple causative relationship. However, the connections between population and climate change are complex. The massive increase in the human impact on the global environment since 1950, dubbed 'The Great Acceleration' (Steffen et al., 2015), is correlated with rapid global population and economic growth. However, while the former was greatest in the Global South, the latter was concentrated in the Global North. Areas with presently high rates of population growth are amongst the lowest emitters of greenhouse gases (GHGs). According to the Intergovernmental Panel on Climate Change (IPCC), while the richest ten per cent of the global population, two thirds of whom live in developed countries, contribute between 36–45 per cent of global GHG emissions, the emissions of poorer residents of emerging countries are between five and fifty times lower (IPCC, 2022).

Nonetheless, as acknowledged by the IPCC (2022), population growth is a major indirect driver of GHG emission growth and, although consumption remains the most significant driver, various commentators have noted that reducing population growth can play an important role in reducing future emissions (O'Neill et al., 2012; Casey and Galor, 2017; Bongaarts and O'Neill, 2018; Wolf et al., 2021). While projected population growth will undoubtedly increase emissions, high rates of population growth are also positively correlated with increased vulnerability to the effects of climate change (Price, 2020). Sub-Saharan Africa has the highest

**Figure 1. Annual CO2 emissions and population 1750–2010**




(SOURCE: ADAPTED FROM STEFFEN ET AL. 2015 WITH THE KIND PERMISSION OF THE LATE WILL STEFFEN)

rate of population growth (UN, 2022) and is also the one of the most vulnerable continents to climate change (IPCC, 2014; 2022). This special issue of *The Journal of Population and Sustainability* focuses on population growth as a factor in the resilience and adaptive capacity of communities in Africa facing the effects of climate change.

It is well established that climate change is likely to disproportionately affect the people of the poorest regions of the world who will suffer adverse health effects due to extreme heat, growth of disease vectors, increasing water scarcity, soil erosion, crop failure, flooding of low-lying areas, and so forth (IPCC, 2014). Moreover, there is a broad consensus that high rates of population growth adversely affect development and welfare improvements and can negatively impact the availability of natural resources (Das Gupta et al., 2011; Beegle and Christiaensen, 2019; Price, 2020). The precise relationships between high rates of population growth, low levels of economic development, climate vulnerability, resilience and adaptation are complex and geographically uneven. However, in areas vulnerable to climate change, high rates of population growth have a negative impact on the community's resilience and adaptive capacity (Beegle and Christianensen, 2019; Price, 2020).

Importantly, climate-change related impacts exacerbate existing inequalities of power. Women and girls are frequently the most disadvantaged and least skilled members of a community and therefore disproportionately vulnerable. A lack of adaptive capacity in the face of climate-change-associated extreme weather

events has the potential to disrupt sexual health and family planning services, amplifying the vulnerability of women to such events as well as increasing exposure to sexual and gender-based violence (Kwauk and Braba, 2017; Price, 2020; Logie, et al. 2021). Poor resilience and adaptive capacity can also lead to wider social conflict and climate induced migration with associated negative impacts on welfare (Kelley, 2016; Cattaneo et al., 2019).

Shifts in the age structure of populations present problems and opportunities. For the greatest part of human history, population growth was incredibly low at an average of around 0.04 per cent annually (Roser et al., 2013). While this did not mean that the age composition of populations was absolutely stable for all societies at all points in time, it does mean that on average the population age structure remained fairly stable. However, crudely put, the industrial revolution disrupted this relative stability by indirectly improving overall health and lowering mortality, especially amongst children, which in the absence of changes in fertility behaviour led to rapid population growth. The so called 'demographic transition' experienced by the majority of countries in the Global North, where birth rates shifted toward an equilibrium with reduced mortality rates, produced a 'demographic dividend' where the working age population grew relative to dependents. In Africa, while mortality rates have steadily declined, reductions in fertility have not followed the same pattern experienced in the Global North. In the first paper of this special issue, Sunday Adedini and colleagues argue that there are clear synergies between producing a demographic dividend, economic development and tackling climate change vulnerability in Africa.

While all continents will experience the adverse effects of climate change, Adedini et al. point out that' since Africa has many of the world's poorest nations, resilience and adaptive capacity are poor. The effects of climate change are already causing extreme weather events which destroy infrastructure, exacerbate food insecurity and frequently lead to forced migration and the growth of insanitary informal settlements. Moreover, climate change is adversely affecting health through exposure to more extreme temperatures and the creation of conditions for the proliferation of disease. The effects of climate change threaten to erode emerging socioeconomic gains and these setbacks, combined with high rates of population growth, exacerbate climate change vulnerability. Adenini et al. argue that tackling unsustainable population growth through the provision of quality family planning services, reducing adolescent fertility, educating female children, empowering

women and reducing under-five mortality is critical to creating a demographic dividend and building resilience to the effects of climate change.

In a previous issue of the *JP&S*, Illan Kelman (2020) argued that so called 'natural disasters' are not natural at all but the result of societal choices which assist or hinder society's ability to cope with disasters. Vulnerability to disaster is an outcome of these societal choices which enable or constrain a society's ability to cope. However, framing vulnerability in terms of choice must also acknowledge the wider structural context and constraints on agency. For many developing countries, seemingly inexorable urbanisation not only takes place within the context of regional socioeconomic change but also within the wider context of global economic relationships as well as changing environmental conditions. The ability of individual agents to choose, in a situation of forced migration for example, is clearly constrained and even national and regional institutions must order their priorities in the context of conditions outside of their control.

Nonetheless, as Stephanie Dos Santos and colleagues point out in their article in this issue, the vulnerability of growing urban populations to disasters is frequently an outcome of inadequate policy. Dos Santos et al. are directly concerned with the combined effect of environmental and social factors in vulnerability to flooding in African cities. Their interdisciplinary study analyses household level data from contrasting residential areas affected by flooding in the city of Abidjan, Côte d'Ivoire. Abidjan has experienced significant growth over the last sixty years, seeing a 27-fold increase in population to 5.3 million. The two study areas, while both poor in global terms, differ significantly at a socio-economic level, with indicators such as the number of slum and informal dwellings and population density marking a clear demarcation in terms of prosperity. Dos Santos et al. also analysed physical environmental conditions in their two sample areas at a fine level, determining that these factors were significant contributors to flood vulnerability. Their analysis is consistent with other studies showing a clear link between socio-economic factors and flood vulnerability and they observe that urban disasters consequent upon climate change amplify urban inequalities. However, household level physical environmental conditions also contributed significantly to flood vulnerability, leading Dos Santos et al. to conclude that the multidimensional nature of vulnerability at the household level must be understood by policymakers in post-disaster management.

In our third article for this special issue, Paige Passano, Min Ah Choi and Matt Matusiewicz address the threats to social wellbeing and stability in the Sahel posed by climate change, population growth and malnutrition. This semiarid region of Africa is amongst the most vulnerable regions to the effects of climate change. Projected increases in surface temperature of between three and five degrees Celsius by 2050 will exacerbate the region's existing ecologically fragility. The Sahel also contains some of the world's poorest nations with the highest rates of population growth. Indeed, as Passano et al. report, in 1950 the Sahel was sparsely populated with less than fifty million people, but persistently high fertility levels have led the population to grow to over 500 million today with a projected figure of over 900 million by 2050. The authors argue that high rates of population growth combined with deteriorating environmental conditions threaten to reverse developmental gains and overwhelm relief efforts. Acknowledging the value of attempts to boost community resilience through programmes developing critical infrastructure, water conservation, degraded land restoration, biodiversity protection, income diversification etc., Passano et al. observe that the benefits of addressing population growth are frequently overlooked or dismissed. However, they argue that lowering fertility, through the education of girls and provision of voluntary family planning, is essential to strengthening resilience and adaptive capacity and avoiding humanitarian catastrophe.

Presently more than half the global population reside in towns and cities, and by 2050 that figure is expected to rise to more than two thirds (Ritchie and Roser, 2018). Thus, as Dos Santos et al.'s article makes clear, planning for and mitigating the effects of climate change on cities will be critical to the welfare of billions. While the growth of the world's megacities attracts much attention, in our last article Sunday Adedini argues that intermediate cities of less than one million people will absorb most of Africa's burgeoning urbanisation, accommodating more than half of the continent's population by 2030. However, the critical infrastructure of these cities is far from adequate, making them more vulnerable than larger and more established conurbations to climate related stresses and events such as flash flooding. In particular, Adedini notes that many of these intermediate cities are strongly connected with the surrounding agricultural areas and hence more vulnerable to climate related agricultural failure.

Population growth in these cities is largely driven by rural to urban migration, but high fertility rates are also significantly contributing to their expansion. Moreover, the majority of residents are poor, rendering them particularly vulnerable to climate stressors. Adedini argues that great improvements in urban planning policies, investment in critical infrastructure, disaster mitigation and health care systems are required to ensure good welfare in the face of environmental change. However, such development takes time and Adedini advocates investment in family planning as a critical means to slow the rate of urban population growth and ameliorate pressure on resources, which will not only improve resilience to climate change but lead to greater prosperity.

While population growth can be shown to be an indirect driver of climate change, the articles in this special issue of the *JP&S* demonstrate how a combination of demographic, socio-economic and environmental factors create conditions of vulnerability in many regions of Africa. In particular, high fertility and rural to urban migration are exacerbating the unfolding effects of climate change, threatening the welfare of millions. However, it is also clear that progressive and equitable policies can empower women and lower fertility rates and that, in combination with good governance and informed urban planning, urban areas in particular can be made more resilient to the impact of climate change.

Programmes to increase resilience and adaptation require resources. The United Nations Environment Programme estimates that sub-Saharan Africa will need in the region of $36 billion a year, the highest as a proportion of GDP of any region, to finance climate adaptation (UNEP, 2022). Given that it is clear that the populations of the Global North have been the greatest beneficiaries of fossil fuelled economic growth, questions of climate justice are germane.

Recent work for Earth4All (https://earth4all.life/) by Callegari and Stoknes (2023) proposes that diverting two to four per cent of global GDP toward enabling what they term a 'Giant Leap' could avoid or ameliorate the worst consequences of the environmental crisis whilst greatly improving the welfare of the world's poorest people. They argue that, by progressively raising the taxes of the richest ten per cent of the global population by between four and eight per cent, a concerted and internationally coordinated effort could achieve five key turnarounds:

1. End poverty
2. Address gross inequality
3. Empower women
4. Create a food system healthy for people and ecosystems
5. Transition to clean energy

Earth4All's modelling suggests that addressing these objectives would lead to population peaking at 8.5 billion in 2040 and declining to 6 billion by 2100, while greenhouse gases would continuously fall such that global warming could be kept below 2°C above preindustrial levels.[1] Such outcomes are clearly consistent with the broader themes and concerns articulated by contributors to this special edition of the *JP&S* and, while Earth4All's proposals are ambitious, Callegari and Stoknes emphasise that they are nonetheless achievable:

> These extraordinary turnarounds are designed as policy and investment road maps that will work for the majority of people. They are not an attempt to create some impossible-to-reach utopia; instead, they are an essential foundation for a resilient civilisation on a planet under extraordinary pressure. The world is increasingly recognising that there are sufficient knowledge, funds and technologies in the world to implement them. (p. 20)

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1 Critically, the model assumes that carbon capture and storage will play a significant role.

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EDITOR REVIEWED ARTICLE

# How can African countries address climate change problems and optimise demographic dividends for socioeconomic development?

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## Abstract

*As all 54 countries in Africa strive to overcome their different socioeconomic challenges, the climate crisis as well as the unsustainable population growth appear to be threatening the attainment of national and international development agenda across the continent. This paper presents the relationship between climate change and population dynamics; how Africa can address the problems of the climate crisis and rapid population growth, and create the potential to harness a demographic dividend and accelerate economic growth. Many African countries need to take necessary measures to achieve a rapid and sustained fertility transition, including providing access to quality family planning services, reducing adolescent fertility, educating female children, empowering women, reducing under-five mortality and*

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*expanding labour market opportunities. These are necessary conditions for fertility transition and reaping the benefit of a demographic dividend in Africa. As African countries take strategic steps to catalyse fertility transition and accelerate economic growth, there is a need to take urgent measures to fight the climate change crisis which appears to be eroding socio-economic gains across the continent. While Africa adds only a trifling fraction of the global greenhouse gas emissions, the continent bears a disproportionately significant portion of the detrimental impact of climate change. Without the necessary actions to stem and reverse the consequences (such as health crises, food insecurity due to the destruction of crops by severe weather, the destruction of livelihoods and increases in the numbers of internally displaced persons), climate change is likely to have significant negative effects on the achievement of the sustainable development goals and the African Union's Agenda 2063. There is a need to address the twin problems of unsustainable population growth and climate crisis in Africa.*

## Keywords

Climate change, population dynamics, demographic dividend, socioeconomic development, Africa

## Introduction

The need to ensure environmental adaptation and resilience across the world continues to be affirmed in several international strategic efforts. Recent meetings such as the 2022 United Nations Climate Summit in Egypt (COP27) and the 2022 Africities Summit in Kenya acknowledged the importance of curbing the climate crisis and ensuring sustainable socioeconomic development. Back in 2015, seventeen Sustainable Development Goals (SDGs) were adopted by the United Nations as a blueprint and call to ensure a sustainable future across all countries of the world (UNDP, 2023). Several of the goals, including SDG 6 (ensuring access to clean water and sanitation), SDG 7 (having affordable and clean energy), SDG 8 (having decent work and economic growth), SDG 11 (ensuring sustainable cities and communities), SDG 12 (ensuring responsible consumption and production) and SDG 13 (pursuing climate action) all directly or indirectly point to the need to protect the planet and ensure environmental adaptation and sustainable socioeconomic development.

Although there is a commitment to prioritise action and support countries that are furthest behind in achieving the various SDG targets (UNDP, 2023), substantial gaps in climate crisis vulnerabilities and socioeconomic development persist between the high-income and low/middle-income countries. While relevant indicators show that Africa trails many other continents in several indices of socioeconomic development, the climate crisis is also hitting the continent very hard. For instance, in 2022, heavy rainfall and flooding attributed to climate change led to the death of millions of people across many African countries, including South Africa, Nigeria, Burkina Faso, Mali, Niger and Chad (Adedini, 2023a). This precarious situation clearly shows the important link between climate change and socioeconomic development. The challenge of climate change has further worsened the socioeconomic situation of many African countries, thus aggravating problems such as food insecurity due to the destruction of crops by severe weather, the destruction of livelihoods, and increases in the numbers of internally displaced persons (IDPs) due to conflict over increasingly scarce resources (Adedini, 2023b; UNHCR, 2022). The poor socioeconomic situations of many African countries are increasingly exacerbated by the acceleration of the climate crisis.

Further, the World Health Organization has recognised the climate challenge as a health crisis because of the many negative impacts on health associated with increased rainfall, and more intense weather conditions leading to more frequent outbreaks of disease (GAVI, 2022). Global environmental change is threatening human health and welfare and nowhere is this situation more critical than in Africa. Whilst being the lowest contributor to greenhouse gas emissions, Africa has the highest rates of population growth and some of the greatest vulnerabilities to the effects of climate change ((AfDB, 2022; GAVI, 2022). For instance, currently, Africa has more than ninety per cent of the global burden of malaria. It is projected that climate change will lead to additional 60,000 malaria deaths by 2050 due to warmer temperatures and increased rainfall and flooding expanding the habitat for malaria-carrying mosquitoes thus creating budding hotspots for infections. Additionally, environmental change may lead to more cases of diarrhoea, malnutrition and under-five mortality if urgent steps are not taken to curb the climate crisis (GAVI, 2022).

There is a clear link between climate change, demographic dividend and socioeconomic development. The demographic dividend refers to the economic

growth that occurs in a country arising from a favourable change in the age structure of the population following a period of demographic transition from high mortality and high fertility to low mortality and low fertility. While mortality has steadily declined across Africa, fertility decline has remained sluggish in many countries. Bongaarts (2017) noted that Africa has a unique fertility transition due to a stall in mid-transition, a pattern that has not been observed in other continents. With an average total fertility rate (TFR) of 4.2 in Africa (Statista, 2022), which is almost double the world average of 2.4, the prospect of harnessing a demographic dividend on the continent is distant. A large body of empirical research has established the need to take necessary measures to achieve a rapid and sustained fertility transition in Africa, including quality family planning services, reducing adolescent fertility, educating female children, empowering women and reducing under-five mortality (Adedini et al., 2015; Bado et al., 2022; Bradshaw et al., 2023; Reed and Mberu, 2014; Sunmola et al., 2020). These are necessary conditions for fertility transition and reaping the benefit of a demographic dividend in Africa.

Given its richness in human and natural resources, Africa has a great potential to attain high level of socio-economic development, however there is need to urgently address the twin problems of unsustainable population growth and climate crisis that appear to be threatening the achievement of the continent's development agenda such as the African Union's Agenda 2063, the SDGs and others. Considering the increasing threat posed by the climate change, and the problem of rapid population growth occasioned by the persistent high fertility, an important question that must be addressed is 'how can African countries overcome the climate change problems and achieve fertility transition to optimise and harness demographic dividends for socioeconomic development?' Thus, this paper presents the relationship between climate change and population dynamics; and how Africa can address the problems of climate crisis and rapid population growth, and create potential to harness demographic dividend for economic growth.

## Climate Change Challenges in Africa

In recent times, the effects of climate change have been demonstrated by an increase in average seasonal temperatures and unfavourable weather patterns. Global warming anomalies reached a new high in 2016 since the commencement

of global records in 1880, with the ten warmest years occurring between 2010 and the present, and the year 2022 being the sixth warmest since then. Furthermore, glaciers and ice sheets are melting, and sea levels are increasing. Summer arctic sea ice coverage is shrinking by 12.6 per cent per decade, reaching a record low in 2012 (NOAA, 2023; NASA, 2023). The consequences of climate change are also readily apparent in Africa, where temperatures have been rising consistently for the past four decades (NCEI, 2023). Anthropogenic emissions have significantly exacerbated the impacts of climate change, with sixty per cent of GHG emissions emanating from just ten countries, including China and the United States of America, while sub-Saharan Africa contributed very little. In 2019, China alone accounted for a substantial 24 per cent of global total GHG while the whole of sub-Saharan Africa accounted for only 5.6 per cent and 7.26 per cent of global $CO_2$ and total GHG respectively (WRI, 2022).

Although, Africa adds only a trifling fraction of the global greenhouse gas (GHG) emissions, the continent bears a disproportionately significant portion of the detrimental impact of climate change (Ray, 2021). Nonetheless, despite its vulnerability and minimal contribution to GHG emissions, Africa partakes in global initiatives and commitments to mitigate the impact of climate change, as countries like Liberia, Guinea Bissau, Benin Republic, Nigeria, South Africa, and Madagascar have either achieved or set net-zero carbon emissions targets (NCI, 2021). Climate change has widespread global effects to which all continents are exposed, but Africa's vulnerability puts it at greater risk because many African countries do not possess the wherewithal to adequately absorb the shocks of climate change threats. Climate change presents extreme events such as heat waves, droughts, flooding and other tropical events which have significant impact on the African continent. In the summer of 2021, heat waves affected the Northern African countries of Tunisia – which experienced its hottest summer since 1950 – Libya, Morocco and Algeria, engendering wildfires with attendant unfavourable after-effects (WMO, 2022a).

Climate change also threatens food security and exacerbates other challenges to sustainability. Crop production in Africa is principally dependent on rainfall. As the amount of rainfall diminishes as a result of climate change, crops are damaged and agricultural yields decrease with resultant food insecurity. According to the WMO Provisional State of the Global Climate 2022 report (WMO, 2022b), the East African countries of Kenya, Somalia and southern Ethiopia suffered increased

drought intensity with predictions of crop failure and increased food insecurity. Meanwhile the region of southern Africa suffered cyclones with landfalls in Madagascar and resultant flooding in Mozambique and Malawi. These events have multiple effects including the proliferation of internal displacements, forced migration, the growth of urban slums and swelling of refugee numbers. Such outcomes frequently lead to the overstretching of resources, unemployment, increased substance abuse, poor access to healthcare and loss of lives (Yigzaw and Abitew, 2019; Carrillo, 2009; IDMC, 2018). Increases in morbidity and mortality due to transition in disease dynamics and psychosocial health issues, as well as the erosion of African cultural heritage are also likely to increase as temperatures rise. Moreover, climate change will adversely affect biodiversity on the African continent. As temperature rises more than $1.5^0$C, half of those species assessed are projected to have population declines or loss area of suitable habitat exceeding thirty per cent (IPCC, 2022).

These adverse events produce damaging economic consequences. According to a report commissioned by the United Nations Environment Programme (UNEP), the African Development Bank (AfDB) and the United Nations Economic Commission for Africa (ECA), climate change could cause up to fifteen per cent of GDP per capita to be lost in Western and Eastern Africa. Northern and Southern Africa and Central Africa could experience GDP per capita decreases of up to ten and five per cent respectively by 2050. However, if mitigation and adaptation actions are taken, considerable benefits in macroeconomic stability are likely, which could result in the creation of up to 11.8 million jobs by 2050 (AfDB, 2019). Without the necessary actions to stem and reverse the consequences, climate change is likely to have significant negative effects on the achievement of the sustainable development goals (SDGs) by African States.

## Population Dynamics and Demographic Dividend

The management of the population growth rate has been on the front burner of policy discussions in many African countries. The population of Africa is over 1.4 billion based on the latest United Nations estimates and forecast to double by 2050 (UN, 2022). Population growth and demographic transition in sub-Saharan Africa will see a shift in the age structure such that those of working-age outnumber other age groups, creating the potential for a 'demographic dividend'.

The economic implication of this transition is that, as dependency ratios shrink, the potential for those in the labour force to save, invest and contribute to economic growth will increase. Moreover, the transition in age distribution paves the way for a demographic dividend in Africa when the current population boom coincides with higher levels of savings and investment thus moving from a poverty stricken and lifecycle deficit[7] economy to a prosperous industrialised economic system. However, the window of opportunity created by demographic transition does not automatically translate into demographic dividend. Each African country's response to the above and other determinants such as domestic savings, socioeconomic environment and climate change will determine the progression of the dividends as the working age population enlarges and the youngest, less-productive age brackets shrink (Cleland, 2012).

More importantly, the window of opportunity open for demographic dividend is limited in time (Cummins, 2019). Over time, the youth bulge will transition to the older, less-productive age cohorts, thus increasing the dependency ratio and thereby creating a resurgence of economic pressures that may be extremely challenging. To maximise the opportunities that come with lower fertility and mortality rates and avoid the problems of the inevitable return to high dependency ratios, Africa must encourage savings and investment before the window closes. Unfortunately, several countries in Africa are slow to take decisions and institute policies that will benefit development when the window of opportunity for demographic dividend opens (Cardona et al., 2020). Most of the necessary decisions are long-term investments that may yield less immediate political capital. Hence, most African leaders, especially in the sub-Saharan region, prioritise short-term investments which showcase results in preparation for the next elections.

As Africa's labour force is projected to grow by thirty per cent per decade (Cleland, 2012), the danger that lies ahead signals the need to engage and persuade African leaders to create a balance between building political capital and developing a resilient and sustainable economy that will change the people's lives (Osei-Appaw and Christian, 2022). This becomes imperative in the light of multiple threats confronting the African economy, including COVID-19 and climate change. Failure to vigorously increase effort on socioeconomic interventions as

7 Resulting from high dependency ratios.

birth and death rates fall (which would propel the production of more goods and services resulting in poverty reduction, greater income, and opportunities) will result in demographic debt or widespread misery.

## Population Dynamics and Potential for Optimising Demographic Dividend for African Socioeconomic Development

Perspectives on the relationship between population dynamics and economic development frequently oscillate between pessimism and optimism. However, empirical analysis shows that population age structure is more critical than crude population size. The pessimistic perspective contends that population growth limits economic growth because high fertility leads to high dependency, which in turn leads to reduced savings and investments, and ultimately a reduction in capital per worker. In essence, high dependency leads to capital 'widening' rather than 'deepening' (Coale and Hoover, 1958). On the other hand, the optimistic view contends that population growth spurs technological innovation due to the pressure on scarce resources, and that the stock of new ideas can be used more effectively in larger than in smaller populations. In essence, this position contends that 'necessity is the mother of invention' (Kuznets, 1967; Boserup, 1981; Simon, 1981). In contrast, perspectives emerging from empirical analysis conclude that population dynamics which increase the level of dependency have negative effects on economic development while those that reduce them have a positive influence (Bloom and Williamson, 1998; Kelley and Schmidt 2001). Our understanding of the links has more recently evolved to demonstrate that population growth due to increased fertility would have immediate negative effects but *may* have positive effects in a longer term. This is mainly due to the 'baby cohort' creating a bulge in the workforce accompanied by changes in saving and investment rates. Given the current negative effects of high fertility, which is consistent with the immediate term impacts, the hopes and potentials of *Africa Rising* are firmly rooted in these potential long-term effects.

Although selected countries and cities in Africa may have advanced into the third stage of the demographic transition, the African continent is largely in the second stage, where a combination of falling mortality and persistent high fertility is fuelling population growth. As a result, the population of the continent is younger today than it was fifty years ago. While falling fertility rates will open the demographic window of opportunity, shift the age structure in the right direction

for a demographic dividend and realise the first dividend, attention needs to be paid to the levers influencing the second demographic dividend for the purpose of advancing socioeconomic development on the continent.

Changes in savings and investments to drive private capital accumulation represent the most crucial of the levers of the demographic dividend. Indeed, the second demographic dividend depends solely on sufficient private capital accumulation. African countries exhibit enormous gaps in private investments as a result of high consumption propensities, thereby elevating the role of public capital in the socioeconomic development process. Unfortunately, an elevated role for public investments creates grounds for high levels of corruption and a vicious cycle of high fertility and low saving rates. High levels of corruption lower return on both private capital and labour and therefore lower the opportunity cost of having children (Blackburn and Sarmah, 2008; Arsenis and Varvarigos, 2011). Corruption takes the form of embezzlement of public funds, and thus reduces the provision of public goods and services that contribute to health and longevity. In turn, lower life expectancy weakens incentives to save, and thereby slows down capital accumulation and growth. In addition, since corruption hinders the delivery and the quality of public services that support child quality (health and education), parents will find it optimal to divert their resources towards child quantity. A demographic transition may occur as a direct outcome of reduced corruption in the public sector.

Another reason for emphasis on investment and private capital accumulation is that human capital gravitates toward physical capital due to the complementarity between the two factors in productivity and earnings. African countries are currently experiencing the *Canada Rush* and '*japa*',[8] two terms which capture the exit of the young and most productive population from the continent for Europe and North America. This emigration translates into huge loses of the stock of human capital in Africa to countries with high levels of capital per worker. If unabated, the exit of the most productive workforce who are also most likely to exhibit low levels of fertility will put a brake on potential African fertility transition. Along with improvement in public services, private investments are essential for reversing the 'brain drain' that Africa has suffered in the past and for halting the current 'japa' phenomenon. Evidence from global competitiveness

8 From the Yoruba language, meaning to run or flee.

reports indicate that labour market flexibility is not enough to attract productive workforce, but that it must be backed by effective and efficient human capital (education and healthcare) services. Conventions such as the Abuja and Paris Declarations that urge governments to increase spending on healthcare and education respectively need to be given more attention.

Implementation of the provisions of the African Free Trade Agreement (AfCFTA) and intensification of existing regional trade agreements will induce significant population dynamics. The provision of free movement of people within the regional blocks will intensify movement of productive human capital across borders within the continent. This has the potential to simultaneously create advances in some countries and regressions in others with regards to the demographic transition. Unless the managers of local economies develop the critical local and cross-border knowledge and use these in setting socioeconomic development strategies, intensification of cross-border movement under the trade pacts will potentially heighten existing demographic disparities. If smaller countries experience advances and large countries experience setbacks, which is the most probable scenario, then the continent as a whole will experience a setback in the demographic transition. The result will be the absence of a continent-wide demographic dividend.

In light of this, the territorial approach to development planning, also referred to as *local development*, holds huge potential for advancing the pace of demographic dividend and socioeconomic development on the continent. Unlike sectoral approaches to development, the territorial approach recognises the spatial dimensions of development and seeks to better understand the diversity of resources, including demographics, and markets within territories and use these to define development goals. Development plans created under the territorial approach tend to be more objective and tailor-made, use local knowledge and capacity in implementation, focus on the overall development of the specific territory (mainly county or local government area), place emphasis on socio-economic development of the territory, vary from one territory to another in content and strategy, and treat each territory as an open economy trading with other territories. Adoption of this approach requires decentralisation and devolution of authority and responsibility to counties and local government councils.

## The Way Forward

Africa is at a critical moment. As all 54 countries on the continent strive to overcome their particular challenges; the climate crisis, combined with unsustainable population growth, appears to be threatening the attainment of national and international development agenda across many countries on the continent. While economic growth has been strong and rising recently in many countries across the continent, Africa and its leaders and development partners need to collectively work towards simultaneously addressing the problems of unsustainable population growth and climate change. First, African countries must adopt necessary policies and programmes to accelerate demographic transition. Second, they must take deliberate decisions to strengthen human capital development towards placing Africa in a position to harness the demographic dividend and all benefits that demographic transition offers. Third, health is wealth; therefore, Africans and the African economy will benefit immensely from policy and programmatic actions that pay attention to the climate-health nexus and also seek to curb the climate crisis through deliberate measures and steps. These include mitigating the climate crisis through speedy global decarbonisation and increasing financing and other resources toward preventing illnesses to save lives as well as to drive economic growth. Also, Africa needs to embrace the *One Health* principle of developing research, programmes, policies, and legislations through a multisectoral approach to improve public health outcomes and socioeconomic outlook on the continent.

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PEER REVIEWED ARTICLE

# Socio-Environmental and Physical Factors of Flood Risk in African Cities: An Analysis of Vulnerabilities in Two Contrasting Neighbourhoods in Abidjan, Côte d'Ivoire

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## Abstract

*The literature on vulnerability to flooding highlights the multiple dimensions of risk factors. However, little research has analysed the joint effects of environmental and social variables on flood risk at the household level in African cities. We use an interdisciplinary approach to analyse the differentiated significance of these dimensions for the status of 'flood victim' in Abidjan, the major city of Côte d'Ivoire. The data used were collected in a survey of 503 households residing in two contrasting neighbourhoods of Abidjan. Modelling data with logistic regressions, the results show that physical variables (the slope of the housing plot), environmental variables (liquid and solid waste disposal) and social variables (the gender of the head of household or the composition of the household) are factors jointly associated with flood risk. The multidimensional nature of vulnerability*

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*at the household level must be seen as a challenge faced by public authorities in post-disaster management.*

**Keywords:** vulnerability, flood, cities, sub-Saharan Africa, interdisciplinarity.

## Introduction

Worldwide, extreme events related to climate are becoming more and more frequent, mainly because of an ever-increasing number of floods and storms. From 1995 to 2015, floods alone represented 47 per cent of all climate-related disasters, affecting more than two billion people (UNISDR 2015). In Africa, cities are particularly vulnerable to flooding (Douglas et al. 2008).

As early as 1942, White's pioneering doctoral thesis challenged the idea that natural hazards are best addressed by engineering solutions (White 1946). Nevertheless, in the four decades thereafter, a technology-focused paradigm prevailed: understanding a hazard with the geosciences and technological progress (measured and determined by the intensity of the rainfall) was sufficient in itself to reduce the risks encountered by human populations (Becerra 2012). That said, since the 1990s, the need to consider the vulnerability of populations in risk-management analysis has been widely recognised. Turner et al. (2003), and later Birkmann and Wisner (2006), have provided a comprehensive conceptual framework that integrates the multidimensional nature of vulnerability at different scales and in different contexts.

In cities, physical factors related to exposure are decisive with respect to the forms and modes of urban planning: ground coverage, density of the built environment, state of saturation of the ground depending on its topographical position (lower, intermediate or upper part of the catchment basin) or the piezometric level, etc. Urban populations and the built environment are recognised as hotspots with regard to risk of flooding, presenting greater 'probabilities of damage' (Douglas and Wildavsky 1982) related to climate change (McCarthy, Best and Betts 2010; Wilby 2007). In sub-Saharan towns, the unprecedented urban growth observed – most of the times managed by inadequate or unsuitable policies – meets with an increase in risks related to meteorological extremes. These events can have disastrous consequences for most of the population living in risk areas (Kabisch et al. 2015; Rufat et al. 2015), thus exacerbating already existing socioeconomic inequalities (Reckien et al. 2017).

In this respect, there is an abundant literature providing evidence that the factors contributing to vulnerability must also be explored in terms of socio-demographic and economic conditions (Bigi et al. 2021). The articles by Blaikie and colleagues (2004) and Cutter and colleagues (2003) were outstanding in this regard: they found that rainfall, fluvial or coastal flooding in towns intersects with informal settlements, urban poverty, marginalisation and population density in areas exposed to these hazards (Dodman 2019; Douglas et al. 2008; Magadza 2000). Kit et al. (2011) confirmed that slums in Hyderabad, India, are often located in areas of rainwater accumulation. Ajibade and McBean's (2014) work in slum communities in Lagos, Nigeria, also highlighted how aspects such as limited access to housing or weak land rights push populations to settle on land potentially at greater risk of flooding. Generally, research has shown that extreme rainfall events affect the lower-income classes more, as is the case in New Delhi, India (Reckien, Wildenberg and Bachhofer 2013).

Accordingly, studies have assessed flood risk by looking at: 1) physical vulnerability and likelihood of damage, 2) the vulnerability of structures and goods or 3) the risk to death of the populations. The hypothesis is generally that social vulnerability is homogeneous for any population studied (Koks et al. 2015), often populations with low socioeconomic status. An important contribution is the article by Koks and colleagues (2015), which examines flood risk in Rotterdam, Netherlands, since their analysis combines hazard, exposure and social vulnerability at the household level. However, although this article is an important contribution, the variables of social vulnerability that are taken into account are relatively limited. In addition, this study adopts an approach based on the creation of an index of social vulnerability, mainly developed in research on flood risk (Cutter et al. 2013). Yet, although it presents methodological advantages, notably in view of the parsimony of statistical models, using an index based on grouping together a set of variables cannot pinpoint what specific factors related to social vulnerability are actually at stake.

Finally, the study area is one last methodological issue in the literature. In interdisciplinary projects (social sciences and the earth sciences), the study area is often defined by the hazard risk alone (Léone and Vinet 2006). The result is a descriptive analysis of the risk factors in the areas affected by the hazard. However, any risk-mitigation policy should be based on the differentials of risk,

that is, by comparing the groups of affected households with those that have not experienced the phenomenon. Otherwise, it is impossible to identify the relevant factors.

In the present article, we aim to fill these gaps and highlight the differentials of risk in these disasters, combining physical and environmental with socio-demographic factors in two contrasting neighbourhoods in Abidjan, the major city of Côte d'Ivoire. In the years to come, twenty-six per cent of the city's area might be exposed to flooding or is at risk from landslides due to heavy rain (OCHA 2014).

The research question is: what are the joint effects of the different dimensions of vulnerability to flooding, all things being equal, in a West African city? Combining earth and social sciences perspectives helps to better understand how to cope with different forms of vulnerability (Bohle 2007). We thus explore the combined impact of three dimensions of vulnerability operationalised by physical variables, environmental living conditions and socio-demographic variables, all at the household level. The period of analysis is 2009–2018. A four-stage logistic regression analysis enables us to observe the different dimensions of vulnerability in all their diversity.

Before presenting the analytical method used to identify the factors associated with flood-victim status, we will outline the study area of this research. We will then present some descriptive results, followed by the modelling results. Finally, the discussion will focus on the factors that seem most convincing in explaining physical and social vulnerability to flooding.

## Study Area

This study was carried out as part of the project EVIDENCE (Évènements *Pluvieux Extrêmes, Vulnérabilités et Risques Environnementaux: Inondation et Contamination des Eaux*),[5] which is an interdisciplinary project (demography, geography, hydrology and physics) that seeks in particular to analyse the multiple vulnerabilities related to extreme hydro-climatic events in the district of Abidjan, the economic capital of Côte d'Ivoire.

5 More information on the project can be found here: http://www.evidence-ci.org/.

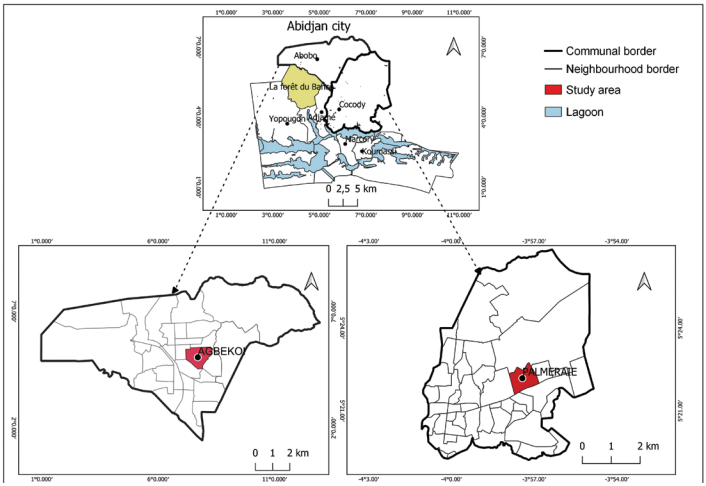
Côte d'Ivoire is a country in West Africa with a Human Development Index (HDI) of 0.538, ranked 162nd out of 189 countries. Its HDI value is higher than the mean within the group of countries with low human development (determined as 0.513) but lower than the mean of the countries of sub-Saharan Africa (which is 0.547). Furthermore, significant socioeconomic inequalities may be observed: the HDI value of Côte d'Ivoire plunges to 0.346 if these inequalities are taken into account. These inequalities are greater than in the rest of sub-Saharan Africa: the coefficient of human inequality is 35.3 per cent for Côte d'Ivoire and 30.5 per cent for the whole of Sub-Saharan Africa (PNUD 2021).

The district of Abidjan is characterised by significant urban growth. Within sixty years, the population of Abidjan multiplied by 27 and thus increased from 192,000 in 1960 to 5.2 million inhabitants in 2020, a result of both natural growth and migration, mainly from the interior of the country. According to the median demographic projections of growth, the city will have reached almost eight million inhabitants by 2035 (UNDESA 2018).

In this context, two neighbourhoods have been selected as they meet the requirements of the interdisciplinary team of the EVIDENCE project, namely being situated in a different catchment area and presenting contrasting topographical and socioeconomic features. The selected neighbourhoods (Figure 1) are Agbekoi, situated in the municipality of Abobo, and Palmeraie, in the municipality of Cocody. These two municipalities were the most heavily impacted by past flooding events, according to a report by the United Nations Office for the Coordination of Humanitarian Affairs, with 12,500 people permanently exposed in Abobo and 40,000 in Cocody (OCHA 2014). Furthermore, the socioeconomic conditions of the inhabitants of these two municipalities are extremely different. A 2013 UNDP survey estimated that 80% of the population of Abobo lives in slums that were upgraded and 16% in informal settlements, where socioeconomic and housing conditions are below-average by the standards of the municipality. No residential housing was recorded. In contrast, in Cocody, 21% of the households lives in a residential area, and 42% in economic housing,[6] the remainder living in slums, if upgraded or not. With regard to the environmental living conditions, only 4% of the households in the municipality of Abobo are connected to the water-supply network, compared to 18% in Cocody (PNUD 2013).

6 Economic housing is social, collective and affordable housing generally managed by state or semi-state companies.

**Figure 1. Localisation of Agbekoi (bottom left) and Palmeraie (bottom right) neighbourhoods in the city of Abidjan (top)**

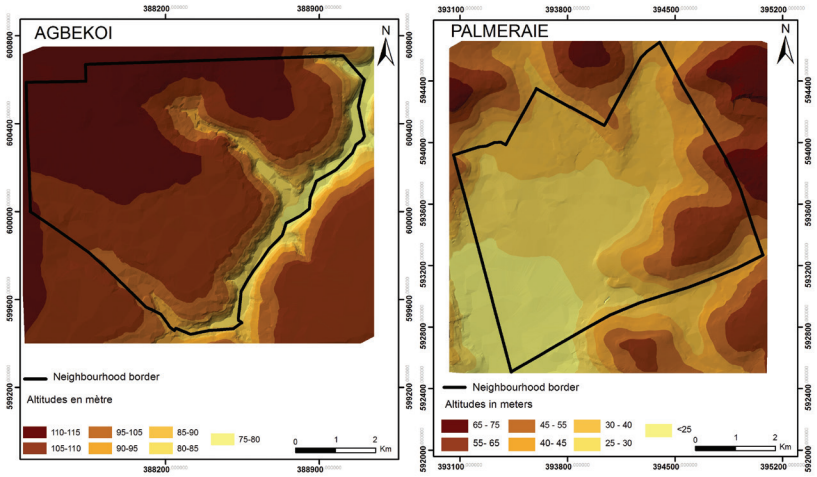



SOURCE: FIGURE BY THE AUTHORS. DATA FROM INS.

Figure 1a shows the location of the neighbourhood of Agbekoi in the centre-east of the municipality of Abobo. The relief of Agbekoi is dominated, from the northwest towards the northeast, by a plateau (Figure 2a). From the northeast southwards, there is a dried-up ravine with one branch. This natural depression of the land's surface divides the neighbourhood into two areas. The topographical profile of Agbekoi slopes progressively from the northwest (where the highest point is close to 110 metres above sea level) towards the southeast (where the altitude is less than 80 metres). The neighbourhood extends over 135 hectares, with a high population density estimated at 600 inhabitants per hectare (INS 2022).

Palmeraie is situated in the centre-east of the municipality of Cocody (Figure 1.b), in the catchment basin of Bonoumin-Palmeraie (Figure 2b). The relief of Palmeraie is marked by a valley, which extends over a width of 1,200 metres and a length of 2,000 metres. In this valley, the altitude ranges from 25 metres to 45 metres. The eastern part of this neighbourhood is the highest area, with an altitude of more than 65 metres. From east to southwest, the topographical profile of Palmeraie is a gradual slope. The population density is much lower than at Agbekoi, estimated at 170 habitants per hectare, over an area of 236 hectares (INS 2022).

**Figure 2. Relief of Agbekoi (left) and Palmeraie (right)**

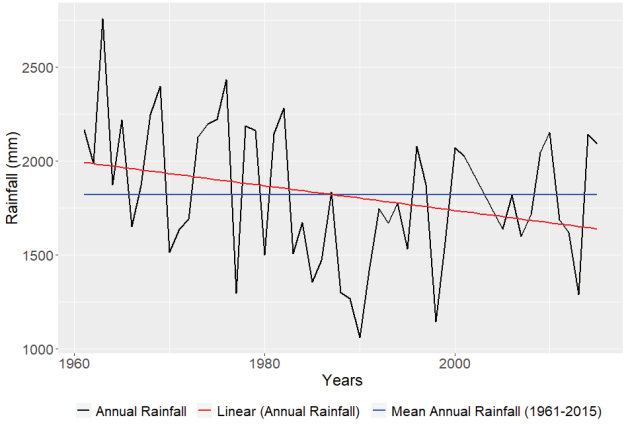



SOURCE: FIGURE BY THE AUTHORS. DATA FROM CCT/BNETD

Finally, regarding climatic and in particular pluviometry, the district of Abidjan has a sub-equatorial climate, with two rainy seasons and two dry seasons. During the long rainy season, from March to July, the rains account for two-thirds of the annual rainfall (1,922 millimetres). This rainy season is followed by the short dry season, lasting from August to September. A second peak in the rainfall is the short rainy season, from October to November, followed by the long dry season from December to March. The mean monthly temperatures range from 24.2 degrees Celsius in August, the coldest month, to 27.4 degrees Celsius in March, the hottest month (Kouassi et al. 2018).

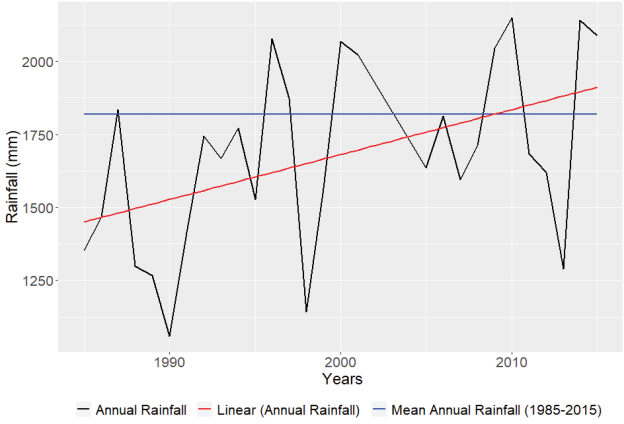
Figure 3 shows the historical data from 1961 to 2014 (Sodexam 2016). The mean annual rainfall was 1819 millimetres over this period. Based on the Mann-Kendal test, determination of the mean trend shows a mean drop in the rainfall over this period of almost 70 years, which corresponds with a declining trend observed in the subregion (Lebel et al. 2000). Nevertheless, looking at a more recent period, from 1985 to 2015, an increase in the mean trend of rainfall (Figure 4) can be observed, which reflects an increase in the occurrence of extreme events (Zahiri et al. 2016; Attoumane et al. 2022) causing recurrent flooding (Kouamé et al. 2022).

## Figure 3. Annual rainfall in Abidjan (1961–2015)




SOURCE: FIGURE BY THE AUTHORS. DATA FROM SODEXAM

## Figure 4. Annual rainfall in Abidjan (1985–2015)




SOURCE: FIGURE BY THE AUTHORS. DATA FROM SODEXAM.

## Methods

*Data Collection*

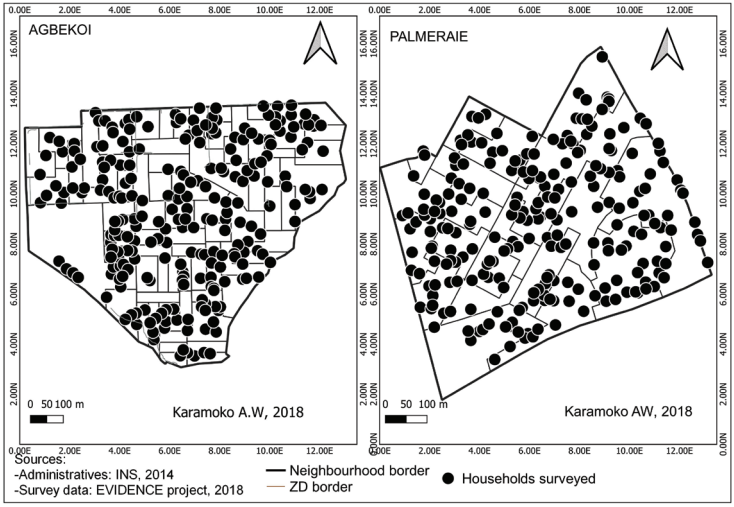
The data used was collected through a household survey as part of the EVIDENCE project. A sample of 503 households (Figure 5) was randomly selected based on two geographical criteria, in the absence of a survey database available in 2018. In the first stage, a preliminary field-sampling study provided the basis for identifying the census district (CD) that is or is not exposed to flood risk in the two neighbourhoods. In a second step, the number of households to survey was calculated in proportion to the surface area of the level of risk in both neighbourhoods. In Agbekoi (Figure 5.a), 58% of the surface area is exposed to flood risk; 146 households were randomly selected in the CD exposed to flood risk and 116 households in the CD not exposed (42% of the surface area of Agbekoi). In Palmeraie (Figure 5b), 136 households were randomly selected in the CD exposed to flood risk (covering 54% of its surface area) and 115 households in the CD not exposed (46% of the surface area). In the absence of an exhaustive, up-to-date list of households in the two neighbourhoods, a random selection was made using the software QGIS. In order to localise the buildings or residential courtyards of the inhabitants, random spatial data were projected onto an image from the satellite Quickbird from 2015. A relocalisation of the spatial data was performed if they were localised in uninhabited areas (empty plot, garden, business building, etc.).

Once a house was localised, one household on the ground floor was surveyed per localisation through an interview with the head of the household. This survey was carried out from December 2018 to January 2019.

*Data Analysis*

The aim was to estimate the net effect, all other factors being equal, of different independent variables related to the physical characteristics, the domestic environment and the socio-demographic characteristics of the household, on the status of flood victim. The status of flood victim was conceptualised by a composite dependent variable created on the basis of variables identifying material damage (fallen walls, split walls, damage to the roof, loss of consumer goods or vehicles), or corporal damage caused by flooding of the surveyed household over the ten years before the survey, from 2009 to 2018. The dependent variable is binary: the household has been affected by flooding at least once during this period, or the household has not suffered any material or corporal damage, and is, therefore, non-flood impacted.

**Figure 5. Spatial distribution of households surveyed in Agbekoi (left) and Palmeraie (right)**




SOURCE: FIGURE BY THE AUTHORS. DATA FROM INS AND EVIDENCE.

We have used the following logistical regression:

$$ln(q_i/1\text{-}q_i)=\beta_0 + \beta_i x_i$$

Here, q is the probability of being declared impacted for the $i^{th}$ household, β0 is the base constant, βi is a series of unknown coefficients and xi is a set of independent variables. The coefficients estimated (βi), once made exponential, are interpreted as the chances of being an impacted household (qi/1-qi), with certain characteristics relative to the chances of being impacted in a reference group of households: that is what is known as the relative chances or odds ratios (OR).

In order to characterise the factors of physical vulnerability, three variables were chosen: (1) the presence of a gutter right in front of the house to evacuate rainwater; (2) the distance between the household and the nearest drainage system (large or small pipes, ravines and streams; continuous variable); (3) the

slope[7] calculated on the basis of a 12 metres ALOS PALSAR[8] digital model. The literature has identified these variables as factors of vulnerability to flooding (Ashraf 2012; Bigi et al. 2021).

We then hypothesised that two types of household characteristics determine the socio-environmental vulnerability. Firstly, the variables relate to the environmental dimension of the living conditions, that is, those related to the domestic environment, to the habitat and the management of the salubriousness of the living environment: the type of roofing, ground and walls as well as the management of sewage and solid waste. Next, we investigated the socio-demographic characteristics of each head of household (sex, age, level of education, place of birth, length of residence in the neighbourhood, residential status), the number of people living in the household and the standard of living[9]. These variables are related to different dimensions of the socio-environmental vulnerability of households (Dos Santos, Peumi and Soura 2019; de Sherbinin and Bardy 2015; Bigi et al. 2021).

To better understand the net effects of the factors related, on the one hand, to the physical characteristics and, on the other, to the household, the variables were introduced separately in the models, block by block, which enabled us to compare the coefficients between the different equations. The status of flood victim was thus modelled step by step. Model 1 tests the variables potentially related to physical vulnerability. Model 2 integrates the variables that operationalised the socio-environmental vulnerability. Model 3 tests the variables dealing with the socio-demographic vulnerability of the household. Finally, Model 4 tests all the above-mentioned variables, integrating the variable 'neighbourhood' to capture any unobserved contextual effects, as we have no such variables in our database. This allowed measuring the specific effect of each independent variable, all other things being equal, including the non-observed heterogeneity on the neighbourhood level.

7 The continuous variable 'slope' was then classified into three modes by the quantile method to obtain three levels of slope: low, medium and high.

8 University of Alaska Fairbanks, Alaska Satellite Facility, https://asf.alaska.edu/ (accessed 22 Jun. 2023).

9 The standard of living index was calculated based on consumer goods (television, radio, car, kitchen equipment, etc.) owned by the household. This index was then classified into three modes by the quantile method to obtain three standards of living: low, medium and high.

The option 'cluster' available in the Stata software was applied on the variable identifying each CD (n=85) to take into account the resemblance and thus control for the non-independence of the households in the same CD. In this way, the standard errors presented are adjusted and are thus more robust in the four successive types of models.

## Results

### *Descriptive Results*

The descriptive results show that with reference to the period from 2009 to 2018, the households surveyed in Agbekoi less often state that they have been flood victims in their homes than the households in Palmeraie, with a proportion of flood victims of 13.5 per cent and 39.4 per cent, respectively (Table 1).

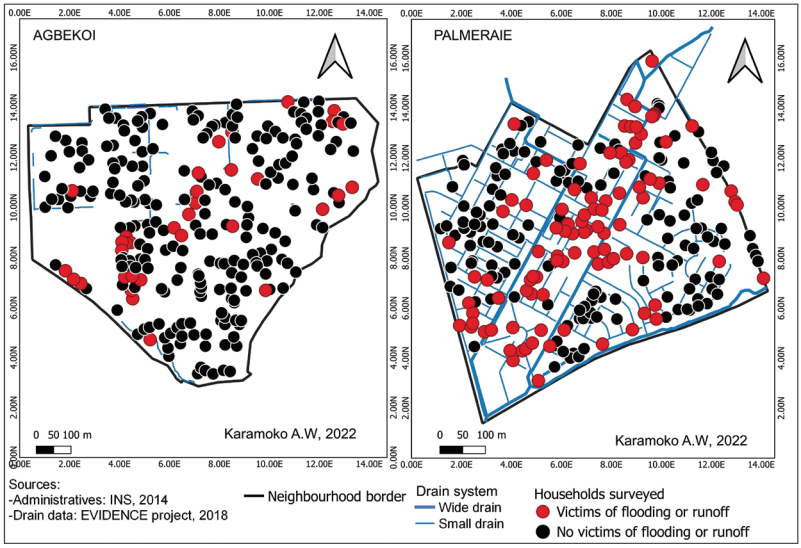
**Table 1. Distribution and frequencies of households by flooding victim status – Abidjan, Côte d'Ivoire**

| Flooding victim | Agbekoi | | Palmeraie | | TOTAL | |
|---|---|---|---|---|---|---|
| | nb | % | nb | % | nb | % |
| Yes | 34 | 13.5 | 99 | 39.4 | 133 | 26.4 |
| No | 218 | 86.5 | 152 | 60.6 | 370 | 73.6 |
| TOTAL | 252 | 100.0 | 251 | 100.0 | 503 | 100.0 |

SOURCE: FIGURE BY THE AUTHORS. DATA FROM EVIDENCE

In Agbekoi, the households affected by flooding during the period from 2009 to 2018 are mainly located along the axis running from the northwest to the centre and the southwest of the neighbourhood. They are located far away from any kind of drainage pipes, which are mainly situated in the northwest and represent the only infrastructure for the whole neighbourhood (only 3.4 kilometres of pipes; Figure 6.a). In Palmeraie, most of the households affected by flooding are located in the centre of the neighbourhood, from the northwest to the southeast, not far from the main rainwater drainage system (Figure 6.b). This neighbourhood has a network of main drainage pipes extending over about 6.4 kilometres and a network of secondary pipes of less than 35.6 kilometres.

**Figure 6. Spatial distribution of households surveyed in Agbekoi (left) and Palmeraie (right) and drainage pipes**




SOURCE: FIGURE BY THE AUTHORS. DATA FROM INS AND EVIDENCE

The descriptive analysis of some social characteristics of the surveyed households also shows stark contrasts between Agbekoi and Palmeraie. For example, the analysis of the standard of living index, measured based on the consumer goods owned by the household, shows that more than half (52.8%) of those surveyed in Agbekoi have a low standard of living, whereas more than half (58.6%) of surveyed households in Palmeraie have a high standard of living. Similarly, regarding the level of education of the head of the household, it is mainly the higher level that is observed in Palmeraie (61.8%), whereas in Agbekoi, 28.2% of households represent this level of education.

*Multivariate Results*

Table 2 shows the results of the multivariate analysis, including the four stages described in the progressive inclusion of the sets of variables, representing the different dimensions of vulnerability in our analytical framework.

**Table 2. Frequencies and multivariate models with estimated net effects [odds ratios and adjusted significance levels] on the status 'affected by flood', taking into account physical, environmental/housing, socioeconomic and neighbourhood variables – Abidjan, Côte d'Ivoire**

| *Independent Variables* | *Frequencies* | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|---|
| ***Outdoor gutter (yes)*** | *(28.8)* | | | | |
| No | *71.2* | 0.58** | | | 0.80 |
| ***Distance to the rainwater pipe (continuous var.)*** | | 0.99*** | | | 0.99 |
| ***Slope (small)*** | *(34.4)* | | | | |
| Medium | 32.4 | 0.70 | | | 0.64* |
| High | 33.2 | 1.22 | | | 0.95 |
| ***Roof (metal or tile)*** | *(72.2)* | | | | |
| Concrete slab | *25.6* | | 1.56 | | 0.71 |
| Plastic sheet | *2.2* | | 1.22 | | 1.62 |
| ***Wall (cement or brick)*** | *(91.2)* | | | | |
| Wood | *8.8* | | 1.21 | | 0.10*** |
| ***Ground (tiles)*** | *(45.3)* | | | | |
| Cement | *45.5* | | 0.98 | | 2.12** |
| Other (sand, etc.) | *9.2* | | 3.07** | | 6.84*** |
| ***Wastewater management (sewer)*** | *(44.1)* | | | | |
| Septic tank | *36.4* | | 0.84 | | 2.68** |
| Other (thrown outside, street, etc.) | *19.5* | | 0.96 | | 3.38** |
| ***Solid waste disposal (public sector collection system)*** | *(25.9)* | | | | |
| Private sector collection system | *42.7* | | 1.89** | | 1.62* |
| Other (thrown outside, street, etc.) | *32.4* | | 0.60 | | 1.10 |
| ***Sex of the household head – HH (male)*** | *(80.1)* | | | | |
| Female | *19.9* | | | 1.61* | 2.27*** |
| ***HH's age (less than 45 years)*** | *(40.2)* | | | | |
| 45-59 years | *35.0* | | | 1.29 | 1.32 |
| 60 years and over | *24.8* | | | 1.17 | 1.33 |
| ***HH's education (none)*** | *(24.8)* | | | | |
| Primary | *15.9* | | | 1.41 | 1.39 |
| Secondary | *22.5* | | | 1.87* | 1.68 |
| Higher | *36.8* | | | 1.66 | 0.83 |

| | | | |
|---|---|---|---|
| ***HH's place of birth (Abidjan)*** | *(34.6)* | | |
| Other towns | *38.2* | 1.12 | 0.89 |
| Rural area | *17.7* | 0.95 | 0.95 |
| Abroad | *9.5* | 2.11* | 1.30 |
| ***HH's duration of residence in the neighborhood (< 10 years)*** | *(30.0)* | | |
| 10-19 years | *31.6* | 1.02 | 1.27 |
| 20 years and over | *38.4* | 0.53+ | 1.04 |
| ***HH's residential status (owner)*** | *(46.1)* | | |
| Tenant | *40.6* | 0.65 | 0.93 |
| Hosted | *13.3* | 1.25 | 1.58 |
| ***Number of usual members in the household (1-4)*** | *(24.4)* | | |
| 5-9 | *53.3* | 1.47+ | 2.03** |
| 10 and over | *22.3* | 1.03 | 1.60+ |
| ***Life level index (low)*** | *(39.2)* | | |
| Medium | *28.6* | 1.28 | 1.60 |
| High | *32.2* | 1.18 | 0.69 |
| ***Neighbourhood (Agbekoi)*** | *(50.1)* | | |
| Palmeraie | *49.9* | | 40.0*** |

Reference category in parenthesis. Significant levels : *** p<1% ; ** p<5% ; * p<10% ; + p<15%

SOURCE: FIGURE BY THE AUTHOR. DATA FROM EVIDENCE

In Model 1, some variables related to the physical vulnerability are linked to the flood-victim status during the period from 2009 to 2018. These variables represent the presence of a gutter in front of the household's dwelling and the distance from drainage pipes. Therefore, households that do not have a gutter to evacuate rainwater in front of their dwelling are less at risk of having experienced damage than households that have a gutter in front of their dwelling (OR=0.58; p<5%). The same applies to the distance between dwelling and the next drainage pipe: the farther the household is from the pipe, the lower the risk of having experienced damage. We also found that the slope of the ground on which the dwelling is built does not seem to be statistically related to flood-victim status.

The variables dealing with the environmental vulnerability were introduced in one block in Model 2. The results show that two variables in this group are linked to flood-victim status. Households where the floor is not made of solid material (sand, earth, etc.), are three times more likely to have experienced damage than households living

in a dwelling where the ground is covered with paving. Furthermore, households that use a private waste-collection service are twice as likely to have been flooded than those that use a public sector waste-collection service.

Regarding the personal characteristics of the head of household, reflecting social vulnerability, the statistically significant odds ratios obtained in Model 3 are those of sex, level of education, place of birth, duration of residence in the neighbourhood and a variable representing the composition of the household, i.e., the size of the household. For example, households where the head is a woman are more at risk of flooding than households where the head is a man (OR=1.61; $p<10\%$). Similarly, the level of instruction variable is statistically significant: the general gradient can be interpreted as if the households where the head did not go to school are less at risk of becoming a flood victim than other households. This especially applies to households where the head continued up to high-school level: these are twice as much at risk of being affected by flooding than households where the head did not go to school ($p<10\%$). In addition, households where the head has lived in the neighbourhood for more than twenty years are half as much at risk of flooding than households where the head has lived in the neighbourhood for less than five years. In contrast, households where the head was born outside Côte d'Ivoire are twice as much at risk of being a flood victim than households where the head was born in Abidjan. Finally, households of medium size (composed of nine people) were one and a half times more likely to have been affected by flood than those of small size (composed of less than five people).

These results should nonetheless be qualified by introducing the variable 'neighbourhood' since, as we have seen, these two neighbourhoods present different characteristics that must be taken into account, other things being equal. Model 4 shows the odds ratios after introducing the neighbourhood variable, which itself has a significant effect on a certain number of variables and confirms the very high-risk differential between these two neighbourhoods. During the period from 2009 to 2018, a household resident in Palmeraie had a 40 times greater risk of being impacted by flooding than a household living in Agbekoi, all other physical and socio-environmental characteristics being equal.

The variables concerning physical vulnerability are thus affected by the variable 'neighbourhood' in the complete model. In particular, the variables relating to

the infrastructure of the neighbourhood (gutters and drainage pipes) are no longer statistically associated with the likelihood of being flooded. On the other hand, all else being equal, whichever neighbourhood, the effect of the slope of the ground where the dwelling is located is statistically significant: households situated on slopes ranging from 1.7 to 3.4 degrees are less at risk of flooding than households situated on a slope of less than 1.7 degrees (OR=0.64; $p<10\%$). Analyses of the individual neighbourhoods (not shown) highlight that the slope has the greater effect in Agbekoi.

The introduction of this neighbourhood variable also has an important effect on the variables related to the vulnerability associated with the environmental dimension of the living conditions. This is particularly apparent with the variables of the type of wall, the type of floor and the sewage management, whose effects now become highly significant. Thus, households that do not have a paved floor and those that do not have a sewer for the removal of wastewater are at greater risk of flooding, to a highly significant degree, compared to the reference modes, whatever the neighbourhood. In contrast, households that have wooden walls are much less likely to have been impacted by flooding than those with walls of cement or brick (OR=0.1; $p<1\%$). It should be noted that almost all of the households whose dwellings have wooden walls are located in the better-off neighbourhood of Palmeraie (91%) and are among the poorest in this neighbourhood (91% have a low standard of living index).

Finally, the introduction of the neighbourhood variable has a significant impact on the effect of variables related to social vulnerability and, in particular, the variable sex of the head of the household. The effect of this variable is enhanced both in the odds ratio and in the degree of confidence we can have in its interpretation: between Model 3 and Model 4, the differential between the fact of being a male or a female head of household is increased (OR = 2.27; $p<1\%$), to the detriment of households headed by women. Moreover, stratified analysis by neighbourhood (results not shown) confirms this effect of the sex of the head of household in the two neighbourhoods studied.

This confirmation of the differentials is also observed for the variable that operationalises the family structure: comparing Model 3 and 4, we confirm that large families had a greater risk of becoming flood victims during the period from

2009 to 2018 than households with less than five people.[10] Thus, the introduction of the neighbourhood variable no longer offers a basis for confidently interpreting the effects of the other variables related to social vulnerability, proving the importance of the contextual effect, in this case the type of neighbourhood, in the interpretation of vulnerability to flooding.

## Discussion

Based on econometric models (logistic regressions), our results highlight two major contributions. The first one is that there are several dimensions combined of flooding vulnerability. Using a multi-criteria approach, we have shown how vulnerability is a process that should be analysed at different spatial scales and in relation to the various aspects of sustainable development (social, economic and environmental). This concept should take into account the probability of undergoing a shock, either physically or materially, by the deterioration or loss of the means of subsistence (Blaikie et al. 2014).

The second one is the important contextual effect of differentials on the vulnerability to flooding. First of all, about the latter point, the results relate to human-security framing (O'Brien et al. 2007) having conceptualised the necessity of having an analysis that can detect the discriminating contextual effect of the neighbourhood and, in doing so, reduce the non-observed heterogeneity of this type of analysis. Thus, our results show it is essential to perform a disaggregation of the levels of analyses at a fine scale, neighbourhoods of towns but also at the household scale (Koks et al. 2015): (1) the effect of neighbourhood *per se* is dominant in our results, each neighbourhood representing a very different level of risk; (2) the introduction of the neighbourhood variable alters the effect of certain variables of vulnerability measured at household scale; (3) the effects of different dimensions of vulnerability are happening simultaneously.

Concerning the variables related to physical vulnerability, the results show that, regardless of the neighbourhood, a household living on a slope that is neither too steep nor too flat benefits from a protective effect on the risk of suffering flood damage. In fact, the slope has an important physical effect, notably about the rate of runoff of rainwater, and is highly sensitive to rainfall events of different

10 This effect of the household's family structure seems to be stronger in the Palmeraie district (results not shown).

duration and frequency (Ashraf 2012). Nevertheless, the phenomena observed are divergent: steep slopes generally tend to induce runoff, whereas flatter slopes may be associated with water stagnation in the case of a drainage system failure.

In this respect, the effect of the distance from drainage pipes is worth discussing, even though it is not statistically significant upon introducing the neighbourhood variable. With regard to this aspect of the physical vulnerability, the two neighbourhoods present major differences, as we have seen in the 'Descriptive Results' section: the neighbourhood of Palmeraie is equipped with drainage pipes (Figure 6b). It is as if the neighbourhood variable captured the effect of the drainage pipes and gutters in front of the dwelling to evacuate rainwater. Thus, in this neighbourhood, a completely counterintuitive phenomenon is at play: the farther the households are from the drainage pipes (or if they do not have a gutter in front of the dwelling), the less likely to be a flood victim, whereas in theory, the presence of infrastructure should lead to the opposite effect. It might result from under-dimensioning the drainage network for rainwater being exacerbated during extreme rainfall (Alla Della 2013). In this neighbourhood, where the correlation between the slope and flood risk is negative, the households situated on ground with little slope are more affected by the rainwater stagnation, which cannot be drained off by the saturated drainage pipes.

With regard to the variables related to environmental living conditions, we see the positive effect of a certain type of environmental quality of the dwelling (except for the quality of the walls). Having a dwelling with paved floors, using a public sector waste-collection service or having access to a sewer for disposing wastewater is generally linked to a lower likelihood of becoming a flood victim during extreme rainfall events. Intuitively, we would be tempted to relate this kind of dwelling to the socio-demographic status of the household and thus to see the effect of these environmental conditions neutralised with the introduction of socioeconomic variables. However, by using the type of models we have constructed, which allow the isolation of the specific effect of one variable, all other independent variables being equal, we see the net effect of variables concerning vulnerability linked to the environmental dimension of the living conditions. Thus, the results obtained to take account of the socioeconomic dimension of vulnerability seem counterintuitive, with no effect. This applies to the standard of living index or the level of education of the head of household. There is, nevertheless, an abundance

of studies showing that the poorest people are generally at greater risk of suffering flood damage (Rentschler, Salhab and Jafino 2022; de Sherbinin and Bardy 2015). However, these analyses are often carried out using an index of poverty, which makes it impossible to demonstrate the differentiated effect of the variables of the households' immediate environment. However, our results show that it is not so much the economic dimension of vulnerability, measured exclusively based on the possession of material goods for example, that is particularly linked to the climate risk but the environmental dimension of the households' living conditions. The economic, or socioeconomic, status of a household does not allow any assumptions about the environmental living conditions, as has been shown in other contexts with regard to other types of risk (Dos Santos, Peumi and Soura 2019). This is an important result to take into account in adapting responses to future climate risks, notably with regard to the sustainable development of towns in Africa, prioritising the environmental dimension of the living conditions.

Some explanation is required regarding the highly counterintuitive effect concerning wooden walls. As stated above, 91 per cent of these households live in the wealthiest neighbourhood of Cocody. We hypothesise, on the basis of our field investigations, that part of the explanation for this result simply is a sampling artefact: the survey was carried out a few months after a very extreme event (on 18 and 19 June 2018) when a certain number of very poor inhabitants were expelled from the zones at risk. The dwellings with wooden walls at the time of the survey and still resident in this neighbourhood were located in areas that are far away from the centre, which lies alongside the main rainwater-drainage system (results not shown).

Our results show, nevertheless, that it would appear that the marginal social groups are less vulnerable: living in environmental conditions that are very precarious or, on the contrary, very sustainable, would offer protection against the risk of being affected by flooding. More in-depth investigations would be required for a better understanding of this finding.

Finally, in the results presented, we observe that the effects of some socio-demographic variables measured at the scale of the household are fairly consistent with the scientific literature on social vulnerability to extreme climatic events. These variables generally concern certain forms of social inequality (Campion and

Venzke 2013; Cannon 2010; Cutter, Boruff and Shirley 2003). Notably, a literature review highlights how a set of socio-demographic variables, in particular gender inequalities, are critical factors of social vulnerability to flooding (Rufat et al. 2015). Thus, our results regarding gender are consistent with the literature in general that has shown how the gender variable is an important factor of social vulnerability to flooding. Households headed by a woman may have less resources and less independence, and are thus less able to adopt measures of prevention and/or adaptation (Mukuna 2015; Morrow 1999; de Sherbinin and Bardy 2015). Soares and colleagues (2012) even interpret gender as one of the key factors of social vulnerability. Our results, nevertheless, contrast with other results obtained in a case study of the capital of Burkina Faso, where the authors were unable to explain why women seemed to be less vulnerable to the risk of losing their dwelling in an informal neighbourhood of the town after an extreme rainfall event (Dos Santos, Peumi and Soura 2019). Indeed, the variable that requires explanation was not the same as in the present study (losing one's dwelling because it was completely destroyed by a single extreme rainfall event versus, in the present case, having suffered at least one damage following an extreme rainfall event over ten years). This shows the importance of how the concept of flood victim or sufferer from flood damage after an extreme climatic event is operationalised: the measurement of the phenomenon might have a significant incidence on the effect of the explanatory variables concerning vulnerability, included in the statistical model.

The composition of the household, measured by its size, is a second important social variable in our results. The largest families are more vulnerable of becoming a flood victim, which is consistent with similar studies about other geogrpahical contexts (Ajibade, McBean and Bezner-Kerr 2013). These authors have shown how, at Lagos in Nigeria, the sex of the head of household has a marked effect when in interaction with other social factors, such as the family structure.

The limitations of the present research are related, above all, to the sample size. The limited sample size did not enable us to go very far in seeking contextual effects, ruling out, for example, a proper multi-level analysis. The use of the cluster option, available with the Stata software, nevertheless enabled us to statistically compensate for this concern and provide a much more robust interpretation of the odds ratios. Similarly, the size of the sample in each neighbourhood made it

difficult to provide analyses by neighbourhood, which would have enabled us to obtain results specific to each neighbourhood. Nevertheless, the integration of the neighbourhood variable made it possible to consider the explained part of the phenomenon specific to each neighbourhood.

Despite these limitations, the results obtained are robust and contribute to the definition of the conceptual and analytical elements considered essential in theories for assessing vulnerability to climate change by analysis of the differentials. They also prove the richness of combining different approaches to understand the physical, environmental and social vulnerabilities, allowing the construction of a systemic and holistic analytical framework (Cutter, Boruff and Shirley 2003).

## Conclusion

In view of the climate forecasts and the slowness with which states are acting to tackle global warming, the extreme meteorological phenomena resulting from climate change are likely to amplify the multiple challenges facing African city dwellers (IPCC 2022), in particular the most vulnerable of them (Simon and Leck 2015). In this context, adaptation is undoubtedly the key to the resilience to climate change in the African towns of the present and the future. The implementation of policies for sustainable urban flood-risk management requires that public resources are dedicated to actions to protect the most vulnerable groups and the areas most exposed to these hazards. It is thus of primary importance to understand the social and environmental factors of vulnerability, considering the context and the scale of various independent variables (Turner et al. 2003). In this regard, the scholarly contribution of the present article is threefold. On the one hand, the empirical results show that the vulnerability of populations to the risk of extreme rainfall should be analysed both concerning the physical characteristics specific to the households – that is, their living conditions – and their environmental and socio-demographic dimensions. Our analysis reinforces the idea that the leading cause of disaster is not hazards. In sub-Saharan Africa, urban disasters triggered by climate extremes amplify urban inequalities, given the role played by variables related to socio-environmental vulnerability as determinant factors. The multidimensional nature of vulnerability at the household level must be a challenge to public authorities in post-disaster management.

On the other hand, the detailed analysis of the socio-environmental characteristics measured at a fine scale (household level) offers new methodological perspectives for assessing social vulnerability and calls for advocacy for more data at this scale.

Finally, these results reaffirm the necessity of adopting an interdisciplinary approach to understand better the complexity of the phenomenon of vulnerabilities to climate change and thus contribute more sustainably to the adaptation of African towns in the face of these hazards. This interdisciplinary approach must respect the rules of disciplinary cultures: choosing to survey households that are not affected by the phenomenon observed is a classic approach in population sciences, unlike earth sciences, which exclusively focus on the area affected by the hazard. However, the former allowed distinguishing differentials and thus understanding the characteristics of the populations most vulnerable to flooding.

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PEER-REVIEWED ARTICLE

# How Can Girls' Education and Family Planning Improve Community Resilience to Climate Change in the Sahel?

Paige Passano,[1] Min Ah Choi[2] and Matt Matusiewicz[3]

## Abstract

*Population growth and climate change are currently the two greatest threats to food security in the Sahel region of Africa. The population of the countries that make up the Sahel is projected to nearly double by 2050, from 506 million to 912 million. Paired with the expected rise in temperature and increased frequency of extreme climatic events, these numbers could quickly overwhelm relief efforts. Strengthening human capital and economic stability are critical to prevent catastrophic suffering. This article recommends two evidence-based approaches that expand women's autonomy and support their income-earning potential while building resilience to climate change. The first recommendation, would be greater investments in adolescent girls' education and autonomy, including efforts to delay marriage and childbearing. The second calls for an improvement in the availability and quality of reproductive health services, with a special focus on voluntary family planning. These interventions can increase incomes, reproductive autonomy and gender equity which build community resilience and adaptability to climate change.*

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Keywords: population, climate change, resilience, adaptation, family planning, girls' education.

## Introduction

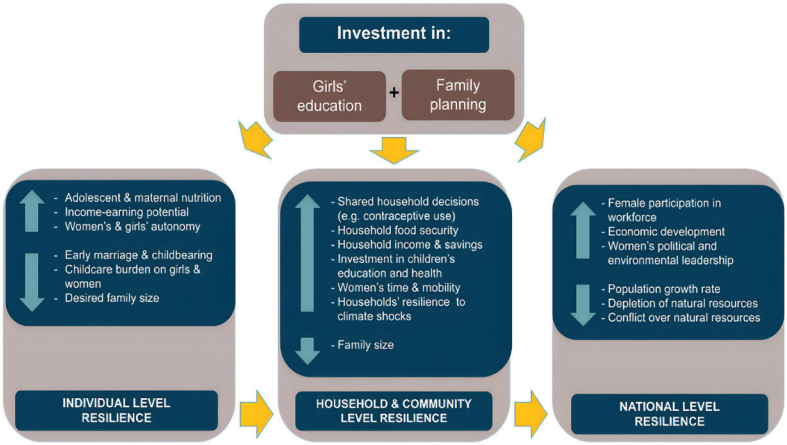
Human presence and consumption patterns have driven global warming and environmental degradation, with the richest tenth of the world's population contributing 52 per cent of cumulative emissions from 1990 to 2015. During that same time period, the poorest half of the global population was responsible for only seven per cent of emissions (Kartha et al., 2020). In higher income countries the primary driver of environmental damage is excess consumption, rather than population growth (O'Neill et al., 2018; Samways, 2022). At the UN Conference of Parties (COP) 27 in 2022, experts reiterated the urgency to reduce global emissions by 43 per cent by 2030 and for rich countries to assume greater responsibility for the climate-related damage that poor countries have had to shoulder to date (UN Convention on Climate Change, 2022).

Populations in ecologically fragile regions like the Sahel bear the worst consequences of climate change. Their vulnerability to direct environmental threats like drought and flooding are exacerbated by two silent demographic phenomena: population growth and a young age structure (Guengant and Lahmani, 2012). Contributing factors are: high desired family size, low contraceptive use, limited reproductive autonomy among women and child marriage (Leahy et al, 2007). Large families are an established norm. However, for impoverished families whose livelihoods are under threat, providing children with adequate nutrition, education and healthcare is becoming a major challenge. Women's participation in society is restrained by gender norms and by a heavy burden of childcare and domestic labour (Coole, 2018; Gribble and Bremner, 2012). At the national level, governments struggle to provide education and jobs to youth, maintain national security, protect natural resources and help their citizens adapt to climate change (Leahy et al., 2007).

Girls' education and voluntary family planning are two solutions that contribute to women's autonomy, smaller families and enhanced climate resilience (Figure 1) (Vollset et al., 2020; Dodson et al., 2020; OASIS, 2021). Despite their relevance, these solutions continue to be viewed as unrelated to core climate objectives and are rarely included in climate strategies (Vollset et al., 2020; Canning and Schultz,

2012; Götmark and Andersson, 2020; Phillips et al., 2012). Many policymakers view the shift in social norms from a larger to a smaller desired family size as a spontaneous occurrence that accompanies economic prosperity, rather than a process supported by strategic policy decisions that also protect individual rights and choices (Coole, 2018).

**Figure 1. The combined power of girls' education and family planning for population resilience. Adapted from Muttarak and Lutz 2014**




The economic benefits of a demographic dividend[4] are significant and can last a decade or more. In parts of Asia, North Africa and Latin America, demographic dividends increased Gross Domestic Product (GDP) per capita by 50 per cent to 100 per cent, reducing poverty, improving the quality of life and strengthening resilience and adaptive capacity (Lutz and Muttarak, 2017; Bongaarts and Hodgson, 2022). African leaders have embraced the idea of a demographic dividend but many have sidestepped the fertility aspect, ignoring the fact that declines in both mortality and fertility are necessary catalysts (Cleland, 2017).

4 A demographic dividend is accelerated economic growth that can result from a shift in a country's age structure whereby the proportion of workers exceeds that of dependents (Population Reference Bureau. 2012. Attaining the Demographic Dividend. https://www.prb.org/resources/fact-sheet-attaining-the-demographic-dividend/).

Expanding access to girls' education is a less controversial goal. It has been embraced by most African leaders for the powerful co-benefits it brings to communities and nations by increasing women's wages, employment options and other economic opportunities (Sterling, Winthrop and Kwauk, 2016). Investing in girls' education benefits the whole household, since women reinvest an average of 90 per cent of their income into their families, compared to the 30–40 per cent of income typically re-invested by men (International Finance Corporation, 2013). However, insufficient funding and competing priorities have limited necessary investments in girls' education.

Scholars increasingly view population dynamics as a variable in climate change adaptation and mitigation. Some highlight the linkages between reproductive rights and environmental sustainability beyond the direct impact of contraceptive use on fertility (Delacroix, 2022). Others also see population decline as critical to achieving a decent quality of living within ecosystem limits. Still others focus on the need for radical global economic changes to achieve socio-economic and environmental justice (Brand-Correa et al., 2022; O'Neill et al., 2012; Samways, 2022; O'Neill et al., 2018).

This article examines the triple threat of rising temperatures, population growth and malnutrition on the well-being and future stability of the Sahel. In the next section, we emphasise the need to complement environmental strategies tackling climate change through reinforcing human capital within individuals and families. We explain how girls' education and family planning are powerful strategies to enhance the resilience and adaptive capacity of vulnerable populations, despite the ambivalence about family planning in the region.

In the following section, Resilience across Sectors, we examine the multisectoral interplay between various sectors including food security, health, education and environment, as they relate to climate change resilience. We highlight the disproportionate effect of environmental changes on women and girls and question the emphasis on military overdevelopment solutions to quell crises in a volatile region.

In the section, Policies and Programs in the Region, we explore policy trends in family planning, education, and climate change, urging policy makers and

governments to employ more integrated and prevention-oriented strategies. We conclude by underscoring the need for systems thinking, and the urgency of investing in women and girls' resilience to improve population health and regional stability.

## Population Dynamics in the Sahel

### *Defining the Sahel*

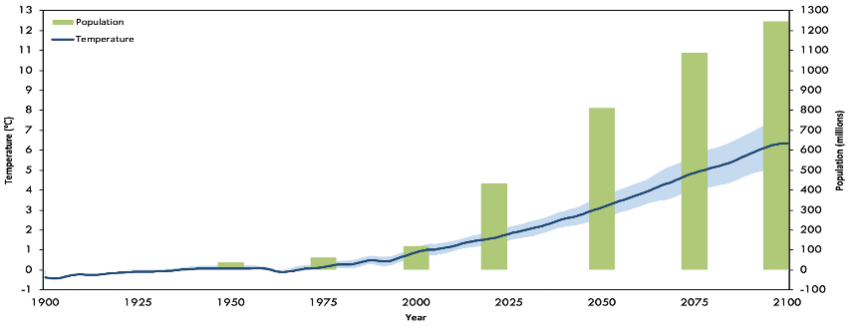
The Sahel, a 1,000-kilometre arid and semi-arid zone between the Sahara Desert in the north and savannahs in the south, expands across ten countries: Senegal, Mauritania, Burkina Faso, Mali, Niger, Nigeria, Chad, Sudan, Eritrea and Ethiopia. We selected this region due to its extreme vulnerability to climate change and its ongoing challenge with health, education and food security. With a projected average surface temperature rise of 3°C to 5°C by 2050, agriculture, pastoralism and watersheds are at risk. To save lives and preserve regional stability, the Sahel requires international attention and collaboration. (Tesfaye, 2022; World Bank, 2021b).

Most interventions seeking to reduce the Sahel's vulnerability employ livelihood and environmental strategies to boost communities' resilience. These include water conservation, biodiversity protection, restoration of degraded land, diversification of income sources, strengthening infrastructure and establishment of early warning systems. Despite the importance of these approaches, this paper focuses on two less common but equally essential strategies: girls' education and voluntary family planning, which foster resilience and adaptive capacity in individuals and families.

In 1950, the Sahel was sparsely inhabited by fewer than 50 million people. By 2050, the UN's medium variant population projection is 912 million across the ten countries mentioned above. (Figure 2). (UNPD, 2023). Except for Eritrea, Ethiopia and Senegal, contraceptive uptake has been slow in the region (Measure DHS, 2023) and the total fertility rate (TFR)[5] ranges from 3.7 in Eritrea to 6.5 in Niger (Macrotrends, 2023). These demographic trends have serious implications for food security, migration, employment, quality of life and peace for the residents.

5 The total fertility rate (TFR) is the average number of children a woman is likely to bear in her lifetime.

**Figure 2. Projections for changes in temperature and population in the Sahel**




DATA SOURCES: UN POPULATION DIVISION, 2014; TAYLOR ET AL., 2012.

*Meeting the Needs of Women and Girls*

From 1970 to 2000, several Asian countries with initial fertility rates between five and six achieved dramatic declines in fertility and mortality which led to demographic dividends and boosted economic growth. Success factors included strong political will to invest in health and education, well-implemented population and health policies and expanded access to family planning (Gribble and Bremner, 2012). The Sahel defies demographic trends observed globally, as fertility has not declined as expected with mortality decline. (Guengant and Lahmani, 2012).

The role of women's reproductive autonomy in a demographic transition is often overlooked. Girls' education and family planning programmes help individuals and families achieve desired family size by providing information and supplies for informed decisions. In the Sahel, where children bring status and many people question the safety and social acceptability of modern contraceptives, change is slow. However, with improved access, once community members witness the health and economic benefits of contraceptive use, interest and uptake often grows.

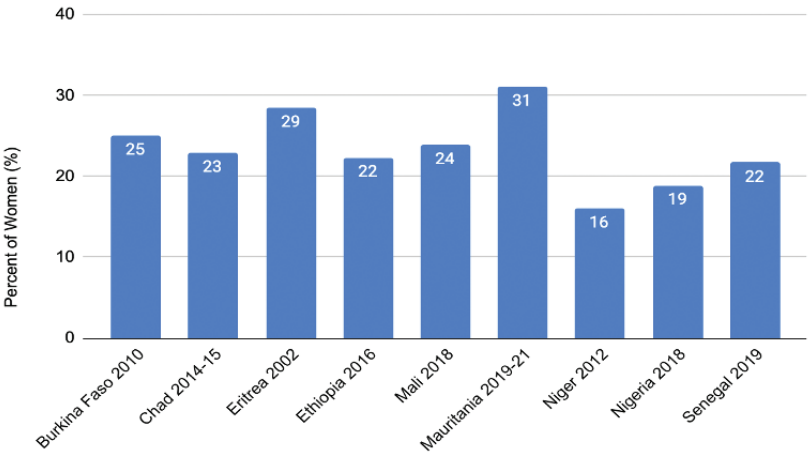
Girls' education indirectly affects fertility by expanding livelihood options for young women and increasing their income-generating potential, which affect their ability to influence strategic life decisions. Being in school also reinforces the fact that girls are still children who are not yet ready for marriage, thus serving as a deterrent to child marriage (Perlman et al, 2017). Higher educational attainment correlates with a lower desired family size as self-determination and economic opportunities for women increase (Bongaarts, 2020). Education has a significant impact on demographic trends because a higher age of marriage delays childbearing. This protects the health of women and children while also lowering total fertility (Sterling, Winthrop and Kwauk, 2016). For example, in Ethiopia, each additional year of girls' schooling led to a 6–7 per cent decline in early marriage and childbearing. A two-year increase in the median age of first birth could reduce population growth by ten per cent (Hugh and Ramanarayanan, 2019).

Of the ten focal countries, in 2023, only Ethiopia and Eritrea had a total fertility rate below four children per woman. Family planning remains a sensitive issue for leaders and policymakers in the Sahel. Some leaders have made it a public priority, while others are concerned about dwindling natural resources and strained social safety nets, but do not know how to tackle the problem. Many others avoid the subject in the face of cultural or religious opposition. The combined legacy of this ambivalence is weak population policies, under-prioritisation of family planning programmes and the world's fastest growing population (Guengant and Lahmani, 2012).

Leaders are not the only ones with reservations about family planning. It is viewed with wariness in many Sahelian communities due to patriarchal norms, cultural and religious values, and a mistrust of external actors who arrive with various agendas. Except for Ethiopia that has a 41 per cent contraceptive prevalence rate (CPR), the CPR is low, ranging from 5 per cent in Chad to 26 per cent in Senegal (Measure DHS, 2023). Some policymakers have misconstrued the preference for large families as fixed, signalling a disinterest in contraception. However, low contraceptive prevalence doesn't necessarily reflect demand. Women's desire to manage their fertility is high, with 16–31 per cent of non-contraceptive-using married women wanting to delay or stop childbearing (Measure DHS, 2023).

Understanding and addressing the contraceptive needs of men, women and youth is paramount. Unmet need refers to the percentage of women who want to stop or delay childbearing but who are not using contraception (Measure DHS, 2023). Eliminating legal, institutional and geographic barriers, as well as reducing or removing user fees, would make contraceptive methods available to interested individuals, regardless of age, financial status or sociocultural barriers. Family planning is a voluntary choice, not a mandate: there is enough work to be done in meeting the needs of those who are interested in contraceptive use.

**Figure 3. Unmet need for family planning among married women in the Sahel**




SOURCE: DEMOGRAPHIC AND HEALTH SURVEYS. 2023. STAT COMPILER.

*The Hush Around Population and Environment*

In alignment with a rights-based approach to reproductive health, donors and organisations often avoid discussing fertility rates and environmental sustainability in the same breath. Though well-meaning, this approach has unintended consequences for vulnerable populations, including women and girls. Upholding women's rights is essential but the reluctance to address the linkages between these two topics limits funding and hinders progress towards environmental sustainability and population health (Mayhew et al., 2020).

The words "population" or "family planning" are rarely mentioned in high-level environmental policy discussions. Policies and programmes related to climate change (e.g., agriculture, water and natural resource conservation) seldom mention population dynamics, or the interventions that influence it, like girls' education and family planning. Yet, the connections are clear: land use patterns and natural resource scarcity directly impacts community health and resources. For example, soil degradation, exacerbated by global warming, has diminished the productivity of inherited land over generations. In communities with large families, the subdivision of inherited land parcels over generations reduces the viability of the land (Giller et al., 2021). Conversely, investments to enhance access to and quality of girls' education and family planning could yield distinct socio-environmental benefits, from climate change mitigation (e.g. reduced emissions) to resilience (e.g. higher incomes) to adaptation (e.g. climate-smart agriculture) (Jameel et al., 2022).

## Resilience Across Sectors

*Relationship Between Climate, Food Security and Nutrition*

Food insecurity is a major challenge in the Sahel region: emergency food assistance needs nearly quadrupled from 2015 to 2022. In 2022, an estimated 34 million people faced food insecurity, including 2.4 million children with severe acute malnutrition (European Commission, 2014). Volatile food prices exacerbate the issue, leading to reduced protein consumption and difficulty purchasing staple grains. Severe consequences arise when families must sell productive assets, which traps them in debt and chronic food insecurity.

Rising temperatures and increasing extreme climatic events reduce cereal yields, damage livelihoods and worsen food insecurity (Schlenker and Lobell, 2010; Sultan et al., 2013). Chronic low crop yields and sudden losses due to drought or floods significantly impact health and human potential, threatening individuals, communities and nations (Stephenson et al., 2000). Concurrently, arable land is becoming desert, which will render larger parts of the Sahel uninhabitable by the end of this century (Intergovernmental Panel on Climate Change, 2021).

Climate-related conflicts in the Sahel threaten vulnerable families' food security. Pastoralists have to travel longer distances to feed livestock, leading to clashes with farmers stressed by heatwaves, drought, floods and pests. Lacking access to

information, agricultural inputs and credit, farmers of both genders need support to optimise yields (Potts et al., 2013). Women and girls from both agricultural and pastoralist families also need protection from gender-based violence as they travel farther for water, fuel and fodder.

Climate change directly impacts women and girls by increasing their daily labour, reducing time for girls to attend school and for mothers to care for children (World Food Programme, 2021). Multinational corporations contribute to nutritional deficits in children by aggressively marketing pre-packaged foods to mothers who have less time to cook and care for children. (UNICEF, 2021).

*Relationship Between Nutrition and Resilience*

Under-nutrition starts in utero, when a pregnant woman's nutritional deficiencies affect her and her developing child (Conde-Agudelo et al., 2012; Kaplan, 1972). Poor diet, overwork and disease during pregnancy increase the risk of intrauterine growth restriction, preterm birth and low birth weight. The first 1000 days of life are critical for a child's cognitive and physical development; malnutrition at this juncture has lasting consequences (Ruel and Alderman, 2013).

Children in the Sahel are susceptible to *marasmus* and *kwashiorkor*, two types of protein-energy malnutrition that can result in wasting, stunting or underweight conditions. Marasmus usually affects infants after sudden onset emergencies. Kwashiorkor, meaning "the sickness the baby gets when the new baby comes" often affects one to five-year-olds who experience chronic protein deficiency over time (Pham et al., 2021).

Low contraceptive use leads to short birth intervals and early weaning, exposing infants to malnutrition and illness (Manda, 1999). Poor dietary diversity impairs growth and increases susceptibility to infection (e.g. diarrhoea), trapping the poorest families in chronic, intergenerational health issues (Grantham-McGregor, 2002).

From 2000–2016, childhood stunting in West and Central Africa increased by 20 per cent (23 to 28 million), while the rest of the world saw a decrease (UNICEF, n.d.). Current stunting rates range from 23 per cent in Mauritania to 44 per cent in Ethiopia, Eritrea and Niger (Measure DHS, 2023). Stunting compromises growth

and cognitive potential (Kaplan, 1972), with impact varying by gender. Stunted girls face increased risks of obstructed labour, fistula, stillbirth and maternal mortality. To effectively prevent stunting, nutritional interventions must target pregnant women and mothers of children aged 0–18 months, before the impact is irreversible (Velez et al., 2007).

**Table 1. Indicators of nutritional status among children under five years old in the Sahel**

| Country | Under five mortality median rate per 1000 live births* | Moderate + Severe Stunting (%) | Exclusive Breastfeeding <6 months (%) | Complementary feeding 6–8 months (%) | Zero Fruit and Vegetable Consumption (6–23 months) |
|---|---|---|---|---|---|
| Burkina Faso | 85 | 26 | 58 | 61 | 26 |
| Chad | 110 | 35 | 16 | 71 | 48 |
| Eritrea | 39 | 49 | 69 | 44 | n/a |
| Ethiopia | 49 | 35 | 59 | 69 | 69 |
| Mali | 91 | 26 | 40 | 59 | 44 |
| Mauritania | 71 | 24 | 40 | 74 | 51 |
| Niger | 78 | 47 | 22 | 80 | 43 |
| Nigeria | 114 | 35 | 29 | 74 | 53 |
| Senegal | 38 | 17 | 41 | 64 | 52 |
| Sudan | 57 | 34 | 55 | 61 | 67 |
| Cut-off indicative of public health problem | | ≥20 of concern | good is ≥ 50 | good is ≥ 80 | |

SOURCES: ADAPTED FROM WEUHLER, HESS AND BROWN, 2011; UN DATA WAREHOUSE, 2022

Table 1 includes indicators of child health that influence the physical and intellectual potential of future generations. Family planning, exclusive breastfeeding and safer weaning have the potential to improve children's outcomes, but undernutrition will remain the primary driver of child deaths attributed to climate change (World Food Programme, 2021). Climate change exacerbates childhood malnutrition through reduced yields, less parental care time and increased disease exposure. Undernourished populations are less productive and less resilient to climate shocks (Tirado et al., 2013).

To uphold the basic rights of communities living in the Sahel region, the global community needs to address structural factors that increase vulnerability. Improving knowledge and behaviour related to exclusive breastfeeding,[6] birth spacing and sanitation/hygiene is one step (Labbok, 1994). Promising data from radio programmes and other 'edutainment' approaches have successfully stimulated an uptake in contraceptive use and more equitable spousal decision-making (Sarrasatt et al., 2018; Jah 2014).

Diversifying income sources and implementing social safety net programs, such as fortification of staple grains, school feeding programs, vouchers for education or healthcare and cash-for-work programs are important investments for communities with climate-dependent livelihoods (UNICEF, 2021). Agroecological interventions like tree or shrub planting provide long-term benefits, including shade, food, fuel and fodder, which can protect the nutritional status of marginalised families and reduce the need to migrate in the lean season (Tirado et al., 2013). The resultant gains in health, nutrition and cognition contribute to higher educational attainment, increased workforce productivity and enhanced resilience against climate change impacts (Ruel and Alderman, 2013).

*Relationship Between Family Planning and Resilience*

Integrating family planning into food security, nutrition and climate interventions is an often-overlooked strategy for improving nutritional status and increasing household resilience to shocks (Hardee et al., 2018). While family planning is often considered unrelated to the core objectives of non-health sectors – and outside of the expertise of implementing organisations, cross-sectoral collaboration is

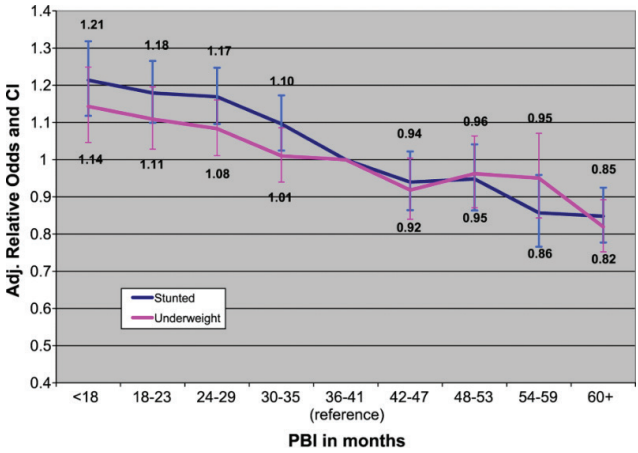
6 Exclusive breastfeeding, or Lactational Amenorrhea Method, optimises child nutrition while providing protection against pregnancy for postpartum mothers.

advantageous. Family planning could positively impact all of the UN Sustainable Development Goals by transforming people's ability to adapt to crises, including environmental ones (Smith and Woodward, 2014; Bremner et al., 2015).

Organisations and projects from non-health sectors that partner with reproductive health initiatives, particularly those targeting adolescent girls, pregnant or postpartum women and mother-child dyads, could strengthen household resilience and adaptive capacity. By integrating reproductive rights, communities can enhance their ability to adapt to climate shocks through health, education and greater economic stability.

Family planning prevents malnutrition and improves the resilience of vulnerable populations through birth spacing. Studies show reduced risk of stunting and undernutrition with a pregnancy interval of at least 24 months. The risk decreases further as birth intervals widen to three or more years (Gribble, Murray and Menotti, 2009; Rutstein, 2005). In a systematic review of 22 countries, most saw a reduction in stunting of ten to fifty per cent with pregnancy intervals of over 36 months (Dewey and Cohen, 2007). Figure 4 demonstrates how the risks of stunting and underweight decrease as birth intervals increase.

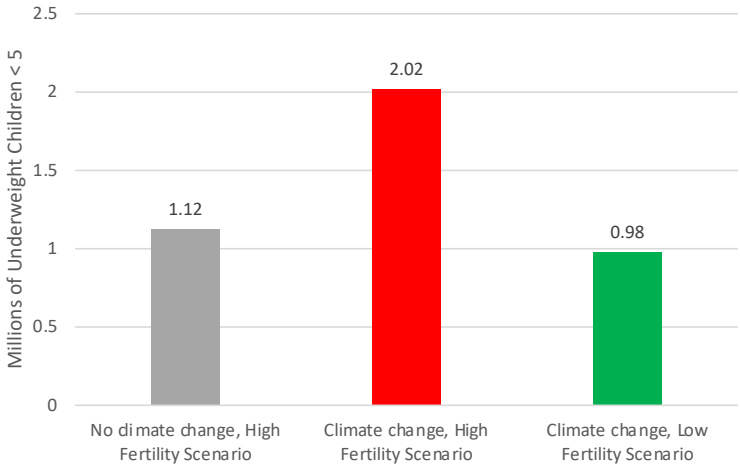
**Figure 4. Impact of preceding birth intervals (PBI) on reducing stunting and underweight**




SOURCE: RUTSTEIN, 2005. WITH THANKS TO SHEA RUTSTEIN FOR PERMISSION TO USE

Improved access to family planning could reduce malnutrition rates by enabling couples to space births or end childbearing when they choose to do so. A study modelling potential outcomes for food security in Ethiopia compared the projected shortfall in calories using the UN's low versus high fertility projections (Figure 5). The model shows that achieving the lower fertility projection could nearly cancel out the adverse impact of climate change on caloric intake for children – with 51 per cent (roughly 100 million) fewer malnourished children by 2050 (Moreland and Smith, 2013).

**Figure 5. Malnourished children in Ethiopia: three projected scenarios for 2050**




SOURCE: ADAPTED FROM MORELAND AND SMITH, 2013

From 2014 to 2020, the United States spent $809 million on peace and security in the G5 nations, compared to $65 million on family planning (US Foreign Assistance Explorer, 2022). An additional $107 million from the global community is still needed to meet the current levels of unmet need for family planning (OASIS, 2021).

Investing in universal access to contraceptives has long-term benefits that exceed direct investment in military solutions and public health campaigns. The Copenhagen Consensus shows that every US dollar invested in access to family planning yields US$120 of improved economic output, far surpassing yield

per dollar spent on in peacekeeping (US$5), childhood malnutrition (US$45) and scaling up immunisation programmes (US$60) (Herzer Risi et al., 2022; Copenhagen Consensus, 2015). These data call for a critical examination of how overseas aid and government investments are being allocated in the Sahel (Blankespoor et al., 2010). European and American donors, as well as Sahelien governments, have spent a lot more money addressing the social and economic consequences of natural and man-made disasters than investing in programmes that could prevent them from occurring.

*Relationship Between Education and Resilience*

Girls' education is associated with smaller families and greater investments in future children's nutrition, health and education (Population Reference Bureau, 2015). Exposure to formal education promotes the skill of advance planning, broadens perspectives and facilitates adaptability and risk assessment. It increases access to diverse livelihood options and is linked to stronger social capital, social support networks and better access to communication technologies (Muttarak and Lutz, 2014). Supporting girls' autonomy and leadership skills is the foundation for their future engagement in community life, politics or environmental conservation. A 72-country study that ran over three decades found a positive association between women's participation in civil society and positive environmental outcomes, including a reduction in carbon emissions (Lv and Deng, 2019).

Education is critical for mitigating and adapting to climate shocks in agriculture, pastoralism or business. A Nepali study found education to be more strongly associated with reducing vulnerability to natural disasters than income or wealth, in terms of human lives lost, animals lost and damage to households (KC, 2013). Investing in girls' education may offer wider climate resilience benefits than direct emergency preparedness because of its role in advancing gender equity, which also lowers climate vulnerability (Blankenspoor, 2010). Furthermore, numerous studies show that countries with higher proportions of women in parliament or government positions are associated with greater ratification of environmental treaties and action to protect land (Norgaards and York, 2005; Nugent and Shandra, 2009).

Between 2014 and 2020, total investments in education for the G5 Sahel were about US$246 million annually, but still only a quarter of what is needed (OASIS,

2021). In 2018, over half of the funding requested for food and nutritional aid in the Sahel was received, while only seventeen per cent of the aid requested for education was received (UNOCHA, 2018). This trend has remained steady over time, with the amount requested for education in 2021 being barely a fifth of that for food security (UNOCHA, 2022).

## Policies and Programmes in the Region

While a comprehensive policy analysis is beyond the scope of this paper, the sections below mention policies and regional initiatives related to: a) family planning b) girls' education and c) climate change adaptation.

### *Family Planning: Policies and Programmes*

West African governments, with the exception of Ghana, were not focused on population growth until the mid-1980s (Caldwell and Sai, 2007; UNPD, 2010). Senegal was the first francophone African country to adopt a population policy and by the 1990s, most neighbouring countries had done the same, but this did not lead to a significant increase in contraceptive use in the Sahel region (Guengant and Lahmani, 2012).

In February 2011, a major regional effort to revitalise family planning in the francophone Sahel was launched when nine West African countries signed the Ouagadougou Declaration for Population, Development and Family Planning. The countries and donors of the Ouagadougou Partnership (OP) integrated family planning into national development plans and poverty reduction strategies, scaled-up training, decentralised services and encouraged governments to increase budget line items to support programmes (UNFPA, 2011). Ten years later, the program had surpassed expectations – there were over three million new contraceptive users and funding from core donors had more than doubled (Fleishman, 2020).

Countries in the region seized this opportunity in numerous creative ways. Ethiopia focused on policy change, outreach and demedicalisation, increasing the contraceptive prevalence rate (CPR) from 6 per cent to 37 per cent between 2010 to 2022. Burkina Faso changed policies, implemented a solid plan for contraceptive security and supported mobile outreach: its CPR rose from 17 per cent in 2012 to 31 per cent in 2022 (Measure DHS, 2020; Track 20, 2023).

Senegal's awareness campaign promoting birth spacing included debates on television, press coverage and radio programs about this previously taboo topic. With support from politicians, lawyers, entrepreneurs and religious leaders, a monumental shift in norms took place in Senegal which currently has a CPR of 28 per cent and a TFR of 3.7 (Gates, B. and Gates M., n.d., Track 20, 2023).

Despite these gains, political instability in the Sahel region threatens the progress made in the health and education sectors by diverting government resources from development to the military, resulting in school and health centre closures and unsafe roads for civilians. Besides risks brought by extremist groups, conflicts over access to land due to climate change and population pressure have heightened tensions between pastoralists and farmers. The current security situation underscores the need for regional cooperation in the Sahel because instability spills quickly across porous national borders.

*Girls' Education: Policies and Programmes*

Despite global support for universal education, extreme poverty hinders equal access. Household poverty was the primary factor for school dropouts in a study of 63 developing countries from 2005–2011 (UN, 2013b). School-related costs account for 25 per cent of poor families' budgets in Africa (UN, 2013a), while families in countries with the highest GDP spend only 10 per cent of their budget on education (World Bank, 2021b). Mali, Niger, Chad and Burkina Faso are in the lowest quintile of GDP per capita and have the highest proportion of their populations living in extreme poverty.

Universal primary education has been a top global priority for decades. Ethiopia, Burkina Faso, Sudan and Nigeria made significant progress, with current primary school completion rates ranging from 64 per cent to 74 per cent. However, completion rates in Mali, Chad, Eritrea and Niger remain low, between 45 per cent and 58 per cent (WB/UNESCO, 2022). In Chad, Burkina Faso, Ethiopia, Mali and Niger, only 26–40 percent of girls aged 11–15 attend school (UNICEF, 2017). The G5 Sahel region also has one of the highest pupil-teacher ratios (1:41) worldwide, triple that of industrialised countries (Leist, 2022). This untenable ratio, paired with insufficient resources for teacher training and supplies, reduces educational quality. Over half of primary students in the Sahel graduate without meeting minimum literacy or numeracy standards (Leist, 2022).

Social protection programmes that have abolished school fees, used conditional cash transfers and established school feeding programs have improved enrolment rates (African Development Bank, 2013). In the past fifteen years, at least seven sub-Saharan countries saw explosive growth in primary school enrolment after eliminating school fees. One study in five African countries found that removing fees led to a 12–51 per cent increase in enrolment within a year and improved gender parity. However, attracting more students can present new challenges; in Malawi and Mozambique, for example, education quality declined when school fees were abolished, with teacher-student ratio rising to 1:66 to 1:74, respectively, over two years (World Bank / UNICEF, 2009).

Demographic trends, often overlooked in the field of education, significantly impact educational quality. From 2000–2011, Africa added 32 million primary school age children to its rosters (UN, 2013b). In the Sahel, schools need to make room for one million new school-aged children every year, forcing education systems "to sprint to stay in place" (World Bank, 2021b).

Although the education sector in the Sahel needs funding, governments must also address pressing humanitarian and environmental crises. Students and schools across the Sahel have been targeted by extremist groups, leading to fear and displacement. From 2017 to 2019, Burkina Faso, Mali and Niger suffered a six-fold increase in school closures due to insecurity (World Bank, 2021b). Environmental crises equally weaken the education sector, as aid for rebuilding schools during droughts or floods is often insufficient. While food aid remains a top priority, greater funding for education can enhance the long-term effectiveness of humanitarian aid by reducing vulnerability, increasing incomes and decreasing the number of people needing help in future crises.

Between 2015–2019, the World Bank disbursed US$212 million dollars for the Sahel Women's Empowerment and Demographic Dividend Project (SWEDD), aiming to promote education, women's earning potential, gender equity and demographic change in nine African countries. Though designed and managed externally, SWEDD had a significant impact. From 2015 to 2020, it provided financial support for schooling to around 160,000 girls, established over 3,400 safe spaces for out-of-school girls and provided vocational training to 20,000 young women. Additionally, 6,400 religious leaders promoted girls' education

and family planning and 24,000 young men participated in programs addressing violence and fostering gender equity (World Bank, 2020). In 2020, Phase Two of SWEDD began with a commitment of US$376 million and US$72 million has been disbursed so far.

The Nouakchott Declaration, signed by G5 Sahel leaders in 2021, is a recent regional framework aiming to enhance education quality in the Sahel. It outlines four main objectives: supporting teachers, improving learning environments, increasing educational spending from 3 per cent to 4 per cent of GDP by 2030 and prioritising out-of-school children's needs (World Bank, 2021a). The implementation of this declaration is yet to be observed.

*Climate Change: Policies and Programmes*

In 2009, high-emitting countries pledged US$100 billion annually from 2020–2025 to help low-income countries combat climate change. This commitment has remained only partly fulfilled. Eleven African countries, including Chad, Eritrea, Ethiopia, Sudan, Mali and Mauritania, whose greenhouse gas emissions are 27 times below the global average, now face climate adaptation costs exceeding their national healthcare budgets. In future years, climate adaptation costs to safeguard livelihoods are likely to compete with development funding (Tearfund International, 2022).

In 2022, the UN COP27 in Egypt concluded with a historic decision to set up a fund for countries most affected by unpreventable climate disasters (UN Climate Change, 2022). However, family planning and girls' education were not included as climate adaptation strategies in National Adaptation Plans at COP27. These topics have been largely ignored in climate discussions and funding streams (Mogelgaard, 2018). Major funds, such as the Green Climate Fund and the Adaptation Fund, have not yet incorporated these interventions as priorities (Adaptation Fund, 2022; Green Climate Fund, 2022). Unless family planning and education are integrated into national climate adaptation plans, they will not be considered when allocating climate change adaptation funds in the future (Patterson et al., 2021).

## Conclusion

Population dynamics, human health and environmental health are inextricably linked. Insufficient attention to any of these three factors could make current

challenges in the Sahel insurmountable. Over 11,000 global scientists assert that the climate emergency should not be considered a standalone environmental problem (Ripple et al., 2019). The Intergovernmental Panel on Climate Change (IPCC) also emphasises that gender equity and social justice are core elements of strategies aiming to limit temperature increases below 1.5 degrees Celsius (IPCC, 2018).

Global initiatives for environmental sustainability and climate change have not paid sufficient attention to the importance of population dynamics and to women's self-determination. Two key interventions – voluntary family planning and girls' education – offer positive spill-over effects on demographic trends, nutrition, employment, health, climate resilience and adaptive capacity. Considering these numerous benefits, girls' education and family planning should be prioritised when budgets are being drawn up to tackle humanitarian and environmental crises.

In the Sahel, women's lives will be increasingly affected by climate change. They had no role in creating this crisis, yet they are on the frontline facing its impact. The health of future generations – and of the planet – will hinge on whether the global community invests sufficiently in women and girls, who are uniquely positioned to build human resilience from within their households for a multigenerational ripple effect.

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COMMENTARY

# Population dynamics, urbanisation and climate change in Africa's intermediate cities: what can family planning contribute?

Sunday A. Adedini[1]

## Abstract

*Africa's large cities are rapidly urbanising and are becoming expensive, regressive and unhealthy; hence, secondary or intermediate cities have become the continent's backbone for absorbing most of the urban population growth. Africa's intermediate cities will be home to more than half its urban population by 2030. However, these cities have considerable investment gaps in critical infrastructure: consequently, they are less resilient and face disproportionate disasters and risks of climate stressors and other environmental challenges. The vulnerabilities of Africa's intermediate cities are exacerbated by rapid urbanisation and inappropriate planning. As Africa's intermediate cities continue to experience population growth and rapid urbanisation occasioned by a youthful population, high fertility and excess of births over deaths, family planning is one of the most critical investments that city leaders and officials can make to ensure a slow urban population growth and thus buy sufficient time for governments to put critical hard infrastructure and appropriate planning in place to support healthy living. Increased investment in family planning will contribute to prosperous and resilient intermediate cities in Africa.*

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## Keywords
Population dynamics; climate change; urbanisation; intermediate cities; family planning; Africa

## Introduction
As Africa continues to urbanise, secondary or intermediate cities are increasingly becoming a buffer for the ever-expanding urban population. The United Cities and Local Governments (UCLG) defines intermediate cities as those with a population of less than one million, though this figure may vary from one country to another (Bolay and Kern, 2019; Rankin, 2019). An intermediate or secondary city may be the capital city of a second-tier administrative unit or the seat of a country's sub-national government such as a county, province, or state. It may also be a cluster of smaller cities within a metropolitan area (Rodríguez-Pose and Griffiths, 2021). Intermediate cities are important and are home to more than half of the world's urban population (Bolay and Rabinovich, 2004; Bolay and Kern, 2019). They play a critical role and serve as a linkage between rural and urban centres, albeit they are often not prioritised in national planning.

The importance of intermediate cities is often underestimated in research and discourse on issues regarding population dynamics, urbanisation and climate change. Most studies on population dynamics and the crises of urbanisation and climate change have focused mainly on large and capital cities (Hove et al., 2013; Zulu et al., 2011). Massive population increase in many of Africa's major cities has overwhelmed infrastructure, thereby causing difficult access to basic services such as transportation, housing, quality and affordable education and health care, as well as adequate sewage and waste management. Recent evidence shows that some of Africa's major cities are regressing, thus leading to the exacerbation of environmental and socioeconomic challenges (UNICEF and UN Habitat, 2020).

Africa's large cities such as Cairo, Lagos, Kinshasa, Dar es Salaam, Johannesburg, Nairobi, Lilongwe, Accra, etc. have received much policy and programmatic attention while intermediate cities are less catered for. However, around fifty per cent of the world's urban population lives in intermediate cities (Bolay and Kern, 2019). Evidence is sparse on the proportion of the African population living in intermediate cities. However, available evidence shows that about a third of the

sub-Saharan African population lives in secondary or intermediate cities compared to ten per cent who inhabit large cities (Satterthwaite, 2016). Thus, intermediate cities in the region deserve more programmatic and policy attention.

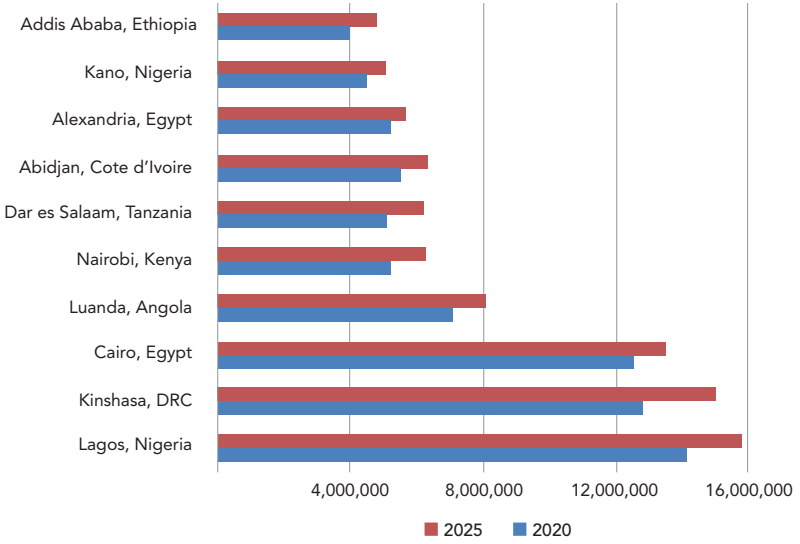
Some of the recent global health threats, such as the climate change crisis, appear to affect the residents of Africa's intermediate cities more than those who live in the continent's large cities. For instance, many of Africa's intermediate cities are agrarian societies whose crop production is affected by droughts, crop failure and famine due to climate change (Guzmán et al., 2009). Other climate change crises that affect intermediate cities are natural disasters, flooding and health hazards (Kumar, 2021; Leichenko and Silva, 2014; Satterthwaite, 2008). Recently, severe flooding and landslides due to heavy rainfall led to the death of nearly 500 people with about 40,000 individuals displaced in KwaZulu Natal, South Africa (Reliefweb, 2022). Further, scholars and policymakers have warned that many intermediate cities, particularly those in coastal or equatorial areas, may face disproportionate risks of climate stressors and shocks (Harman, 2021; Kumar, 2021; Zerbo et al., 2020). The vulnerabilities of these cities are exacerbated by rapid urbanisation, inappropriate planning, and limited financial, infrastructural, and human capacities occasioned by poor government attention. Thus, twenty-first century urban and territorial planning needs to give more attention to intermediate cities.

## The growth of Africa's urban population and intermediate cities

Historically, the period following the Second World War was characterised by two remarkable global features: the vigorous pursuit of socio-economic development and rapid population growth (Mathur, 1984; UNICEF and UN Habitat, 2020). These two phenomena led to rapid urbanisation, particularly in developing countries. Figure 1 shows that many African large and capital cities have experienced rapid population growth. Many of these cities have become unmanageable. Some of the challenges faced by the residents of these cities in Africa include overcrowding, limited job opportunities, poverty and poor liveability, housing problems, air and noise pollution, conflict and heightened criminality, as well as heavy traffic – with commuters losing several hours to gridlock daily. These challenges largely stem from the problem of rapid urbanisation, with the large number of residents occupying a relatively small amount of space. For instance, in Nigeria, more than 15 million individuals live in the smallest state, Lagos, which has a land area of just 3,577 $km^2$, while the largest, Niger State, has a total population of less than

4 million occupying 76,363 km$^2$ (Lagos Bureau of Statistics, 2022; Niger Bureau of Statistics, 2012, 2022). In Ghana, Accra covers an area of 225.67 km$^2$ with an estimated 4.2 million population (Atenvo, 2022).

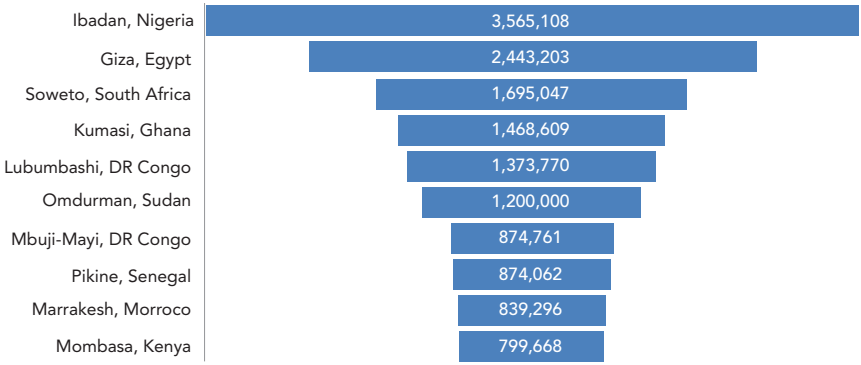
**Figure 1. Ten most populous cities in Africa**




SOURCE: UNITED NATIONS HUMAN SETTLEMENTS PROGRAMME (UN-HABITAT, 2020)

The situation of high population density and rapid urbanisation is common across large cities in Africa. As a result, intermediate cities have become attractive to rural-urban migrants in many countries, thus leading to an increasing percentage of the urban and national population residing in intermediate cities (Satterthwaite, 2016). Several secondary or intermediate cities in many African countries have experienced phenomenal growth in population size. Figure 2 shows that intermediate cities such as Giza, Kumasi, Ibadan, Lubumbashi, Mombasa, Omdurman, Soweto, etc. now have large populations.

**Figure 2. Population of selected African intermediate cities**




SOURCE: WORLD POPULATION REVIEW (2022)

## Urbanisation, climate change and intermediate cities in Africa

It is important to recognise the complexity of urban dynamics in large and intermediate cities. While research, policy, and programmatic attention have largely focused on issues of environmental challenges and climate change in large cities, the need for a recognition of the vulnerabilities of intermediate cities to the crises of climate change and other environmental problems has been canvassed in the literature (Harman, 2021; Simon et al., 2021). A review of the literature shows that little is known about how intermediate cities respond to sustainability challenges such as environmental problems and climate change (Simon et al., 2021). However, a recent study shows that 84 per cent of the fastest-growing cities (many of which are intermediate cities in Africa) are at great risk (Harman, 2021). The high exposure of intermediate cities to the crises of climate change and other environmental problems is largely due to the preponderance of poor and vulnerable populations in those cities as well as their lack of disaster mitigation structures and poor healthcare systems (Harman, 2021). While intermediate cities are Africa's backbone for absorbing most of the continent's urban population growth, they face considerable investment gaps in critical infrastructure (AfDB and Alliance, 2022). There is need for investments in disaster management and mitigation and healthcare systems of Africa's intermediate cities to enable them cope with the crises of climate change and other broad environmental challenges.

One of the events marking the 2022 Africities Summit in Kisumu, Kenya was the release of a report by the African Development Bank and Cities Alliance entitled 'Dynamics of Secondary Cities in Africa: Urbanization, Migration and Development'. There is a need for a concerted effort by African governments and their partners to implement the recommendations of this report and other agendas that seek to ensure the resilience and preparedness of intermediate cities against the challenges of climate change and other developmental challenges.

## Roles of family planning towards building resilient and sustainable intermediate cities

Future population growth will mainly happen in urban areas of developing countries, particularly in sub-Saharan Africa and south Asia (Saghir and Santoro, 2018; Srivastava, 2020). Africa's urban population growth rate averaged around 3.9 per cent (World Bank, 2022b) and the continent's urban population is projected to increase from 472 million to over 1.3 billion by 2050 (Mo Ibrahim Foundation, 2015). Intermediate cities in Africa will also continue to grow and will account for more than half of urban population growth by 2030 (Roberts, 2015; Satterthwaite, 2016). Although rural-urban migration is a contributing factor to urbanisation in Africa, natural population increase (excess of births over deaths) remains a major determining factor (Adedini et al., 2022; Harpham et al., 2021; Montgomery et al., 2013). While life expectancy has continued to increase in Africa, fertility rates have remained high, with the average total fertility rate in 2020 standing at 4.6 (World Bank, 2022a). And, while progress has been made, stalls or reversals in fertility decline have been experienced in many countries (Schoumaker, 2019). Thus, to achieve fertility transition in Africa's intermediate cities, urgent action is required.

The role of family planning in ensuring fertility transition, and healthy and sustainable intermediate cities, is crucial, particularly in sub-Saharan Africa. United Nations' Sustainable Development Goal 11 aims to make cities and human settlements inclusive, safe, resilient and sustainable. In line with this goal, family planning can serve as a strategic tool and contribute toward building prosperous, healthy and sustainable urban areas in Africa. According to the AfDB & Alliance's (2022) report, family planning services have desirable effects at an urban and rural level and can serve as part of a critical economic empowerment programme especially for women to enable them to control their fertility and desired family size and then align their occupations with maternal or

family obligations. However, as of 2022, an estimated 20 million urban women of childbearing age in African cities who would like to use family planning methods do not have access to reproductive health services (Standard, 2022). Poor access to quality family planning often leads to unintended pregnancies, unsafe abortion or unwanted births.

Due to the high unmet need for family planning and high rates of unintended pregnancies and unwanted births, many African cities will continue to have high fertility and rapid population growth. As a result, cities will find it difficult to optimally meet basic needs such as housing, adequate nutrition, potable water, road, sanitation, education, healthcare, employment, etc. With rapid urbanisation, no amount of investments in hard infrastructure by city Mayors and municipal officials will be able to keep pace with rapid urban population growth in African cities. Intermediate cities in particular will face much greater challenges than large cities due to gaps and neglect of the former in terms of investments in critical infrastructure. As African countries strive to build the necessary infrastructure to make their intermediate cities resilient and prosperous, family planning will be one of the most critical investments to help cities gain sufficient time for the proper city and territorial planning that is congruent with sustainable and healthy socio-economic development. This will contribute to the wellbeing of individuals, families, communities and the nations at large. Investment in family planning will contribute to climate change adaptation and promote rights-based development. Africa's intermediate cities will benefit greatly from family planning programmes that respect human rights. Africa must make increased investments in family planning to address the unmet need for contraceptives, especially among the vulnerable urban population, including the urban poor, slum dwellers, and adolescents.

## Frontiers for future research

Given the critical roles of intermediate cities in Africa, more research on a wide range of issues (such as environmental, socioeconomic, health, urban dynamism and resiliency) is needed in the relatively less known African cities. Currently, little evidence is available about how intermediate cities respond to their various environmental challenges and climate change. There is an urgent need for research on the crises of urbanisation and climate change in Africa's intermediate cities.

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SPECIAL ISSUE

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